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FINAL
PRELIMINARY ASSESSMENT
Main Installation
Naval District Washington
Indian Head, Maryland

SEPTEMBER 2005

Prepared for:

Naval District Washington, Indian Head
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Indian Head, Maryland

DoD Contract Number: N62472-02-D-1300

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Malcolm Pirnie, Inc. prepared this report at the direction of Engineering Field Activity Northeast. This document should be used only with the approval of the Engineering Field Activity Northeast. This report is based, in part, on information provided in other documents and is subject to the limitations and qualifications presented in the referenced documents.

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Table of Contents

EXECUTIVE SUMMARY **1**

1. INTRODUCTION **1-1**

1.1. PURPOSE **1-2**
1.2. PROGRAMMATIC FRAMEWORK **1-3**
1.3. PROJECT MANAGEMENT **1-4**
1.4. PRELIMINARY ASSESSMENT APPROACH **1-4**

2. INSTALLATION BACKGROUND **2-1**

2.1. LOCATION AND SETTING **2-1**
2.2. INSTALLATION HISTORY **2-4**
2.3. MUNITIONS RELATED TRAINING / STORAGE / USAGE **2-6**

3. PHYSICAL AND ENVIRONMENTAL CHARACTERISTICS **3-1**

3.1. CLIMATE **3-1**
3.2. TOPOGRAPHY **3-1**
3.3. GEOLOGY **3-2**
3.4. SOIL AND VEGETATION TYPES **3-3**
3.5. HYDROLOGY **3-4**
3.6. HYDROGEOLOGY **3-5**
3.7. CULTURAL AND NATURAL RESOURCES **3-6**
3.8. ENDANGERED AND SPECIAL STATUS SPECIES **3-7**

4. SUMMARY OF DATA COLLECTION EFFORT **4-1**

4.1. HISTORICAL ARCHIVE REPOSITORIES (OFF-SITE) **4-1**
4.2. PERSONAL INTERVIEWS **4-4**
4.3. ON-SITE DATA REPOSITORIES **4-5**
4.4. VISUAL SURVEY **4-6**
4.5. OFF-SITE DATA SOURCES **4-6**

5. SITE CHARACTERISTICS **4.5-1**

5.1. FDR SKEET RANGE **5.1-1**
5.1.1. History and Site Description *5.1-1*
5.1.1.1. Topography 5.1-2
5.1.1.2. Geology 5.1-2
5.1.1.3. Soil and Vegetation Types 5.1-2
5.1.1.4. Hydrology 5.1-3
5.1.1.5. Hydrogeology 5.1-3
5.1.1.6. Cultural and Natural Resources 5.1-3
5.1.1.7. Endangered and Special Status Species 5.1-3
5.1.2. Visual Survey Observations and Results *5.1-3*
5.1.3. Munitions and Munitions Related Materials Associated with the Site *5.1-4*
5.1.4. MEC Presence *5.1-4*
5.1.4.1. Known MEC Areas 5.1-5
5.1.4.2. Suspected MEC Areas 5.1-5

5.1.4.3. Areas Not Suspected to Contain MEC 5.1-5
5.1.5. Ordnance Penetration Estimates *5.1-5*
5.1.6. Munitions Constituents *5.1-6*
5.1.7. Contaminant Migration Routes *5.1-6*
5.1.8. Receptors *5.1-7*
5.1.8.1. Nearby Populations 5.1-7
5.1.8.2. Buildings Near/Within Site 5.1-7
5.1.8.3. Utilities On/Near Site 5.1-7
5.1.9. Land Use *5.1-7*
5.1.10. Access Controls / Restrictions *5.1-8*
5.1.11. Conceptual Site Model *5.1-8*
5.1.12. Summary *5.1-15*
5.2. GATE 3 BURNING GROUND 5.2-1
5.2.1. History and Site Description *5.2-1*
5.2.1.1. Topography 5.2-1
5.2.1.2. Geology 5.2-1
5.2.1.3. Soil and Vegetation Types 5.2-2
5.2.1.4. Hydrology 5.2-2
5.2.1.5. Hydrogeology 5.2-2
5.2.1.6. Cultural and Natural Resources 5.2-2
5.2.1.7. Endangered and Special Status Species 5.2-2
5.2.2. Visual Survey Observations and Results *5.2-2*
5.2.3. Munitions and Munitions Related Materials Associated with the Site *5.2-3*
5.2.4. MEC Presence *5.2-4*
5.2.4.1. Known MEC Areas 5.2-4
5.2.4.2. Suspected MEC Areas 5.2-4
5.2.4.3. Areas Not Suspected to Contain MEC 5.2-4
5.2.5. Ordnance Penetration Estimates *5.2-4*
5.2.6. Munitions Constituents *5.2-5*
5.2.7. Contaminant Migration Routes *5.2-5*
5.2.8. Receptors *5.2-6*
5.2.8.1. Nearby Populations 5.2-6
5.2.8.2. Buildings Near/Within Site 5.2-6
5.2.8.3. Utilities On/Near Site 5.2-6
5.2.9. Land Use *5.2-6*
5.2.10. Access Controls / Restrictions *5.2-6*
5.2.11. Conceptual Site Model *5.2-7*
5.2.12. Summary *5.2-14*
5.3. NG SLUMS BURNING GROUND 5.3-1
5.3.1. History and Site Description *5.3-1*
5.3.1.1. Topography 5.3-2
5.3.1.2. Geology 5.3-2
5.3.1.3. Soil and Vegetation Types 5.3-2
5.3.1.4. Hydrology 5.3-3
5.3.1.5. Hydrogeology 5.3-3
5.3.1.6. Cultural and Natural Resources 5.3-3

5.3.1.7. Endangered and Special Status Species 5.3-4
5.3.2. Visual Survey Observations and Results *5.3-4*
5.3.3. Munitions and Munitions Related Materials Associated with the Site *5.3-4*
5.3.4. MEC Presence *5.3-5*
5.3.4.1. Known MEC Areas 5.3-5
5.3.4.2. Suspected MEC Areas 5.3-5
5.3.4.3. Areas Not Suspected to Contain MEC 5.3-5
5.3.5. Ordnance Penetration Estimates *5.3-6*
5.3.6. Munitions Constituents *5.3-6*
5.3.7. Contaminant Migration Routes *5.3-6*
5.3.8. Receptors *5.3-6*
5.3.8.1. Nearby Populations 5.3-7
5.3.8.2. Buildings Near/Within Site 5.3-7
5.3.8.3. Utilities On/Near Site 5.3-7
5.3.9. Land Use *5.3-7*
5.3.10. Access Controls / Restrictions *5.3-7*
5.3.11. Conceptual Site Model *5.3-7*
5.3.12. Summary *5.3-16*
5.4. SAFETY THERMAL TREATMENT POINT 5.4-1
5.4.1. History and Site Description *5.4-1*
5.4.1.1. Topography 5.4-2
5.4.1.2. Geology 5.4-2
5.4.1.3. Soil and Vegetation Types 5.4-3
5.4.1.4. Hydrology 5.4-3
5.4.1.5. Hydrogeology 5.4-3
5.4.1.6. Cultural and Natural Resources 5.4-4
5.4.1.7. Endangered and Special Status Species 5.4-4
5.4.2. Visual Survey Observations and Results *5.4-4*
5.4.3. Munitions and Munitions Related Materials Associated with the Site *5.4-6*
5.4.4. MEC Presence *5.4-7*
5.4.4.1. Known MEC Areas 5.4-7
5.4.4.2. Suspected MEC Areas 5.4-7
5.4.4.3. Areas Not Suspected to Contain MEC 5.4-7
5.4.5. Ordnance Penetration Estimates *5.4-8*
5.4.6. Munitions Constituents *5.4-8*
5.4.7. Contaminant Migration Routes *5.4-11*
5.4.8. Receptors *5.4-12*
5.4.8.1. Nearby Populations 5.4-12
5.4.8.2. Buildings Near/Within Site 5.4-12
5.4.8.3. Utilities On/Near Site 5.4-12
5.4.9. Land Use *5.4-12*
5.4.10. Access Controls / Restrictions *5.4-13*
5.4.11. Conceptual Site Model *5.4-13*
5.4.12. Summary *5.4-22*
5.5. SINGLE BASE PROPELLANT GRAINS SPILL AREA 5.5-1
5.5.1. History and Site Description *5.5-1*

5.5.1.1. Topography 5.5-2
5.5.1.2. Geology 5.5-3
5.5.1.3. Soil and Vegetation Types 5.5-3
5.5.1.4. Hydrology 5.5-3
5.5.1.5. Hydrogeology 5.5-3
5.5.1.6. Cultural and Natural Resources 5.5-3
5.5.1.7. Endangered and Special Status Species 5.5-4
5.5.2. Visual Survey Observations and Results 5.5-4
5.5.3. Munitions and Munitions Related Materials Associated with the Site 5.5-4
5.5.4. MEC Presence 5.5-5
5.5.4.1. Known MEC Areas 5.5-5
5.5.4.2. Suspected MEC Areas 5.5-5
5.5.4.3. Areas Not Suspected to Contain MEC 5.5-5
5.5.5. Ordnance Penetration Estimates 5.5-6
5.5.6. Munitions Constituents 5.5-6
5.5.7. Contaminant Migration Routes 5.5-6
5.5.8. Receptors 5.5-6
5.5.8.1. Nearby Populations 5.5-6
5.5.8.2. Buildings Near/Within Site 5.5-7
5.5.8.3. Utilities On/Near Site 5.5-7
5.5.9. Land Use 5.5-7
5.5.10. Access Controls / Restrictions 5.5-7
5.5.11. Conceptual Site Model 5.5-7
5.5.12. Summary 5.5-14
5.6. SOUTHWESTERN PISTOL RANGE 5.6-1
5.6.1. History and Site Description 5.6-1
5.6.1.1. Topography 5.6-1
5.6.1.2. Geology 5.6-2
5.6.1.3. Soil and Vegetation Types 5.6-2
5.6.1.4. Hydrology 5.6-2
5.6.1.5. Hydrogeology 5.6-2
5.6.1.6. Cultural and Natural Resources 5.6-2
5.6.1.7. Endangered and Special Status Species 5.6-2
5.6.2. Visual Survey Observations and Results 5.6-3
5.6.3. Munitions and Munitions Related Materials Associated with the Site 5.6-3
5.6.4. MEC Presence 5.6-5
5.6.4.1. Known MEC Areas 5.6-5
5.6.4.2. Suspected MEC Areas 5.6-5
5.6.4.3. Areas Not Suspected to Contain MEC 5.6-6
5.6.5. Ordnance Penetration Estimates 5.6-6
5.6.6. Munitions Constituents 5.6-6
5.6.7. Contaminant Migration Routes 5.6-7
5.6.8. Receptors 5.6-8
5.6.8.1. Nearby Populations 5.6-8
5.6.8.2. Buildings Near/Within Site 5.6-8
5.6.8.3. Utilities On/Near Site 5.6-8

5.6.9. Land Use 5.6-8
5.6.10. Access Controls / Restrictions 5.6-8
5.6.11. Conceptual Site Model 5.6-9
5.6.12. Summary 5.6-15
5.7. THE VALLEY 5.7-1
5.7.1. History and Site Description 5.7-1
5.7.1.1. Topography 5.7-6
5.7.1.2. Geology 5.7-7
5.7.1.3. Soil and Vegetation Types 5.7-7
5.7.1.4. Hydrology 5.7-8
5.7.1.5. Hydrogeology 5.7-8
5.7.1.6. Cultural and Natural Resources 5.7-8
5.7.1.7. Endangered and Special Status Species 5.7-9
5.7.2. Visual Survey Observations and Results 5.7-9
5.7.3. Munitions and Munitions Related Materials Associated with the Site 5.7-10
5.7.4. MEC Presence 5.7-13
5.7.4.1. Known MEC Areas 5.7-14
5.7.4.2. Suspected MEC Areas 5.7-14
5.7.4.3. Areas Not Suspected to Contain MEC 5.7-14
5.7.5. Ordnance Penetration Estimates 5.7-14
5.7.6. Munitions Constituents 5.7-15
5.7.7. Contaminant Migration Routes 5.7-15
5.7.8. Receptors 5.7-15
5.7.8.1. Nearby Populations 5.7-16
5.7.8.2. Buildings Near/Within Site 5.7-16
5.7.8.3. Utilities On/Near Site 5.7-16
5.7.9. Land Use 5.7-16
5.7.10. Access Controls / Restrictions 5.7-17
5.7.11. Conceptual Site Model 5.7-17
5.7.12. Summary 5.7-26

APPENDICES

APPENDIX A: REFERENCES

APPENDIX B: PROJECT SOURCE DATA – GENERAL

APPENDIX C: PROJECT SOURCE DATA – SITE SPECIFIC

APPENDIX D: ORDNANCE TECHNICAL DATA SHEETS

MAPS

MAP 2.1-1 AREA LOCATION MAP 2-2
MAP 2.1-2 MAIN INSTALLATION AREA LOCATION MAP 2-3
MAP 5.1-1: VISUAL SURVEY: FDR SKEET RANGE 5.1-16
MAP 5.1-2: RANGE/SITE DETAILS: FDR SKEET RANGE 5.1-17
MAP 5.1-3: MUNITIONS CHARACTERIZATION: FDR SKEET RANGE 5.1-18
MAP 5.2-1: VISUAL SURVEY GATE 3 BURNING GROUND 5.2-15
MAP 5.2-2: RANGE/SITE DETAILS GATE 3 BURNING GROUND 5.2-16
MAP 5.2-3: MUNITIONS CHARACTERIZATION GATE 3 BURNING GROUND 5.2-17
MAP 5.3-1: VISUAL SURVEY: NG SLUMS BURNING GROUND 5.3-17
MAP 5.3-2: RANGE/SITE DETAILS MAP: NG SLUMS BURNING GROUND 5.3-18
MAP 5.3-3: MUNITIONS CHARACTERIZATION: NG SLUMS BURNING GROUND 5.3-19
MAP 5.4-1: VISUAL SURVEY: SAFETY THERMAL TREATMENT POINT 5.4-23
MAP 5.4-2: RANGE/SITE DETAILS: SAFETY THERMAL TREATMENT POINT 5.4-24
MAP 5.4-3: MUNITIONS CHARACTERIZATION: SAFETY THERMAL TREATMENT POINT 5.4-25
MAP 5.5-1: VISUAL SURVEY: SINGLE BASE PROPELLANT GRAINS SPILL AREA 5.5-15
MAP 5.5-2: RANGE/SITE DETAILS MAP: SINGLE BASE PROPELLANT GRAINS SPILL AREA 5.5-16
MAP 5.5-3: MUNITIONS CHARACTERIZATION: SINGLE BASE PROPELLANT GRAINS SPILL AREA 5.5-17
MAP 5.6-1: VISUAL SURVEY SOUTHWESTERN PISTOL RANGE 5.6-16
MAP 5.6-2: RANGE/SITE DETAILS SOUTHWESTERN PISTOL RANGE 5.6-17
MAP 5.6-3: MUNITIONS CHARACTERIZATION SOUTHWESTERN PISTOL RANGE 5.6-18
MAP 5.7-1: VISUAL SURVEY: THE VALLEY 5.7-27
MAP 5.7-2: RANGE/SITE DETAILS: THE VALLEY 5.7-28
MAP 5.7-3: MUNITIONS CHARACTERIZATION: THE VALLEY 5.7-29
MAP 5.7-4: FIRING FAN: THE VALLEY 5.7-30
MAP 5.7-5: FIRING FAN OVER MAIN INSTALLATION: THE VALLEY 5.7-31
MAP 5.7-6: FRAGMENTATION ZONE: THE VALLEY 5.7-32
MAP 5.7-7: FIRING FAN – 1916 DETAIL MAP: THE VALLEY 5.7-33

FIGURES

FIGURE 2.3-1: THE VALLEY FIRING FAN 2-9
FIGURE 5.1-1: CURRENT CONDITIONS OF FDR SKEET RANGE AREA 5.1-1
FIGURE 5.1-2: MC EXPOSURE PATHWAY ANALYSIS 5.1-14
FIGURE 5.2-1: CURRENT CONDITIONS OF GATE 3 BURNING GROUND - WOODED AREA ALONG POTOMAC RIVER. 5.2-1
FIGURE 5.2-2: REMAINS OF AN OLD STOVE AND BURNED GROUND SURFACE . 5.2-3
FIGURE 5.2-3: MEC EXPOSURE PATHWAY ANALYSIS 5.2-12
FIGURE 5.2-4: MC EXPOSURE PATHWAY ANALYSIS 5.2-13
FIGURE 5.3-1: CURRENT CONDITIONS OF THE NG SLUMS BURNING GROUNDS AREA 5.3-2
FIGURE 5.3-2: MATTAWOMAN CREEK SHORELINE AT THE NG SLUMS BURNING GROUND 5.3-3
FIGURE 5.3-3: MEC EXPOSURE PATHWAY ANALYSIS 5.3-13
FIGURE 5.3-4: MC EXPOSURE PATHWAY ANALYSIS 5.3-14
FIGURE 5.3-5: NG SLUMS GRAPHICAL ILLUSTRATION 5.3-15
FIGURE 5.4-1: AERIAL VIEW OF STTP AT MAIN INSTALLATION. 5.4-1
FIGURE 5.4-2: WETLAND AREA VEGETATION ON THE STTP. 5.4-3
FIGURE 5.4-3: STEEL BURN TANK LOCATED ON STTP. 5.4-5
FIGURE 5.4-4: MISCELLANEOUS EQUIPMENT AT THE STTP. 5.4-5
FIGURE 5.4-5: LOCATION OF SOIL AND GROUNDWATER SAMPLES FROM THE 1995 CHARACTERIZATION REPORT PERFORMED FOR THE STTP. 5.4-9
FIGURE 5.4-6: MEC EXPOSURE PATHWAY ANALYSIS 5.4-19
FIGURE 5.4-7: MC EXPOSURE PATHWAY ANALYSIS 5.4-20
FIGURE 5.4-8: STTP GRAPHICAL ILLUSTRATION 5.4-21
FIGURE 5.5-1: AERIAL PHOTOGRAPH OF THE SINGLE BASE PROPELLANT GRAINS SPILL AREA. 5.5-1
FIGURE 5.5-2: FORMER RAILROAD TRACKS AND BUILDINGS 5.5-2
FIGURE 5.5-3: SINGLE BASE PROPELLANT GRAIN OBSERVED AT BUILDING 188.5.5-4
FIGURE 5.5-4: MEC EXPOSURE PATHWAY ANALYSIS 5.5-12
FIGURE 5.5-5: MC EXPOSURE PATHWAY ANALYSIS 5.5-13
FIGURE 5.6-1: 1942 INSTALLATION MAP WITH LOCATION OF SOUTHWESTERN PISTOL RANGE. 5.6-1
FIGURE 5.6-2: DESIGNATED WILDLIFE FIELD AT SOUTHWESTERN PISTOL RANGE5.6-2

FIGURE 5.6-3: CURRENT CONDITIONS OF THE SOUTHWEST PISTOL RANGE. 5.6-3
FIGURE 5.6-4: SDZ FOR A TYPICAL .45-CAL PISTOL RANGE 5.6-4
FIGURE 5.6-5: MC EXPOSURE PATHWAY ANALYSIS 5.6-14
FIGURE 5.7-1: CURRENT VIEW OF THE VALLEY 5.7-1
FIGURE 5.7-2: AERIAL PHOTOGRAPH OF THE VALLEY. 5.7-2
FIGURE 5.7-3: EXCERPT FROM DOCUMENT IDENTIFYING SHOTS FIRED IN RESIDENTIAL PORTIONS OF VIRGINIA 5.7-4
FIGURE 5.7-4: 1891 VIEW OF CANNON BALL STOCKPILE AT THE VALLEY 5.7-5
FIGURE 5.7-5: VIEW OF VEGETATION ALONG THE POTOMAC RIVER AT THE WEST SIDE OF THE VALLEY 5.7-8
FIGURE 5.7-6: VIEW OF MONUMENT OF FORMER TEST ARMOR PLATE USED AT THE VALLEY 5.7-9
FIGURE 5.7-7: 1915 PANORAMIC VIEW OF THE VALLEY 5.7-10
FIGURE 5.7-8: CURRENT VIEW OF THE VALLEY 5.7-17
FIGURE 5.7-9: MEC EXPOSURE PATHWAY ANALYSIS 5.7-23
FIGURE 5.7-10: MC EXPOSURE PATHWAY ANALYSIS 5.7-24
FIGURE 5.7-11: THE VALLEY GRAPHICAL ILLUSTRATION 5.7-25

TABLES

TABLE ES-1: SUMMARY OF OTHER THAN OPERATIONAL RANGES AT THE MAIN INSTALLATION 2
TABLE 2.2-1: TIMELINE OF HISTORICAL EVENTS AT NDW, IH 2-4
TABLE 3.8-1: SUMMARY OF KNOWN OR POTENTIAL PROTECTED SPECIES 3-7
TABLE 4.2-1: NDW, IH PERSONNEL INTERVIEWED DURING SITE VISITS 4-4
TABLE 5.1-1: CONCEPTUAL SITE MODEL INFORMATION PROFILES – FDR SKEET RANGE 5.1-8
TABLE 5.2-1: CONCEPTUAL SITE MODEL INFORMATION PROFILES – GATE 3 BURNING GROUND 5.2-7
TABLE 5.3-1: CONCEPTUAL SITE MODEL INFORMATION PROFILES – NG SLUMS BURNING GROUND 5.3-8
TABLE 5.4-1: SUMMARY OF SOIL SAMPLE RESULTS (MILLIGRAM/KILOGRAM) AT THE STTP 5.4-10
TABLE 5.4-2: SUMMARY OF GROUNDWATER SAMPLE RESULTS (MICROGRAMS/LITER) AT THE STTP 5.4-11

TABLE 5.4-3: CONCEPTUAL SITE MODEL INFORMATION PROFILES – STTP 5.4-13

TABLE 5.5-1: CONCEPTUAL SITE MODEL INFORMATION PROFILES – SINGLE BASED PROPELLANT GRAINS SPILL AREA 5.5-8

TABLE 5.6-1: CONCEPTUAL SITE MODEL INFORMATION PROFILES – SOUTHWESTERN PISTOL RANGE 5.6-9

TABLE 5.7-1: HISTORY OF THE VALLEY 5.7-5

TABLE 5.7-2: CONCEPTUAL SITE MODEL INFORMATION PROFILES – THE VALLEY 5.7-18

ACRONYMS

AP	Armor Piercing
bgs	Below Ground Surface
BRAC	Base Realignment and Closure
CAD	Cartridge Actuated Device
CD	Compact Disc
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CSM	Conceptual Site Model
CWM	Chemical Warfare Materiel
DDESB	Department of Defense Explosive Safety Board
deg F	Degrees Fahrenheit
DERP	Defense Environmental Restoration Program
DNT	2,4-dinitrotoluene
DoD	Department of Defense
DU	Depleted Uranium
ECC	Environmental Chemical Corporation
EFACHES	Engineering Field Activity Chesapeake
EFANE	Engineering Field Activity Northeast
EOD	Explosive Ordnance Disposal
ESQD	Explosive Safety Quantity Distance
FDR	Franklin Delano Roosevelt
FUDS	Formerly Used Defense Site
FY	Fiscal Year
ft^2/day	Square Feet per Day
GIS	Geographic Information System
HMX	Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetraocine (Her Majesty's Explosive)
NDW	Naval District Washington
IH	Indian Head
IR	Installation Restoration
IRP	Installation Restoration Program
ITRC	Interstate Technology Regulatory Council
LANTDIV	Atlantic Division

MEC	Munitions and Explosives of Concern
MC	Munitions Constituents
MD	Maryland
MMRP	Military Munitions Response Program
MRP	Munitions Response Program
MSDS	Material Safety Data Sheet
msl	Mean Sea Level
NACIP	Navy Assessment and Control of Installation Pollutants
NAVEODTECHDIV	Naval Explosive Ordnance Disposal Technology Division
NAVFAC	Naval Facilities Engineering Command
NCP	National Contingency Plan
NDW	Naval District Washington
NG	Nitroglycerin
OB	Open Burning
OD	Open Detonation
OE	Ordnance and Explosives
PA	Preliminary Assessment
PAD	Propellant Actuated Device
PAH	Polycyclic Aromatic Hydrocarbon
PETN	Pentaerythrite Tetranitrate
RCRA	Resource Conservation and Recovery Act
RDX	Cyclotrimethylene trinitramine (Royal Demolition Explosive)
RG	Record Groups
RPM	Remedial Project Manager
SARA	Superfund Amendment and Reauthorization Act
SDZ	Surface Danger Zone
STTP	Safety Thermal Treatment Point
SWMU	Solid Waste Management Unit
TNT	Trinitrotoluene
U.S.	United States
USACE	United States Army Corps of Engineers
U.S.C.	United States Code
USEPA	United States Environmental Protection Agency

GLOSSARY OF TERMS

Base Realignment and Closure (BRAC) – A Department of Defense (DoD) program that focuses on compliance and cleanup efforts at military installations undergoing closure or re-alignment, as authorized by Congress in four rounds of base closures for 1988, 1991, 1993, and 1995. (DERP Management Guidance, September, 2001)

Closed Range – A range that has been taken out of service as a range and that either has been put to new uses that are incompatible with range activities or is not considered by the military to be a potential range area. A closed range is still under the control of a DoD component. (DERP Management Guidance, September, 2001)

Defense Site – All locations that are or were owned by, leased to, or otherwise possessed or used by the DoD. The term does not include any operational range, operating storage or manufacturing facility, or facility that is used or was permitted for the treatment or disposal of military munitions. (10 U.S.C. 2710(e)(1))

Discarded Military Munitions – Military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage area for the purpose of disposal. The term does not include unexploded ordnance, military munitions that are being held for future use or planned disposal, or military munitions that have been properly disposed of consistent with applicable environmental laws and regulations. (10 U.S.C. 2710(e)(2))

Explosive Ordnance Disposal (EOD) – The detection, identification, field evaluation, rendering-safe, recovery, and final disposal of unexploded explosive ordnance (UXO). It may also include the rendering-safe and/or disposal of EO (explosive ordnance) which has become hazardous by damage or deterioration, when disposal of such EO requires techniques, procedures, or equipment which exceed the normal requirements for routine disposal. (OPNAVINST 8027.1G, 14 Feb 92)

Explosives Safety – A condition where operational capability and readiness, personnel, property, and the environment are protected from the unacceptable effects of an ammunition or explosives mishap. (DoD Directive 6055.9 July 1996)

Formerly Used Defense Site (FUDS) – Real property that was formerly owned by, leased by, possessed by, or otherwise under the jurisdiction of the Secretary of Defense or the Components (including governmental entities that are the legal predecessors of DoD or the Components) and those real properties where accountability rested with DoD but where activities at the property were conducted by contractors (i.e., government-owned, contractor-operated (GOCO) properties) that were transferred from DoD control prior to October 17, 1986. The status of a site as a FUDS is irrespective of current ownership or current responsibility within the federal government. (DERP Management Guidance, September, 2001)

Munitions Constituents (MC) – Any materials originating from unexploded ordnance, discarded military munitions or other military munitions, including explosive and non-explosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions. (10 U.S.C. 2710 (e)(4))

Munitions and Explosives of Concern (MEC) – This term, which distinguishes specific categories of military munitions that may pose unique explosives safety risks, means: unexploded ordnance, discarded military munitions or munitions constituents (e.g., TNT, RDX) present in high enough concentrations to pose an explosive hazard. (OUSD(AT&L) 18 December 2003)

Operational Range – A range that is under the jurisdiction, custody, or control of the Secretary of Defense and that is used for range activities, or although not currently being used for range activities, that is still considered by the Secretary to be a range and has not been put to a new use that is incompatible with range activities. (10 U.S.C. 101 (e)(3))

Other than Operational Range – Encompasses closed, transferred and transferring ranges.

Range – A designated land or water area set aside, managed, and used for range activities of the DoD. Ranges include firing lines and positions, maneuver areas, firing lanes, test pads, detonation pads, impact areas, electronic scoring sites, buffer zones with restricted access and exclusionary areas, and airspace areas designated for military use in accordance with regulations and procedures prescribed by the Administrator of the Federal Aviation Administration. (10 U.S.C. 101 (e)(3))

Transferred Range – A property formerly used as a military range that is no longer under military control and had been leased by the DoD, transferred, or returned from the DoD to another entity, including federal entities. This includes a range that is no longer under military control but was used under the terms of a withdrawal, executive order, special-use permit or authorization, right-of-way, public land order, or other instrument issued by the federal land manager. (DERP Management Guidance, September, 2001)

Transferring Range – A range that is proposed to be transferred or returned from the DoD to another entity, including federal entities. This includes a range that is used under the terms of a withdrawal, executive order, act of Congress, special-use permit or authorization, right-of-way, public land order, or other instrument issued by the federal land manager or property owner. An operational or closed range will not be considered a "transferring range" until the transfer is imminent. (DERP Management Guidance, September, 2001)

Unexploded Ordnance – Military munitions that have been primed, fused, armed, or otherwise prepared for action; have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material; and remain unexploded either by malfunction, design, or any other cause. (10 U.S.C. 101(e)(5))

EXECUTIVE SUMMARY

The Department of Defense (DoD) has established the Military Munitions Response Program under the Defense Environmental Restoration Program (DERP) to address munitions and explosives of concern (MEC) [which include unexploded ordnance (UXO) and discarded military munitions (DMM)] and munitions constituents (MC) at other than operational military ranges and other sites. Closed, transferred, and transferring military ranges and sites not located on an operational range are considered other than operational. This report addresses other than operational ranges at an active installation. It may include transferring and/or transferred ranges and munition disposal sites associated with an active installation if they are not included in Base Realignment and Closure (BRAC) or Formerly Used Defense Site (FUDS) programs.

This report presents a Preliminary Assessment (PA) for the other than operational ranges at the Main Installation at Naval District Washington (NDW), Indian Head, Maryland. While NDW, Indian Head consists of the Main Installation and the Stump Neck Annex, the Stump Neck Annex ranges are addressed in another report. The DoD, United States Navy, and United States Environmental Protection Agency guidance for conducting and documenting PAs was followed and tailored, where appropriate, to address the unique aspects of MEC and MC. By definition, PAs do not include intrusive work such as environmental sampling.

NDW, IH is located in northwestern Charles County, Maryland, approximately 25 miles southwest of Washington, D.C. The 2,300-acre Main Installation is located at the point of a peninsula known as Cornwallis Neck, located at the confluence of the Potomac River and the Mattawoman Creek. The neighboring 1,100-acre Stump Neck Annex is located across Mattawoman Creek (to the south) from the Main Installation.

Activity at the Main Installation is reported to date back to 1890. The Main Installation has a varied history that covers most aspects of gun and weapons proving and powder and propellant development, manufacturing and testing.

This PA Report includes seven other than operational ranges at the Main Installation. Table ES-1 provides a summary of the Main Installation other than operational ranges.

Table ES-1: Summary of Other than Operational Ranges at the Main Installation				
Range Name	**NORM Range No.**	**Size (acres)**	**Use**	**Dates of Use**
FDR Skeet Range	UXO 000013	34	Potential Skeet range	1940s – 1960s
Gate 3 Burning Ground	UXO 000030	0.23	Burning ground	1955 – 1961
NG Slums Burning Ground	UXO 000006	0.3	Potential Burning ground	Late 1940s - 1953
Safety Thermal Treatment Point	UXO 000020	1.6	Burning ground	Early 1940s - 1988
Single Base Propellant Grains Spill Area	UXO 000009	52.2	Propellant transportation area	1927 – late 1980s
Southwestern Pistol Range	UXO 000029	1.26	Small arms range	1942 - unknown
The Valley	UXO 000011	21	Testing, experimental research of all Navy ordnance	1891 - 1921

FDR Skeet Range - The FDR Skeet Range, which covers approximately 34 acres, is located adjacent to Mattawoman Creek on the southeast portion of NDW, IH Main Installation. Reportedly, the range was used as a recreational skeet range between the 1940s and 1960s; however, documentation confirming the use of this area is not available. While its existence is unconfirmed, the FDR Skeet Range is reportedly located in a hilly wooded area that is currently not used. Formal skeet ranges are typically level; current terrain features at the FDR Skeet Range would inhibit the sport. Several buildings are also located within the presumed firing fan of this range.

Burning Grounds - As production operations at NDW, IH have required the need for disposal of waste by burning, several areas at the Main Installation are reported to have been utilized for burning. The four documented burning areas include the Original Burning Ground [Installation Restoration (IR) Site 28], the Safety Thermal Treatment Point, the Strauss Avenue Thermal Treatment Point, and Caffee Road Thermal Treatment Point. The Strauss Avenue and Caffee Road Thermal Treatment Points are either active or located in active areas and therefore are not included in this assessment. The Original Burning Ground is being addressed under the Installation Restoration Program (IRP) and is not included in this assessment. Based on interviews conducted during this PA, two additional burning grounds are suspected to have been operated at the Main Installation: the Gate 3 Burning Ground and the nitroglycerine (NG) Slums

Burning Ground. The following three paragraphs provide a brief summary of the burning grounds that are part of this Preliminary Assessment.

Gate 3 Burning Ground - The Gate 3 Burning Ground is a 0.23-acre site that was used for burning of explosives between 1955 and 1961. The range is located on the Main Installation, northwest of the intersection of Strauss Ave. and E. Caffee Road, west of Strauss Avenue, and along the Potomac River shoreline. During Malcolm Pirnie's site reconnaissance, evidence of burned ground surface was observed. The site is currently vacant.

NG Slums Burning Ground - The NG Slums Burning Ground, also identified as IR Site 22, is a 0.3-acre range located on the southeastern shore of the Main Installation adjacent to the Mattawoman Creek. The suspected location lies east of Building 1216 and runs parallel to the east end of Hussey Circle Road. This range was presumably used as an open burning ground for NG slums (i.e., excess NG mixed with sawdust for stabilization) generated at the NG production facilities. The NG Slums Burning Ground was in operation from the late 1940s, when the NG production facilities were constructed, until approximately 1953. The range is currently not used.

STTP - The Safety Thermal Treatment Point (STTP) is a 1.6-acre site that was used for the open burning of waste pyrotechnics and single, double, and composite based propellants beginning in 1942. The range is located on a man-made area that was created by filling in a portion of the creek. The STTP, also designated Solid Waste Management Unit (SWMU) 20 under the Resource Conservation Recovery Act (RCRA) program, was segregated into two areas. The primary burn area, located from the tip of the small peninsula and approximately 150 feet inward, was used for the open destruction of munitions. The secondary burn area covered the remainder of the small peninsula and was used for munitions testing. The burning of propellants was terminated in 1954. Burning of cartridge actuated devices (CADs), propellant actuated devices (PADs), primers, less sensitive explosives, and various other pyrotechnics continued until 1988.

Single Base Propellant Grains Spill Area - The Single Base Propellant Grains Spill Area is approximately 52 acres in area and was utilized in the transportation of propellant from the former production area. This site is comprised of an area where propellant grains, composed of nitrocellulose, were spilled during rail transportation at the installation. Use of the rail line to transport single base propellant began between 1927 and 1942, and was terminated in the late 1980s. The Single Base Propellant Grains Spill Area is located in the northeastern portion of the

Main Installation peninsula, south of East Farnum Road. The site was investigated in the 1983 Initial Assessment study under the IR Program (identified as IR Site 10). Currently, the site is a grassy area with two designated wildlife grazing areas and a number of buildings, which are either vacant or used for general equipment storage. During Malcolm Pirnie's site reconnaissance, single base propellant grains were observed under the porch of Building 188. Grains have also been observed by installation personnel throughout the area.

Southwestern Pistol Range - The Southwestern Pistol Range is a 1.3-acre range located at the western end of the Indian Head Main Installation peninsula, between Drop Tower Drive and Pump House Lane. The range was identified on a 1942 installation map as a "target range." The range was presumably used for small arms (pistol) training. The dates of use are unknown. Currently, the site is an unused, overgrown grassy area designated as a wildlife field.

The Valley - The Valley occupies an area approximately 21 acres in size and was used from 1891 through 1921 for experimental research, development and testing of Navy ordnance, including gun proving and testing projectiles, armor plates, primers, fuzes, powder, and mines. The range is currently used for recreational access to the Potomac River and Navy conference meetings. No evidence of MEC or MC was observed at The Valley during the site visit; however, historical documentation was identified that described numerous testing activities. In addition, personnel interviews stated that MEC and related debris have been found and removed from the area at various times over the last several years.

1. INTRODUCTION

The Department of Defense (DoD) has established the Military Munitions Response Program under the Defense Environmental Restoration Program (DERP) to address munitions and explosives of concern (MEC) (including unexploded ordnance (UXO) and discarded military munitions (DMM)) and munitions constituents (MC) at other than operational military ranges and other sites. Closed, transferred, and transferring military ranges and sites not located on an operational range are considered other than operational. This report addresses other than operational ranges and sites at an active installation. It may include transferring and/or transferred ranges and munition disposal sites associated with an active installation if they are not included in Base Realignment and Closure (BRAC) or Formerly Used Defense Site (FUDS) programs.

The DoD and the United States (U.S.) Navy (Navy) are currently establishing policy and guidance for munitions response actions under the Navy Munitions Response Program (MRP). However, key program drivers developed to date conclude that munitions response actions will be conducted under the process outlined in the National Contingency Plan (NCP) (40 Code of Federal Regulations 300) as authorized by the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, 42 United States Code (U.S.C.) 9605, as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), Public Law 99-499 (hereinafter referred to as CERCLA). This report presents a Preliminary Assessment (PA) for the other than operational ranges at the Main Installation at Naval District Washington (NDW), Indian Head (IH) located in Indian Head, Charles County, Maryland (MD).[1] DoD, Navy, and U.S. Environmental Protection Agency (USEPA) guidance for conducting and documenting PAs were followed and tailored, where appropriate, to address the unique aspects of MEC and MC.

This PA Report is organized into the following sections:

- Section 1 – Introduction
- Section 2 – Installation Background
- Section 3 – Physical and Environmental Characteristics

[1] *On 1 October 2003, the installation management functions at Indian Head transferred from Naval Surface Warfare Center – Indian Head Division to Naval District Washington. References to this installation will now be Naval District Washington, Indian Head (NDW, IH).*

- Section 4 – Summary of Data Collection Effort
- Section 5 – Site Characteristics

The following supporting information is appended to this PA:

- References (Appendix A)
- Project Source Data – General (Appendix B)
- Project Source Data – Site Specific (Appendix C)
- Ordnance Technical Data Sheets (Appendix D)

An interactive compact disc (CD) report for Main Installation of NDW, IH is included with this report. The CD will include electronic files of the report text, tables, and figures; appendices; project source data; additional site photographs; and interactive maps of the installation and will be provided under separate cover.

1.1. Purpose

This PA summarizes the history of munitions use for the following seven former ranges at the Main Installation of NDW, IH:

- FDR Skeet Range
- Gate 3 Burning Ground
- NG Slums Burning Ground
- Safety Thermal Treatment Point
- Single Base Propellant Grains Spill Area
- Southwestern Pistol Range
- The Valley

The PA provides an assessment of the current conditions with respect to MEC and MC based on a review of readily available information, personnel interviews, and a non-intrusive survey of the sites. The PA provides the necessary information for Navy and regulatory decision-makers to: 1) eliminate from further consideration those MEC sites that pose minimal or no threat to public health or the environment; 2) differentiate MEC sites that may not require further munitions response actions from those that will require further investigation and/or munitions response actions; 3) determine if an imminent explosives safety hazard from MEC is present that warrants

an accelerated response action; and 4) determine if an imminent hazard from MC to human health and the environment is present and warrants an accelerated response action.

1.2. Programmatic Framework

The regulatory structure for managing Navy MRP sites is guided by a complex mixture of federal, state, and local laws, as well as DoD and Navy regulations and guidance. The key legislation, policy, and guidance directing the program include, but are not limited to, the following:

Defense Environmental Restoration Program (DERP) Management Guidance (September 2001)

The DERP Management Guidance establishes a MRP element for MEC and MC defense sites. The history of DERP dates back to the Superfund Amendments and Reauthorization Act (SARA) of 1986[2]. The scope of the DERP is defined in 10 United States Code (U.S.C.) §2701(b), which states that the: Goals of the program shall include the following: … (1) The identification, investigation, research and development, and cleanup of contamination from hazardous substances, and pollutants and contaminants. (2) Correction of other environmental damage (such as detection and disposal of unexploded ordnance) which creates an imminent and substantial endangerment to the public health or welfare or to the environment …

Draft DoD Directive Military Munitions Response Policy on Other-Than-Operational Ranges

The Draft DoD Directive 4715.MRP (September 2003 version) states that munitions response will be conducted "in accordance with CERCLA and the National Oil and Hazardous Substances Pollution Contingency Plan (NCP)".

National Defense Authorization Act (FY02) (Sections 311-312)

Sections 311-312 of the National Defense Authorization Act of FY02 reinforced the DoD's 2001 DERP Management Guidance by tasking the DoD to develop and maintain an inventory of defense sites that are known or suspected to contain MEC and MC. Section 311 requires the DoD to develop a protocol for prioritizing defense sites for response activities in consultation with the

[2] *SARA was signed into law on October 17, 1986, and amended the CERCLA of 1980, 42 U.S.C. §9601* et seq. *Related sections in Title 10 of the U.S.C. (10 U.S.C. §§2702-2710 and §§2810-2811) further define the program.*

states and Tribes. Section 312 requires the DoD to create a separate program element to ensure that the DoD can identify and track munitions response funding.

The September 2001 Management Guidance for the DERP and the Defense Authorization Act 2002, described above, established the MRP. The DoD provides program guidance and methods for conducting a baseline inventory of defense sites containing, or potentially containing, MEC and/or MC. The Navy baseline inventory of sites was completed in FY02 and was used to establish the sites where PAs are needed to further evaluate the potential for MEC and MC.

1.3. Project Management

This PA has been coordinated and managed by the Navy Engineering Field Activity Northeast (EFANE), a component of the Atlantic Division (LANTDIV) of the Naval Facilities Engineering Command (NAVFAC). The EFANE performs engineering functions for Navy installations throughout the northeast U.S. and is the Program Manager for this PA. Malcolm Pirnie, Inc. has been contracted by EFANE to prepare this PA. The Navy Remedial Project Manager (RPM) from Naval Facilities Engineering Command Washington[3] (NAVFAC Washington) and the installation point of contact for NDW, IH provided valuable information and assistance throughout the PA data collection process.

1.4. Preliminary Assessment Approach

CERCLA implementing guidance, which was prepared for sites contaminated with hazardous substances, describes the PA as a limited-scope investigation based upon existing and available data. However, the guidance also states that the PA process developed under CERCLA is not equally applicable to all sites and all contaminants and that variation from the guidance may be necessary. Sites containing MEC are prime examples of sites where the generic CERCLA process does not fully address potential environmental and safety issues that may be present at a range. Unique explosives safety issues associated with MEC cannot be assessed solely with the parameters developed for chemical and hazardous waste contaminants. While this PA generally follows CERCLA guidance, certain elements of the PA report have been tailored to address the unique explosives safety aspects of MEC.

[3] *On July 23, 2004 Engineering Field Activity Chesapeake (EFACHES) was decommissioned and is now part of Naval Facilities Engineering Command Washington (NAVFAC Washington).*

The PA process for each site involves collecting and reviewing available information regarding the site. Data collection activities included on- and off-site research and interviews. They also included limited visual surveys to observe physical evidence that might indicate presence of MEC (e.g., discarded munitions items, ordnance penetration holes, and scarred trees) and MC (e.g., ground scarring, stressed vegetation, and chemical residue) at the sites. The Malcolm Pirnie data collection team conducted the on-site portion of the data collection and visual survey during four multi-day site visits: June 23-27, 2003; November 17-21, 2003; December 1-2, 2003; and June 2-3, 2004. Substantial field time and multiple visits were required due to the large number of sites and potentially available data sources.

This PA is inclusive and makes use of readily available data relating to munitions use at the NDW, IH including historical records, field data, anecdotal evidence, interviews with current and former site personnel, and professional knowledge and experience. It is based, in part, on information provided in documents referenced in Appendix A and is subject to the limitations and qualifications presented in the referenced documents.

2. INSTALLATION BACKGROUND

The following sections provide general information about NDW, IH including its location and setting; a brief history of the installation; its missions over time; and a history of munitions related training, storage, and usage.

2.1. Location and Setting

The locations of NDW, IH and the other than operational ranges subject to this PA are shown on Map 2.1-1 and Map 2.1-2. The Main Installation covers approximately 2,300 acres of Cornwallis Neck in Charles County, MD. Cornwallis Neck is located at the confluence of the Potomac River and Mattawoman Creek, which border the installation to the northwest and south, respectively. The town of Indian Head is located east of NDW, IH. The NDW, IH Stump Neck Annex is south of the Main Installation. The proximity of the town of Indian Head to the MD 210 corridor and wildlife management areas makes the area a destination of outdoors enthusiasts including boaters, hunters, and fisherman.

The population at NDW, IH consists of 2,200 civilians, 500 military personnel, 800 contractors, and 550 dependents. The 2000 U.S. Census indicates 3,422 residents for the town of Indian Head and 120,546 residents for Charles County.

Preliminary Assessment
NDW, Indian Head, Maryland

Map 2.1-1
Area Location Map

Legend

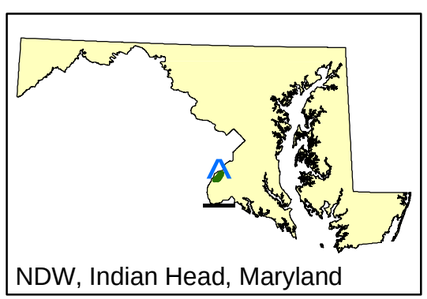
Installation Boundary

0 600 1,200 1,800 2,400 Meters

Data Source: USGS. 7.5 Minute Series
Topographic Survey - Bathymetric Map
Indian Head, MD-VA, 1981
Quantico, VA-MD, 1981

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005



Preliminary Assessment
NDW, Indian Head, Maryland

MALCOLM PIRNIE

Map 2.1-2
Main Installation Area Location Map

Legend

- Installation Boundary
- MRP Sites

0 400 800 1,200 1,600Meters

Data Source: USGS. 7.5 Minute Series
Topographic Survey - Bathymetric Map
Indian Head, MD-VA, 1981
Quantico, VA-MD, 1981

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

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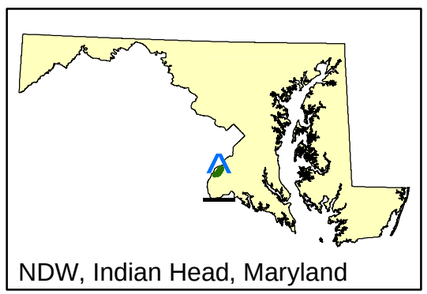

2.2. Installation History

Established in 1890, NDW, IH is the Navy's oldest ordnance station. Throughout its long and distinguished history, the facility has proved guns, armor, and propellants; developed and manufactured powder and propellants; and is recognized as a leader in energetics research and development. Shortly after operations commenced, additional property was acquired by the Navy to increase the size of the installation. The most notable acquisition was of the land that currently makes up the Stump Neck Annex, which was acquired for use in 1901 as an impact area and safety buffer. The Main Installation and Stump Neck Annex have had both separate and joint missions. Therefore, from a historical perspective, these sites are discussed together.

With the opening of the nearby Dahlgren Naval Proving Ground in the early 1930s, the primary focus of NDW, IH turned from gun proving to powder manufacturing. Additional acquisition and improvement to the installation continued through the 1960s to increase operational capacity and safety buffers required for the manufacturing, testing, and storing of energetic materials.

In recent decades, NDW, IH has come to be known as a center of excellence in the development and manufacture of specialized energetic materials used in demolition and propulsion. Now under the direction of the Naval Sea Systems Command, the current mission of NDW, IH is to:

- Provide services in energetics for all warfare centers through engineering, fleet and operational support, manufacturing technology, limited production, and industrial base support;
- Provide research, development, testing, and evaluation of energetic materials, ordnance devices and components, and other engineering standards including chemicals, propellants, propulsion systems, explosives, pyrotechnics, warheads and simulators; and
- Provide support to all warfare centers, military departments and the ordnance industry for special weapons, explosives safety and ordnance environmental issues.

Table 2.2-1 summarizes the key milestones in the history of NDW, IH.

Table 2.2-1: Timeline of Historical Events at NDW, IH

Time Period	NDW, IH Milestones
1890 - 1900	• Constructed on 659 acres on Cornwallis Neck in 1890 as the *Naval Proving Ground* to test guns, armor, shells and mounts. • Within one year, added the 222.75-acre Mount Pleasant Farm.
1900 - 1910	• Factory constructed for smokeless powder production. • Stump Neck Annex property purchased in 1901 to extend firing range.
1910 -1920	• Work gradually moved from proving of guns and armor to include

Time Period	NDW, IH Milestones
	standardization of shells and powder. • Acquired 1,160 acres of land adjacent to the Main Installation in 1918. • 161 acres acquired for a railroad right-of-way running from the Naval Proving Ground to the Pennsylvania Railroad junction at White Plains, Maryland; 13.8-mile railroad spur constructed.
1920 – 1940	• Mission gradually shifted from a Naval gun proving ground to a chemical factory, research laboratory and an Explosive D factory. • Facility changed name to the *Naval Powder Factory*. • All proving ground activities were moved to Dahlgren, Virginia.
1940 – 1950	• Navy established *Explosives Investigation Laboratory* where extensive examination of captured enemy ordnance was performed. • Explosive Ordnance Disposal (EOD) unit moved from White Oak to Stump Neck Annex. • Joint forces EOD school led by Navy formed in 1947. • Propellant research and development added to installation mission. • Jet Propulsion Research Lab founded (1940-1944).
1950 – 1960	• Facility changed its name to the *Naval Propellant Plant*. • Research and development on the Polaris and other rocket programs began.
1960 – 1980	• Rum Point, an 80-acre promontory on the Mattawoman Creek, was acquired by condemnation in 1966. • Bullitts Neck, a separate 47-acre promontory in the Mattawoman Creek, was purchased in five small acquisitions (1965-1966). • The Naval Propellant Plant changed its name to the *Naval Ordnance Station* to reflect the diversification from propellants into related fields of chemistry, engineering, and production contract management.
1980 - 1990	• Full-scale production at the Naval Ordnance Station concentrated on several processes/products too unprofitable, too dangerous, or too difficult for the private sector to manufacture. • The Naval Ordnance Station became the center of excellence for the following technologies: guns, rockets and missiles; energetic chemicals; ordnance devices; missile weapon simulators; explosive process development engineering; and explosive safety, occupational safety and health, and environmental protection.
1990 - present	• EOD School at the Stump Neck Annex was closed in 1999. • Currently, the mission of the NDW, IH is to ensure operational readiness of U.S. and allied forces by providing the full spectrum technical capabilities necessary to rapidly move any “energetics” product from concept through production to operational deployment.

2.3. Munitions Related Training / Storage / Usage

Based on the historical use of NDW, IH it is evident that munitions training, storage and use have been extensive over the operational history of the installation. Since the establishment of NDW, IH, mission critical areas have included:

- Energetics research;
- Chemical/physical characterization;
- Detonation science;
- Weapons product development;
- Cartridge-actuated devices/propellant-actuated devices (CADs/PADs) ordnance evaluation.
- Underwater warheads;
- Nitramine gun/high-energy propellants;
- Weapon simulation;
- Chemical processing/nitration; and

Reported ordnance items accounted for at the installation include mines, torpedoes, rockets, missiles, small arms, mortars, grenades, bombs, Naval guns, explosives and their byproducts from testing and manufacture.

This section is limited to the other than operational ranges that are the subject of this PA. These ranges were either identified during the Navy Range Inventory process or as a result of the data collection for this PA. Current storage near the ranges is not addressed for security concerns. A brief description of the usage of each other than operational range is provided below:

FDR Skeet Range – The FDR Skeet Range is a 34-acre area located on the southeast portion of the Main Installation. Reportedly, the range was used as a recreational skeet range between the 1940s and 1960s; however, use as a skeet range could not be confirmed. Based on the reported information regarding the FDR Skeet Range, it is assumed that the area's use was limited to shot gun ammunition and clay targets.

Burning Grounds - Production operations at NDW, IH have required the need for disposal of waste by burning. Several areas at the Main Installation at NDW, IH are reported to have been utilized for burning. The four documented burning areas include the Original Burning Ground [Installation Restoration (IR) Site 28], the Safety Thermal Treatment Point, the Strauss Avenue Thermal Treatment Point, and Caffee Road Thermal Treatment Point. The Strauss Avenue and Caffee Road Thermal Treatment Points are either active or located in active areas and therefore are not included in this assessment. The Original Burning Ground was operated from the 1930's

until the early 1940's for the incineration of scrap single and double-base propellants, composite propellants, and various propellant ingredients. This range is being addressed under the Installation Restoration Program (IRP), Site 28 and is not included in this assessment. The Safety Thermal Treatment Point, in operation from approximately 1942 to 1988, was the burning ground used after the Original Burning Ground was closed.

Based on interviews conducted as part of this PA, two additional burning grounds are suspected to have been operated at the Main Installation: the Gate 3 Burning Ground and the Nitroglycerine (NG) Slums Burning Ground. Reportedly, these areas were used to dispose of by-products generated from the NG Plant, which has been in operation at the Main Installation since approximately 1948.

The following three paragraphs provide a brief summary of the burning grounds that are part of this Preliminary Assessment.

Gate 3 Burning Ground **–** The Gate 3 Burning Ground is a 0.23-acre area located along the shoreline of the Potomac River near the intersection of Strauss Ave. and E. Caffee Road. According to a former installation employee in charge of the burning points, Mr. Ivan Tominack, explosives may have been brought to this location for burning. Reportedly, the Gate 3 Burning Ground was in operation from approximately 1955 to 1961.

NG Slums Burning Ground **–** The 0.3-acre NG Slums Burning Ground (IR Site 22) was reported to be located on the southeastern shore of the Main Installation adjacent to the Mattawoman Creek; however, the location of the range is speculative. Reportedly, the area was used as an open burning (OB) ground for NG slums (i.e., excess NG mixed with sawdust for stabilization) generated at the NG production facilities. The NG Slums Burning Ground was reported to have been operated from the late 1940s, when the NG production facilities were built, until approximately 1953. Potential MEC at the NG Slums Burning Ground is NG.

Safety Thermal Treatment Point **–** The Safety Thermal Treatment Point (STTP) is approximately 1.6 acres located at the end of a small peninsula that extends southwest from the Indian Head Main Installation peninsula into the Mattawoman Creek. The area was used for OB/open detonation (OD) and testing of projectiles, bulk propellant, bulk high explosives, demolition charges, CAD/PADs, primers, less sensitive explosives, and various other pyrotechnics from the

late 1940s to 1988. As reported in the 1996 Draft Closure and Post Closure Plans for the Safety Thermal Treatment Point, soil and groundwater samples demonstrated elevated levels of explosives and metals.

Single Base Propellant Grains Spill Area – The Single Base Propellant Grains Spill Area is a 52-acre site located in the northeastern portion of the Indian Head peninsula, south of East Farnum Road. This site is comprised of an area where propellant grains were spilled during transportation of the propellant by rail at the installation. Transportation of the grains by rail started between 1927 and 1942, and was terminated in the late 1980s. Single base propellant grains, popular propelling charges that provide efficient smokeless powder, are comprised primarily of nitrocellulose. Under certain conditions, these propellants may present a flammable or explosive hazard.

Southwestern Pistol Range – The Southwestern Pistol Range comprises 1.26 acres located at the western end of the Main Installation, between Drop Tower Drive and Pump House Lane, along the Potomac River. While the dates of use are unknown, the range was identified on a 1942 installation map as a "target range." The range was used for small arms training. No information was found regarding the layout and orientation of the range.

The Valley - The Valley is a 21-acre area that was used for developing and testing numerous ordnance items from 1891 through 1921. Historical documentation states that various calibers of guns (1-inch through 16-inch) were proved at The Valley with various projectiles including armor piercing (AP) shells. Tested shells contained different types of explosives. In addition to projectile testing and gun proving, cartridges cases, fuzes, primers, firing devices, gun implements and powders were also tested.

As illustrated in Figure 2.3-1, the western portion of the Main Installation peninsula lies within the estimated firing fan for The Valley. Based upon its historical use, there is a potential for munitions associated with The Valley to be present in the areas within the estimated limits of this firing fan. The following other than operational ranges at the Main Installation are within the estimated firing fan for The Valley: the Gate 3 Burning Ground and the Southwest Pistol Range.

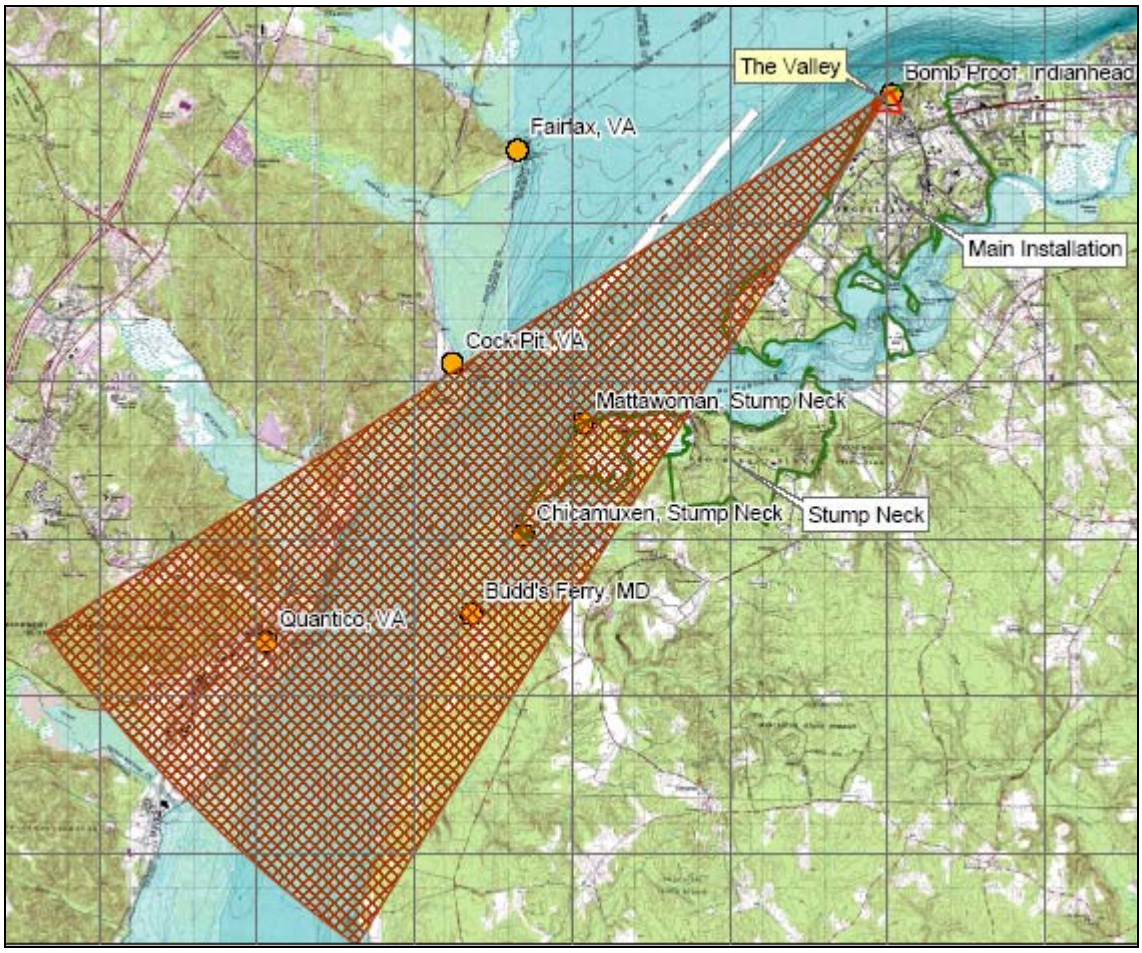

Figure 2.3-1: The Valley Firing Fan

3. PHYSICAL AND ENVIRONMENTAL CHARACTERISTICS

The following sections provide general physical and environmental characteristic information for NDW, IH including its climate, topography, geology, soil and vegetation types, hydrology, hydrogeology, cultural and natural resources, and threatened and endangered species.

3.1. Climate

NDW, IH, located on the eastern shore of the Potomac River in Charles County, MD, has a continental-type climate with four well-defined seasons. Located in the middle latitudes of North America, atmospheric flow is from west to east. The Potomac River and its tributaries significantly affect the climate, moderating extreme temperatures and causing higher humidity at the NDW, IH. In the winter, the Blue Ridge and Appalachian mountain ranges located to the west of the NDW, IH obstruct the cold, continental air. The coldest period occurs in late January and early February, with low temperatures averaging 29 degrees Fahrenheit (ºF). July is the warmest month with average high temperatures of 85ºF. Precipitation is well distributed throughout the year, with July and August as the wettest months. Average annual precipitation is 44 inches. Maximum snow accumulation averages nine inches between November and March. The growing season lasts approximately 190 days, starting in mid-April.

3.2. Topography

NDW, IH occupies two peninsulas along the eastern shore of the Potomac River. The Main Installation is located on the northern peninsula. The general topography of the mainland areas of Charles County can be described as gently rolling lands with a few steep slopes. This area includes many drainage swales and streams. Shoreline areas along the Potomac River are generally steeply sloped.

The Main Installation has a relatively low topographic profile. The highest point is the northeastern portion of the peninsula with an elevation of approximately 110 feet above mean sea level (msl). The western border of the Main Installation (along the eastern Potomac River shoreline) is characterized by 40- to 50-foot bluffs, while the eastern portion (along Mattawoman Creek) is more gently sloping, although some areas with 10- to 40-foot bluffs exist.

3.3. Geology

NDW, IH lies within the Atlantic Coastal Plain Physiographic Province, eight to ten miles east of the Fall Line that marks the western extent of the physiographic province. The regional geology consists of a sedimentary wedge of Cretaceous to Quaternary, fluvial and marine deposits overlying crystalline Precambrian metamorphic and igneous bedrock. The sedimentary wedge dips and thickens eastward and ranges in thickness from 550 feet to 900 feet in the vicinity of NDW, IH (Vroblesky, 1991; Hiortdahl, 1990). It lies non-conformably on the crystalline basement rock surface, which dips to the east. The geologic units underlying NDW, IH, in stratigraphically ascending order, are the Lower Cretaceous Potomac Group, the Tertiary age Aquia Formation of the Pamunkey Group, fluvial-estuarine deposits of Tertiary to early Quaternary age, and undivided Quaternary deposits.

The lithology of the Potomac Group consists of interbedded clay, silt, sand, and gravel deposited in fluviodeltaic environments (Hiortdahl, 1990). The Potomac Group ranges in thickness from 650 to 750 feet in the vicinity of the Main Installation (Vroblesky, 1991; Harsh and Laczniak, 1990) and consists of three geologic units (in ascending stratigraphic order): the Patuxent Formation; the Arundel Formation; and the Patapsco Formation.

The Patuxent Formation consists of sand and pebbles with thin clay interbeds and is 300-400 feet thick in the study area. The Arundel Formation generally consists of a massive clay with abundant lignite and siderite concretions and is less than 100 feet thick beneath most of northwestern Charles County. The Patapsco Formation generally consists of sand and silt separated by thick clay layers. The interpreted thickness of the Patapsco Formation in the study area varies from about 200 feet to more than 450 feet (Hiortdahl, 1997).

The Aquia Formation (Upper Paleocene) consists of marine deposits of olive black to olive gray, micaceous, glauconitic quartz sand interbedded with sand, silt, and clay. The formation is up to 80 feet thick in the NDW, IH area. The younger units of the Pamunkey Group and the Chesapeake Group have been removed by erosion in the study area.

Overlying the Aquia Formation are fluvial-sedimentary deposits consisting of gravel, sand, and loam. These sediments are referred to as “upland deposits” and range in age from Pliocene to early Pleistocene (Hiortdahl, 1997). The upland deposits crop out at the surface in the northern portion of NDW, IH where surface elevations exceed 40 feet. However, beneath most of the

study area, the surficial sediments consist of Pleistocene paleochannel deposits and Holocene alluvial and paludal deposits (Hiortdahl, 1997). These deposits consist of gravel, sand, silt, clay, and peat mixtures with irregular bedding, with an aggregate thickness of zero to approximately 40 feet. The Aquia Formation and younger upland deposits are missing in many locations in the NDW, IH region due to erosion and deposition in Pleistocene and Holocene paleochannels. Where this occurs, the overlying Quaternary deposits directly overlie the Cretaceous formations.

3.4. Soil and Vegetation Types

Charles County is located within the inner Potomac Coastal Plain geologic province. The soils in this area are derived from unconsolidated marine sediments that vary from sandy to clayey in texture and from excessively well drained to poorly drained. Hydric and erodible soils are prevalent. High water tables, severe erosion, earth slides and hardpans are common.

The U.S. Department of Agriculture mapped the soils of the Main Installation in the Soil Survey of Charles County, MD, 1974. The primary soil series in this area are the Beltsville, Keyport, and Elkton Silt Loams. Some additional soil types found at the Main Installation are cut-and-fill land, gravelly land, and tidal marsh. The following discussion is a description of the soil types at the Main Installation.

The Beltsville Silt Loam is found primarily in the upland elevations of the northern portion of Indian Head. The Beltsville series soils consist of silt and sand with moderate amounts of clay. They are nearly level to moderately sloping, moderately deep, strongly acidic, slowly permeable and well drained.

The Keyport and Elkton Silt Loams are found in the lower elevations of the southern portion of the Main Installation. They are both clayey silt loam soils and slowly permeable, with the Elkton series being the least permeable.

Cut-and-fill land, gravelly land and tidal marshes are found in the coastal areas of the Main Installation. Cut-and-fill lands are areas where the native soils have been removed and graded or filled with other material or soil. Gravelly land is composed of gravelly deposits with unidentifiable soil types due to severe erosion. Tidal marshes consist of materials ranging from sand to clay, with occurrences of peat and muck.

The land around the Main Installation is heavily vegetated. There are five basic vegetation types present including pine, hardwood, pine-hardwood mix, tidal and non-tidal wetlands, and urban landscape. The hardwoods and the pine-hardwood mix can be further subdivided into upland and wetlands divisions. Most of the forested land is either second or third growth; little, if any, virgin forest remains. The most abundant trees include the Virginia Pine, Sweet Gum, Red Oak, and Yellow Poplar.

Hardwood forest dominates approximately 1,075 acres (nearly 50%) of NDW, IH. Species common to the upland portions of the hardwood forests include Red, White, and Chestnut Oak, Tulip Poplar, and Hickories. The wetland portion is typically comprised of Red Maple, Sweet Gum, Green Ash, and American Sycamore.

The following species are common along the shoreline of the Potomac River: Black Persimmon, Grape, Sea Myrtle, False Indigo, Poison Ivy, Virginia Creeper, and Phlox. In addition, the following grasses are present: Gama Grass, Panic Grass, Bermuda Grass, and Finger Grass. Marsh areas are dominant along the shores of Mattawoman Creek. They are characterized by Jewelweed, Alger, Marsh Cattail, Weedgrass, Sedge, Three Square Bulrush, Wild Rice, Saltmarsh Cordgrass, Smartweek, and Marsh Mallow.

3.5. Hydrology

The three primary waterways in the area are the Potomac River, Mattawoman Creek, and Chixamuxen Creek. The Potomac River and Mattawoman Creek border the Main Installation, while Mattawoman Creek, and Chixamuxen Creek border the Stump Neck Annex. The Potomac River is a continuous, slow-moving, slightly brackish, tidal tributary to the Chesapeake Bay. Mattawoman Creek and Chixamuxen Creek are Potomac River tributaries and are also tidally influenced. Both have large floodplains and contain large expanses of tidal wetlands and marshes. Many small streams cross the area, most of which drain directly into one of the three major waterways. Wetlands and floodplains are valuable habitat for wildlife, important groundwater recharge areas, and filters for surface water runoff, thus minimizing siltation and erosion. They are also important aesthetic buffers, scientific resources and, in some cases, recreational areas.

Based on the drainage divides derived from the topography of the area shown in a 1983 Initial Assessment Study conducted at NDW, IH the majority of the natural drainage at the Main Installation flows to the Mattawoman Creek.

3.6. Hydrogeology

The hydrogeologic framework of the Indian Head area consists of a surficial aquifer and three major underlying confined aquifers: the lower Patapsco aquifer, upper Patuxent aquifer, and lower Patuxent aquifer. Although underlying the surficial aquifer, the upper Patapsco aquifer is considered a poor producer of groundwater in the area and is not considered to be a major aquifer at NDW, IH. Rather than continuous bodies of sands, the individual confined aquifers consist of multiple sand layers interbedded with lower permeability layers. The aquifers are described in detail below.

Surficial aquifer: Shallow, unconfined to semi-confined groundwater at the NDW, IH occurs in the surficial aquifer from near surface to approximately 45 feet below ground surface (bgs), with water-table elevations ranging from sea level to approximately 65 feet above msl. Depending on location, the surficial aquifer is composed of Quaternary paleochannel deposits, Tertiary to Quaternary upland deposits, the Aquia Formation, or even sediments of Patapsco Formation. Typically, the shallow groundwater occurs in perched water-bearing zones and is recharged from infiltration (Hart, 1983). In some lowland areas, surface water intrusion may be an additional source of recharge of the shallow aquifer along the edge of water bodies and during periods of high tide. Shallow groundwater flow follows topography and discharges to local surface water bodies.

The descriptions and hydrogeologic properties of the confined aquifers presented in this section are derived primarily from Andreasen (1999).

Lower Patapsco aquifer: The lower Patapsco aquifer lies at 70-200 feet below msl in the study area, with a thickness ranging from 65-140 feet. The transmissivity of the lower Patapsco aquifer ranges from about 190 to 700 square feet per day (ft^2/d) near Indian Head. The aquifer is underlain by relatively low permeability sediments of the Patapsco Formation and is underlain by the low permeability Arundel Clay. In most places, the Arundel Clay serves as an effective confining unit between the lower Patapsco and upper Patuxent aquifers, although a hydraulic connection occurs where the Arundel Clay is thin or more heterogeneous.

The lower Patapsco aquifer is the principal water-supply aquifer at NDW, IH. Potable water supply wells at NDW, IH are typically screened in multiple sand layers within this aquifer at an average depth of 200 to 300 feet. These potable water wells serve an approximate population of 4,050 people, including civilian and enlisted Navy employees and contractor employees. Although none of the NDW, IH wells supply reserves or residences beyond the facility boundaries, the lower Patapsco aquifer is used extensively for domestic and municipal water supplies in northwestern Charles County. Several production wells are screened in this aquifer northeast of NDW, IH in and near the towns of Indian Head and Potomac Heights.

Upper Patuxent aquifer: The upper Patuxent aquifer lies at 400-600 feet below msl in the study area and is about 50-70 feet thick. The transmissivity of the upper Patuxent aquifer ranges from about 150 to 2600 ft^2/d in northwestern Charles County. The aquifer is underlain by relatively low permeability sediments of the Patuxent Formation.

Lower Patuxent aquifer: The top of the lower Patuxent aquifer lies at 800–1,000 feet below msl in the study area and is about 100 feet thick. Few potable water wells are screened in the lower Patuxent aquifer due to availability of water from the overlying confined aquifers. The lower Patuxent aquifer is underlain by crystalline basement rock. Water levels in the upper and lower Patuxent aquifer are generally similar due to the leaky nature of the intervening confining unit.

3.7. Cultural and Natural Resources

An archaeological reconnaissance survey of NDW, IH was conducted in 1985 (Barse, 1985). Forty-five sites representing prehistoric time periods from the Early Archaic through the Late Woodland/Contact transition period were identified. Four of these sites were considered to be eligible for nomination to the National Register of Historic Places as containing "categories of information that will help further the discipline of archaeology". It was reported that an additional eight sites might be eligible but that further investigation is needed.

A survey of historic buildings at NDW, IH was also conducted in 1985 and remnants dating back to the Civil War were found at the ravine leading up from the original Potomac River landing area. The reported findings included remnants of test guns and metal plates, which date back to the late 19th Century. The Single Base Powder Production Area, a series of buildings located on top of the bluff along the Potomac River, the water tower, the original power plant, the Victorian officers' quarters and the surgeon's house were reported to date to 1899. The review of cultural

and natural resources is based on limited available information. No additional information was discovered to further assess cultural and natural resources.

3.8. Endangered and Special Status Species

According to the 1997 NDW, IH Wildlife Management Plan, four endangered species are located within NDW, IH. The four species are located at the Stump Neck Annex. Three of them are federally endangered: the American Bald Eagle, rainbow snake, and the joint-vetch (flowering plant of the pea family). The fourth species, the scaly blazing-star (perennial herb), is a species of special concern in the State of Maryland. As of the July 2001 Threatened and Endangered Plant/Animal Species of Charles County, Maryland report, the Maryland Department of Natural Resources Wildlife and Heritage Service still listed these four species as federal and state endangered for Charles County. Although these species are located at the Stump Neck Annex, their proximity to the Main Installation creates a potential for these species to be found there as well.

Protected species that are known to or have the potential to inhabit the Main Installation are listed Table 3.8-1:

Table 3.8-1: Summary of Known or Potential Protected Species

Ecological Receptors	Species
Federal Endangered	• American Bald Eagle • Rainbow Snake • Joint-vetch
Federal Threatened	None Reported
State Endangered	Scaly blazing-star
State Threatened	None Reported
Other Ecological Receptors	None Reported

*Sources of data include:

- NDW, IH Wildlife Management Plan, 1997.
- Threatened and Endangered Plant/Animal Species of Charles County, Maryland, July 2001. Maryland Department of Natural Resources.

4. SUMMARY OF DATA COLLECTION EFFORT

Five primary sources of information were researched as part of the data collection effort for the PA. The sources of data included:

1) Historical archives;
2) Personal interviews;
3) Installation data repositories;
4) Visual surveys; and
5) Off-site data sources and repositories.

These data sources are discussed below, along with their applicability relative to this PA. References for the data obtained are included in Appendix A. Appendix B and Appendix C contain the source data listed in Appendix A.

4.1. Historical Archive Repositories (off-site)

The data collection team reviewed archival records located at the National Archives in College Park, MD, and in Washington, D.C. The data collection team researched the following records and record groups (RG) for documents relating to munitions usage at NDW, IH. An asterisk (*) indicates the material was photocopied.

Textual Records:

RG 71, Bureau of Yards and Docks

Naval Property Case Files, Boxes 580*, 581*, 582*, 583*, 584

Unprocessed Naval Property Case Files, Box 36

RG 72, Bureau of Aeronautics

Entry 67, Confidential Correspondence, 1922-1944, Boxes 977, 1205*

Entry 67-A, Confidential General Correspondence, 1945, Box

Entry 62-B, General Correspondence, 1943-1945, Boxes 2320, 2931, 2946, 2938, 2978, 2982, 2996, 2998, 3003, 3010, 3050, 3066, 3078, 3470,

RG 74, Bureau of Ordnance

Entry 25, General Correspondence, 1926-1944, Boxes 937*, 938*, 939*, 940, 941*

Entry 25-C, General Correspondence, Confidential, 1926-1939, Box 98

Entry 25-E, General Correspondence, Confidential, 1940-1942, Box 189*

Entry 25-I, General Correspondence, 1942, Confidential, Box 212*

Entry 25-J, General Correspondence, 1942, Restricted, Boxes 512*, 513*, 514

Entry 25-M, General Correspondence, 1943, Confidential, Box 389

Entry 25-O, General Correspondence, 1943, Restricted, Boxes 600-602

Entry 25-U, General Correspondence, 1944, Confidential, Boxes 557-561

Entry 25-V, General Correspondence, 1944, Restricted, Boxes 1031, 1032*, 1033-1035

Entry 1001, General Correspondence, 1907-1949

1947, Box 36

1948, Box 64

1949, Box 103

Entry 1003 A, General Correspondence, 1948, Boxes 129*, 173, 174, 175

Entry 1003 A, General Correspondence, 1949, Box 534*

Construction and Procurement Subject Files

1945, Boxes 828, 1222, 1256, 1257, 1264, 1265, 1284, 1285, 1354*, 1355*, 1356*, 1357*, 1358*, 1359*, 1360*, 1390-1393, 1443*, 1444*, 1445*, 1446*, 1488*, 1489*, 1600

1946, Boxes 309*, 310*, 311*

RG 127, U.S. Marine Corps, Office of the Commandant

General Correspondence, 1939-1850, Boxes 230, 840, 1805, 1806

RG 334, Records of Inter-Service Agencies, Armed Forces Explosives Safety Board

Entry 15, Explosion Files, 131, 234, 329

Cartographic Records:

RG 23, Coast and Geodetic Survey

Folders for Charts 559*, 560*

RG 57, U.S. Geological Survey

RG 71, Bureau of Yards and Docks

Maps for facility 502*, 509, codes 1, 2, 3, 15, 16, 32, 34, 42, 44-48

Series I microfilm, Rolls 500*, 501, 502, 503*, 516*

Series II Index Boxes 67-69, 73

Series II Microfilm, Reels 418*, 419*, 420, 444*, 1344*, 1345*

RG 77, Department of Army

Army Mapping Service, AMS-V833*

RG 385, Naval Facilities Engineering Command, 1917-1989

Architectural and Engineering Plans, Boxes 2, 185

Restricted UIC Architectural and Engineering Plans, Boxes C27, C28, C29, C30*, C31, C38*

Aerial Photographs:

RG 373, Defense Intelligence Agency

Can ON 38542

Still Photos:

RG 71, Bureau of Yards and Docks

Entry 71-CA, Construction Projects, 1879-1943, Box 191*

Entry 71-CB, Construction Projects, 1940-1943, Boxes 52, 136

Entry 71-CP, Construction Projects, 1941-1953, Boxes 33-35, 70, 78, 83

NAVAL HISTORICAL CENTER, WASHINGTON, D.C.

Photo Archives, Aerials *

Photo Archives, Card File

Operational Archives

Command Histories, 1945-1991*

NATIONAL ARCHIVES, REGIONAL OFFICE, PHILADELPHIA

RG 181, U.S. Naval Districts and Shore Establishments

Central Subject Files, Naval Powder Factory, 1907-1925, Boxes 1, 2, 3*, 4, 5, 6*, 7-11, 12*, 13*, 14, 15*, 16*, 17*, 18*, 19-30

Upon receipt of this information from the archive research subcontractor, Nicklason Research Associates, Malcolm Pirnie's project team organized the information by subject matter and reviewed the content for applicability in the PA process. The relevant information was then digitized and is provided as a part of the project record contained in the CD submitted with this PA.

4.2. Personal Interviews

The following NDW, IH personnel were interviewed during the site visits or via telephone (Table 4.2-1). Relevant interviews have been documented and are included in Appendix C.

Table 4.2-1: NDW, IH Personnel Interviewed during Site Visits

Name	Office
Christina Adams	Public Affairs
Dave Bode	Safety Department
Jeff Bossart	Natural Resources
Walter Carr	NG Plant
Joe Cooper	NG Plant
Tom Cox	Public Works
Bruce Dalton	Safety Department, Retired
Jim Dolph	Navy Historian
Kathy Frey	Environmental Office
Kenny Grimes	NG Plant
Frank James	Safety Department /EOD
Shawn Jorgensen	Environmental Office
Cee Cee Krawling	Base Security
Tara Landis	Public Affairs

Table 4.2-1: NDW, IH Personnel Interviewed during Site Visits	
Name	**Office**
Elaine Magdinec	Environmental Office
John McDevitt	NDW, IH Retired
Gordon Miller	Retired Marine Corp EOD
Heidi Morgan	Environmental Office
Jeff Morris	RPM NAVFAC Washington
William Penn	NDW, IH Retired
AJ Perk	Production Engineer and Former Head of Production, NDW, IH Retired
Wes Pero	Safety Department
Pete Perry	NDW, IH Retired.
Allison Poe	Public Works Office/ Geographic Information System (GIS) Specialist
Diana Rose	Environmental Office
Lou Scalafari	Former Public Works Employee
John Stacey	Public Works/Master Plan
David Stewart	Public Works/Utilities
Ivan Tominack	NDW, IH Retired

4.3. On-Site Data Repositories

The following is a partial list of data sources accessed for this PA. A complete, detailed listing is provided on the CD.

- NDW, IH Environmental Office
- NAVEODTECHDIV Environmental Office
- NDW, IH Natural Resources Office
- NDW, IH Cultural Resources Office
- NDW, IH NEPA Program Office
- NDW, IH Public Works Office
- NDW, IH Safety Office
- Ordnance and Explosives Support Office

- NAVEODTECHDIV Technical Library
- NDW, IH Technical Library
- NDW, IH Public Affairs Office
- NDW, IH Installation Repository ("The Barn")
- NDW, IH Public Works Map Room ("The Vault")
- NDW, IH Photo Lab

4.4. Visual Survey

A visual survey of each site/range was part of the data collection effort to identify MEC related materials (e.g., expended rounds, fragmentation, range debris, old targets), evidence of MC (such as ground scarring, stressed vegetation, or observable chemical residue), and/or surface features that could provide additional information to aid in the characterization of the site. The visual survey was also used to enhance, augment, or confirm the archival data and, in some cases, provide new information regarding the historical use and current conditions of the site. The surveys were completed in 2003 on June 23-27, November 17-21, and December 1-2. A description of the ranges/areas surveyed and the results of the surveys are provided in Section 5.

4.5. Off-Site Data Sources

The following off-site repositories were contacted by Malcolm Pirnie to obtain information for this PA. A listing of informational resources provided is included.

Potomac Branch Library, Indian Head, MD - The book, *Praising the Bridge that Brought Me Over,* was provided.

Town Hall. Indian Head, MD - No relevant information was provided.

Maryland Historical Society, Baltimore, MD- Two books: *Maryland A to Z, A Topographical Dictionary* and *Gun Powder Town on the Potomac* and a newspaper article regarding town history were provided and reviewed.

Torpedo Factory Art Center, Alexandria, Virginia[*]- No references to Indian Head were discovered.

Alexandria Central Library* - No relevant information was provided.

*Researched based on speculation that torpedoes manufactured at the former facility may have been sent to NDW, Indian Head for testing.

5. SITE CHARACTERISTICS

The following sections provide site-specific information about each of the sites located on NDW, IH including history and site description; land use; access controls and restrictions; visual survey observation and results; contaminant migration routes; and receptors.

5.1. FDR SKEET RANGE

5.1.1. History and Site Description

The FDR Skeet Range was reportedly a recreational target practice area from the 1940s until the 1960s. Based on interviews with workers of the NG plant, the range was included in the Navy Range Inventory as a 5.1-acre range. This acreage was increased to 34 acres during the PA. While its location and existence has not been confirmed, the reported location is on the southeast portion of the Main Installation adjacent to the Mattawoman Creek.

Historic facility maps from the 1940s show two small structures in the area of the FDR Skeet Range that were identified as possible trap houses in November 2003 interviews with Mr. Carr and Mr. Cooper (employees of the NG Plant for more than 40 years). According to Mr. Cooper, the remnants of the wooden trap houses were destroyed when the NG Plant exploded in 1967. Using this information, inferred orientations of the trap houses indicate that firing occurred to the northeast towards an outfall creek on the eastern boundary of the range.

Figure 5.1-1: Current conditions of FDR Skeet Range area.

Map 5.1-1 shows two area delineations that illustrate: (1) the 5.1 acre boundary of the FDR Skeet Range as estimated by the Navy Range Inventory and (2) the potential new boundary of the FDR Skeet Range covering 34 acres as identified during the PA process. The new FDR Skeet Range boundary and acreage reflects information collected during the PA. According to Army Technical Manuals (referenced as AR 750-10 and TM 9-855) and the Navy Programming Guide (1958), the shooting

field (i.e., firing arc) for a typical skeet range was laid out as a 63-foot radius semi-circle with concrete/asphalt walkways. The surface danger zone (SDZ), which includes the down range hazard area and safety fan, consisted of a semi-circle with a 900-foot radius that utilized the same apex as the shooting field. Map 5.1-2 indicates the location of the potential trap houses that were used to estimate the new boundary of FDR Skeet Range. The information within this PA report focuses on the updated, 34-acre range boundary.

As shown in Figure 5.1-1, the area identified in the Navy Range Inventory as the FDR Skeet Range area is a hilly and wooded area; vegetation and topography do not support the existence of a skeet range in this area. West Noble Road runs along the southern portion of the range. Remnants of an icehouse and barbeque pit, reportedly associated with the skeet range or other recreational uses in the area, were observed along the Mattawoman Creek. The additional area identified during the PA process extends to the east of the originally identified area, and includes developed areas.

5.1.1.1.Topography

Section 3.2 provides a general description of topography for the Main Installation. At the area known as the FDR Skeet Range, the topography is hilly and has an overall relief that slopes from a high elevation of approximately 35 feet above msl in the northeastern portion of the area to the shoreline at the Mattawoman Creek.

5.1.1.2.Geology

Section 3.3 provides a geologic description for NDW, IH and surrounding area. This general description is applicable to the FDR Skeet Range.

5.1.1.3.Soil and Vegetation Types

Section 3.4 provides a description of the soil and vegetation types at the Main Installation. According to the *US Navy Closed, Transferred, and Transferring Range and Other Sites Questionnaire*, the predominant soil type associated with the FDR Skeet Range area is sand-silt/sand-clay. The FDR Skeet Range is located in a hardwood forest area.

5.1.1.4.Hydrology

Section 3.5 provides a description of hydrology at the Main Installation. The FDR Skeet Range is located along the Mattawoman Creek, and an unnamed creek runs along the eastern portion of the range discharging into the Mattawoman Creek. Surface water flows overland towards the unnamed creek or the Mattawoman Creek. Wetlands exist along the unnamed creek on the eastern portion of the FDR Skeet Range and extend north of the range.

5.1.1.5.Hydrogeology

Section 3.6 provides a description of hydrogeology for the Main Installation. This information is applicable to the area of the FDR Skeet Range.

5.1.1.6.Cultural and Natural Resources

As discussed in Section 3.7, an archaeological reconnaissance survey of NDW, IH was conducted in 1985. None of the archaeologically significant areas identified in the survey were reported to be located in the FDR Skeet Range area.

5.1.1.7.Endangered and Special Status Species

As discussed in Section 3.8, endangered and special status species are reported to exist at the Stump Neck Annex of NDW, IH. The reported endangered and special status species are expected to inhabit the Main Installation and thus, have the potential to inhabit the FDR Skeet Range. Reportedly, an American Bald Eagle resides within the boundaries of the FDR Skeet Range.

5.1.2. Visual Survey Observations and Results

A visual survey of the FDR Skeet Range was conducted on June 23, 2003. Malcolm Pirnie personnel who conducted the visual survey included Ms. Julie Grim, Mr. Stephen Rice, Mr. Mike Baker, and Mr. Robert Wiley. Mr. Jorgensen, NDW, IH Environmental Office, accompanied the team. They performed several walking transects across the range to visually inspect the location. The FDR Skeet Range consisted of a woodland area that is no longer used. Remnants of a wooden building were observed on the northern portion of the area. According to Mr. Walter Carr, shooting occurred in the northern portion of the range towards the unnamed tributary to the

Mattawoman Creek along the eastern boundary. This statement is based on the orientation of the potential trap houses as the range was not active during Mr. Carr's career at the NG plant. A barbeque pit and icehouse were observed along the Mattawoman Creek on the southern portion of FDR Skeet Range.

A visual depiction of the site reconnaissance route is provided on Map 5.1-1 located at the end of Section 5.1. Additional range/site details are illustrated on Map 5.1-2, also located at the end of Section 5.1.

5.1.3. Munitions and Munitions Related Materials Associated with the Site

This section describes the munitions or munitions related materials known or suspected to be at the FDR Skeet Range, including the types and estimated maximum penetration depths. This includes both MEC and non-hazardous munitions related debris (e.g., fragmentation, base plates, and/or inert mortar fins). However, since the FDR Skeet Range was used for small arms training only, MEC and non-hazardous munitions related scrap are not known or suspected to have been present at the site.

Munitions use at the FDR Skeet Range was limited to shotgun ammunition. The exact quantity of shotgun ammunition deployed or fired at the range is unknown. Firing records were not available, and there is no defensible method of determining the amount of ammunition potentially fired at the range. Ordnance technical data sheets for shotgun ammunition are included in Appendix C. Based on the information obtained during the data collection process, special consideration munitions such as chemical warfare materiel (CMW) filled munitions, electrically fuzed munitions, and/or depleted uranium (DU) associated munitions, are not known or suspected to have been used at the site.

5.1.4. MEC Presence

The entire range has been subdivided and categorized into one of three levels of MEC presence including: Known MEC Areas; Suspect MEC Areas; or Areas Where No Evidence Exists to indicate that MEC is known or is suspected to be at the site. The MEC presence is discussed below. Map 5.1-3 illustrates the munitions characterization of the FDR Skeet Range and is provided at the end of Section 5.1.

5.1.4.1.Known MEC Areas

Based on historical documents and information obtained during the data collection process, there is no evidence of MEC at the FDR Skeet Range as only shotguns were used. Therefore, there are no known MEC areas.

5.1.4.2.Suspected MEC Areas

Based on historical documents and information obtained during the data collection process, there is no evidence of MEC at the FDR Skeet Range. Therefore, there are no suspected MEC areas.

5.1.4.3.Areas Not Suspected to Contain MEC

Based on historical documents and information obtained during the data collection process, there is no evidence of MEC at the FDR Skeet Range as only shotguns were used. Therefore, the entire FDR Skeet Range is not suspected to contain MEC.

5.1.5. Ordnance Penetration Estimates

The depth to which munitions penetrate below the ground surface depends on many factors, including the type of soil, the angle of impact, the size of the munitions, the velocity at impact, and site-specific environmental conditions.

For small arms ranges, the Interstate Technology and Regulatory Council (ITRC) has prepared a document titled, "Characterization and Remediation of Soils at Closed Small Arms Firing Ranges", dated January 2003, to provide information on the general layout of small arms ranges, as well as information on areas that may be impacted with MC and/or MEC as a result of range use and the characteristics of the munitions used. According to the ITRC guidance, the penetration depth of small arms on the range floor is one foot or less. The document states that rounds that impact the range floor are typically a flat trajectory that fell short of or missed the target, or those resulting from ricochet, and these fragments are usually found within the top six inches of soil. For trap and skeet ranges, the ammunition is dispersed as pellets over a small area in the direction of fire. According to the 1958 Programming Guide, the minimum safe range from a skeet/trap range is 900 feet. Pellets dispersed from a shotgun would be deposited on the

ground surface and not significantly penetrate the ground, unless the ground was disturbed and turned under.

5.1.6. Munitions Constituents

For shotgun ammunition and clay targets, the primary MC of concern include lead from shot and polycyclic aromatic hydrocarbons (PAHs) from pitch tar used in clay targets. PAHs present in clay targets tend to be tightly bound in the petroleum pitch and limestone matrix of the target and are not readily available to the environment. In addition, the clay targets contain low solubility, high molecular weight PAHs that are not likely to effectively leach into the surrounding soils. Other associated MC less likely to be of concern may include antimony, arsenic, nickel, and lead styphnate/lead azide. These MC items are not consumed when the munitions items function as they are designed. Therefore, these MC may exist at the FDR Skeet Range. Based on discussions with installation personnel, surface soil sampling at the FDR Skeet Range has not occurred. Review of IRP documents indicates that groundwater monitoring wells have not been installed near the site.

5.1.7. Contaminant Migration Routes

Environmental media through which MC may migrate from the FDR Skeet Range include soil, groundwater, surface water, and sediment. Direct human or biota contact with surficial and subsurface soil may take place. Precipitation infiltration may provide for contaminant mobility through the subsurface to the shallow or surficial groundwater aquifer, which is assumed to be connected to the nearby surface water bodies. Based on a review of hydrogeological data, it is unlikely that MC in shallow groundwater would migrate to the deeper aquifers that are used as a water supply. However, shallow groundwater is still considered a potential exposure media.

The FDR Skeet Range's proximity to the Mattawoman Creek and the unnamed tributary creek on its eastern boundary provides possible migration routes to surface water. The majority of the area is sloped toward the creeks, and storm water discharges to surface water via overland flow. Groundwater flow in the shallow water table aquifer also likely trends towards the Mattawoman Creek; therefore, MC leaching from soils into shallow groundwater may migrate to surface water. Sediments can act as contaminant repositories, and sediment mixing and dredging can act as migration routes to surface water. MC in surface soils and sediments may migrate via plant/animal uptake.

5.1.8. Receptors

Potential human receptors include authorized Navy personnel (military and civilian), visitors, contractors, maintenance workers, recreational river users and trespassers. Plant and animal biota are also potential receptors. Examples of potential ecological receptors include deer, wild turkey, and water fowl.

5.1.8.1. Nearby Populations

Charles County's population density is approximately 261.5 people per square mile according to the 2000 U.S. Census. NDW, IH and its tenant commands employ approximately 3,600 military and civilian personnel. NDW, IH is Charles Country's largest employer. Over 76 percent of NDW, IH employees live within Charles County, and approximately 500 military and family members live at the installation. Recreation on and around the installation includes hunting and fishing by permit.

5.1.8.2. Buildings Near/Within Site

A number of buildings including Buildings 807, 807a, 829, 1006, and 1464 are located within the SDZ for the FDR Skeet Range.

5.1.8.3. Utilities On/Near Site

Electrical, water, and sewer utility lines run along the southern portion of the FDR Skeet Range, outside of the reported orientation of shooting.

5.1.9. Land Use

While the use of this area is unconfirmed, historical land use may have included a recreational skeet range. Portions of the area are currently wooded, with no active or reported planned future use, while portions of the potential SDZ area are developed. Navy activities associated with buildings 807, 807a, 829, 1006, and 1464 are located within the identified FDR Skeet Range. The area is part of an Upland Hunting Area, as designated on the NDW's 2003-2004 Hunting Map.

5.1.10. Access Controls / Restrictions

No public access is authorized at NDW, IH. Signs, partial fencing, locked/secured gates, login book/office check-in, and vehicle security patrol control the entire facility. There are no access control features specific to the FDR Skeet Range. Access from the water is not controlled. There are no known land use/development restrictions for the range.

5.1.11. Conceptual Site Model

This Conceptual Site Model (CSM) was developed following guidance documents issued by the USEPA for hazardous waste sites and the U.S. Army Corps of Engineers (USACE) for ordnance and explosives (OE) sites. Guidance documents included the USEPA's Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA (EPA/540/G-89/004) and the USACE CSM Guidance Development of Integrated Conceptual Site Models for Environmental Ordnance and Explosives (OE) Sites, which was final as of February 2003.

The CSM describes the site and its environmental setting. The CSM presents information regarding: (1) MEC and/or MC known or suspected to be at the site; (2) current and future reasonably anticipated or proposed uses of the real property; and (3) actual, potentially complete, or incomplete exposure pathways that link them. The CSM is used as a basis for the prioritization and remediation cost estimate.

The CSM is presented in a series of information profiles that present information about the site. The information profiles are included in Table 5.1-1 below.

Table 5.1-1: Conceptual Site Model Information Profiles – FDR Skeet Range

Profile Type	Information Needs	Preliminary Assessment Findings
Range/Site Profile	Installation Name	NDW, Indian Head
	Installation Location	Indian Head, Charles County, MD
	Range/Site Name	FDR Skeet Range
	Range/Site Location	Adjacent to the Mattawoman Creek on the southeast portion of the Main Installation

Table 5.1-1: Conceptual Site Model Information Profiles – FDR Skeet Range		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
	Range/Site History	Reportedly used for recreational skeet shooting from (or before) the 1940s up until the late 1960s. No activity has been reported for the area since the 1960s. The areas to the east of the suspected trap houses within the firing arc are currently developed.
	Range/Site Area and Layout	An unnamed Mattawoman Creek tributary runs through the eastern portion of the area. Marshlands border the tributary and extend north of the range. Historical evidence indicates that firing occurred to the northeast portion of the range towards the marshlands. Although the use of this area is suspect, a typical skeet range from the period of use would include a 900-foot, 180 degree surface danger zone.
	Range/Site Structures	Two trap houses were formerly located at the range, while an icehouse and old barbeque pit are still located along the Mattawoman Creek. A magazine is located immediately west of the area. Buildings 807, 807a, 829, 1006, and 1464 are located within the estimated boundary of the FDR Skeet Range.
	Range/Site Boundaries	N: Wetlands and woodlands S: Mattawoman Creek W: Woodlands E: Woodlands
	Range/Site Security	NDW, IH has installation wide security and access restrictions. Once within the installation, no additional access restriction features exist for the FDR Skeet Range.
Munitions/ Release Profile	Munitions Types	Shotgun pellets
	Maximum Probability Penetration Depth	Six inches or less
	MEC Density	None anticipated
	Munitions Debris	None anticipated
	Associated Munitions Constituents	Metals from shotgun pellets, including lead, copper, nickel, and antimony; PAHs from pitch tar used in clay targets

Table 5.1-1: Conceptual Site Model Information Profiles – FDR Skeet Range		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
	Migration Routes/Release Mechanisms	Soil surface runoff; infiltration, groundwater discharge; site maintenance; construction; excavation
Physical Profile	Climate	Indian Head, MD has a continental-type climate with four well-defined seasons. The coldest period occurs in late January and early February, with low temperatures averaging at 29ºF. July is the warmest month with average maximum temperatures of 85ºF. The normal annual precipitation is approximately 44 inches, normal monthly precipitation varying from 2.25 (February) to 4.60 (August) inches.
	Topography	The highest point at the FDR Skeet Range is approximately 35 feet above msl in the northern portion of the range; it gradually slopes to the Mattawoman Creek.
	Geology	The Indian Head peninsula lies within the Atlantic Coastal plain physiographic province. The geology of the area is comprised of Precambrian igneous and metamorphic bedrock overlain by 500 to 600 feet of unconsolidated fluvial and marine deposits of the Potomac Group. The Potomac Group consists of, in descending order, the Patapsco, Arundel, and Patuxent Formations.
	Soil	According to the US Navy Closed, Transferred, and Transferring Range and Other Sites Questionnaire, the predominant soil type associated with the FDR Skeet Range area is sand-silt/sand-clay.
	Hydrogeology	The hydrogeological makeup of the Indian Head, MD area consists of a surficial aquifer and several deeper confined and semi-confined aquifers in the Patapsco and Patuxent Formations. The surficial aquifer is expected to be connected to and influenced by the surface water bodies. Regional water supplies, including that of NDW, IH are obtained from the lower and middle sands of the Patapsco and Patuxent Formations of the Potomac Group. The surficial aquifer (i.e., water table) is not used for water supply at NDW, IH.
	Hydrology	Wetlands and unnamed creek exist on the eastern portion of the FDR Skeet Range. The wetlands extend north of the range. The unnamed creek discharges into the Mattawoman Creek.

Table 5.1-1: Conceptual Site Model Information Profiles – FDR Skeet Range		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
	Vegetation	The FDR Skeet Range is located in a hardwood forest area.
Land Use and Exposure Profile	Current Land Use	The area identified by the Navy Range Inventory to be the former FDR Skeet Range is undeveloped and not used; however the area inferred as the firing arc is currently developed by numerous installation buildings.
	Current Human Receptors	Navy personnel (military and civilian), visitors, contractors, maintenance workers, recreational users, and trespassers
	Current Activities (frequency, nature of activity)	Moderate activity. Portions of the area are wooded, while some areas are developed. The area is part of an Upland Hunting Area, as designated on the NDW's 2003-2004 Hunting Map.
	Potential Future Land Use	None reported
	Potential Future Human Receptors	Navy personnel (military and civilian), visitors, trespassers, and contractors. These receptors would include construction workers (if intrusive work is necessary) and maintenance and operations workers (if the range use changes) as well as recreational users.
	Potential Future Land Use-Related Activities:	Moderate activity. No reported future plans for the area.
	Zoning/Land Use Restrictions	None reported
	Demographics/Zoning	Charles County population density is approximately 260 persons per square mile. NDW, IH and its tenant commands employ approximately 3,600 military and civilian personnel.
	Beneficial Resources	None
Ecological Profile	Habitat Type	Mature forest and wetland habitats.
	Degree of Disturbance	Low disturbance; habitat and species present are/will be undisturbed.
	Ecological Receptors	
	Federal Endangered Species:	American Bald Eagle, rainbow snake, and the joint-vetch
	Federal Threatened Species:	None
	State Endangered Species:	Scaly blazing-star

Table 5.1-1: Conceptual Site Model Information Profiles – FDR Skeet Range		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
	State Threatened Species:	None
	Other Ecological Receptors:	Endangered and special status species are reported to exist at the Stump Neck Annex of NDW, IH. Therefore, these species likely inhabit the Main Installation and FDR Skeet Range due to its proximity. Other ecological receptors include various flora and animals typical of hardwood forest habitats. Deer and turkey are known to inhabit the area along with other mammals, birds, reptiles, and amphibians.
	Relationship of MEC/MC Sources to Habitat and Potential Receptors	Receptors may have direct or indirect contact with MC that exist in the environment or have been incorporated into the food chain.

A key element of the CSM is the exposure pathway analysis. For MEC, a complete or potentially complete exposure pathway must include the following components: 1) a source (e.g., locations where MEC are expected to be found); 2) access (e.g., controlled or uncontrolled access, items on the surface or within the subsurface); 3) an activity (e.g., non-intrusive grounds maintenance or intrusive construction); and 4) receptors (e.g., Navy personnel [military and civil servants], construction workers, recreational users, authorized visitors, animals). It is important to recognize that environmental mechanisms (e.g., erosion) and/or human intervention may result in the repositioning of MEC.

For MC, a complete or potentially complete exposure pathway must include the following components: 1) a source (e.g., locations where MC are expected to be found); 2) an exposure medium (e.g., surface soil); 3) an exposure route (e.g., dermal contact); and 4) receptors (e.g., Navy personnel [military and civil servants], construction workers, recreational users, authorized visitors, animals). If the point of exposure is not at the same location as the source, the pathway may also include a release mechanism (e.g., volatilization) and a transport medium (e.g., air).

The potential interactions between the source and receptors are assessed differently between MEC and MC. For MEC, interaction between the potential receptors and an MEC source has two components. The receptor must have access to the source and must engage in some activity that results in contact with individual MEC items within the source area. For MC, interaction between the source and receptors involves an MC release mechanism MC, an exposure medium

containing the MC, and an exposure route that places the receptor into contact with the contaminated medium. An exposure pathway is incomplete if any one component is lacking and unlikely to be present in the future. Typically, all potential exposure pathways are initially considered and then information on current and reasonably anticipated future conditions is used to assess whether an exposure pathway is complete, potentially complete, or incomplete.

For the FDR Skeet Range, historic and visual evidence indicate that MEC are not present. Therefore, no complete exposure pathways exist for MEC. As such, no exposure pathway analysis was completed for MEC. However, MC may be present; therefore, potential MC exposure pathways do exist. The MC exposure pathway analysis for MC at the FDR Skeet Range is presented in Figure 5.1-2.

As illustrated in Figure 5.1-2, soil and surface water/sediments represent a primary source medium for MC. Lead shot and PAHs from clay targets may have been deposited on the ground surface. Based on the estimated fan for the skeet range, lead and PAHs could also have been directly released to surface water. Therefore, in surface soils and surface water/sediments, potentially complete exposure pathways exist for the ingestion, direct contact and inhalation of lead and PAHs for human and animal receptors. Plants may accumulate MC as well. Given that the FDR Skeet Range is located within an upland hunting area, MC entering the food chain may provide migration pathways for human and ecological receptors.

Precipitation infiltration may provide for lead and PAH mobility into the subsurface soil and into the shallow or surficial groundwater aquifer, which is assumed to be connected to the nearby surface water bodies, which are used recreationally. Potentially complete exposure pathways to surface water and sediments exist for human and ecological receptors through dermal contact and ingestion. Potentially complete exposure pathways also exist for MC in subsurface soils (direct contact, ingestion and inhalation during intrusive work activities) for all human and ecological receptors with the exception of trespassers. It is not anticipated that trespassers would come in contact with subsurface soils. Although confining layers are expected to prevent the migration of MC to the lower aquifers used for water supply, potentially complete pathways exist for MC in shallow groundwater for human receptors.

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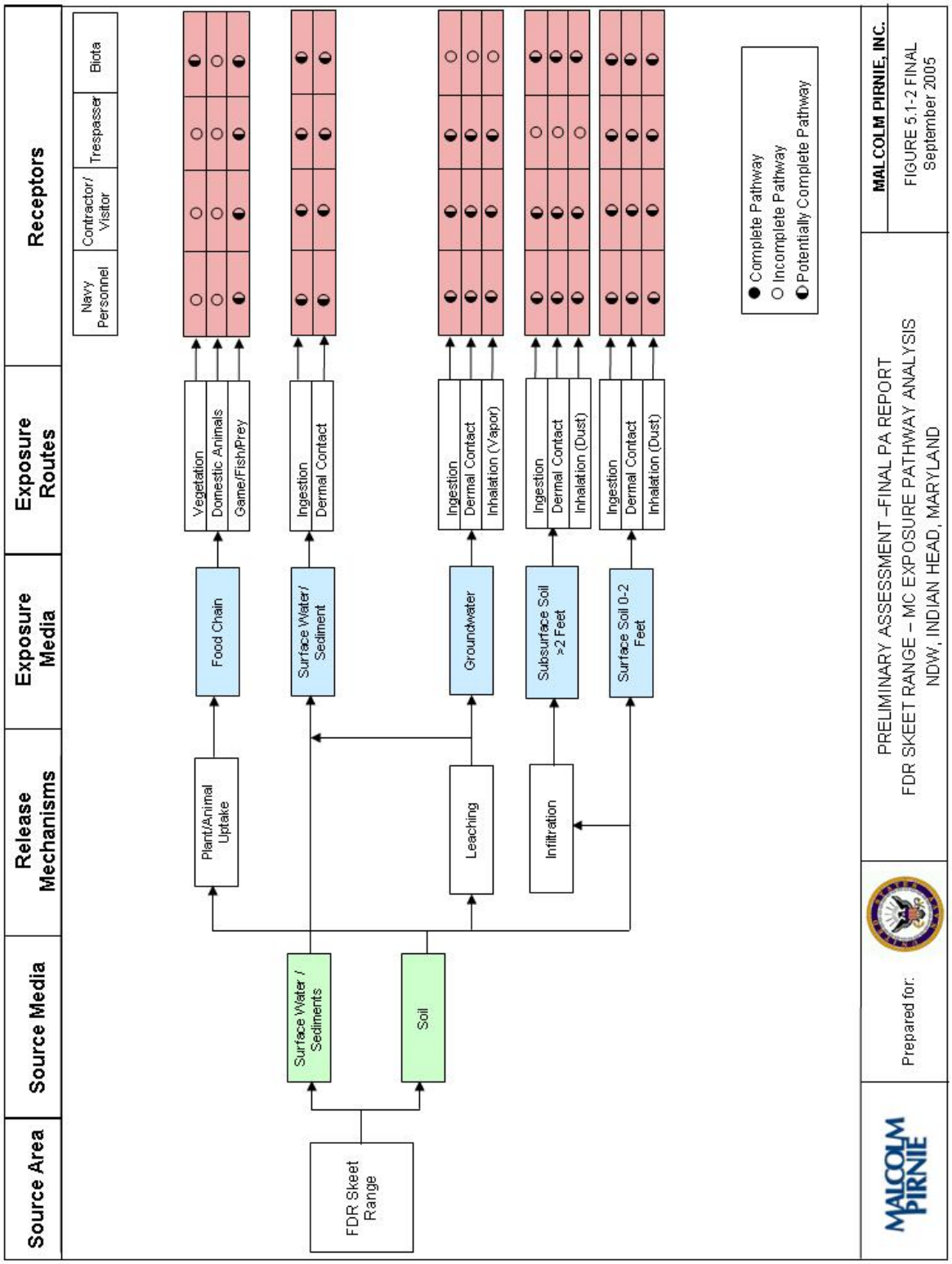
Figure 5.1-2: MC Exposure Pathway Analysis



5.1.12. Summary

From information gathered during the PA, the existence of the FDR Skeet Range is inconclusive. The boundaries of the range have been altered from the Navy Range Inventory to incorporate the potential trap houses, as identified on a 1940s map by former NDW, IH employees. If the FDR Skeet Range area was used as a recreational skeet range, MC associated with shotgun ammunition and clay targets would likely exist. The primary MC of concern, given the suspected nature of use, are lead from shot and PAHs from pitch tar used in clay targets. Since definitive information regarding the location, size, and period of use of the FDR Skeet Range was not available, the intensity and the firing limits of the FDR Skeet Range are not known. The MC at a skeet range is expected to accumulate in the soil horizon. If the area was in fact used as a Skeet Range, the combination of MC presence, access to the area, and migration pathways indicate that potentially complete MC exposure pathways exist. Since only small arms are expected to have been used at the FDR Skeet Range, and MEC are not associated with small arms, no MEC is expected to be present.

Preliminary Assessment
NDW, Indian Head, Maryland

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Map 5.1-1
Visual Survey
FDR Skeet Range

Legend

- Installation Boundary
- FDR Skeet Range From Inventory
- Revised FDR Skeet Range Identified during PA
- Site Reconnaissance

0 50 100 150 200Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005

Preliminary Assessment
NDW, Indian Head, Maryland

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Map 5.1-2
Range/Site Details
FDR Skeet Range

Legend

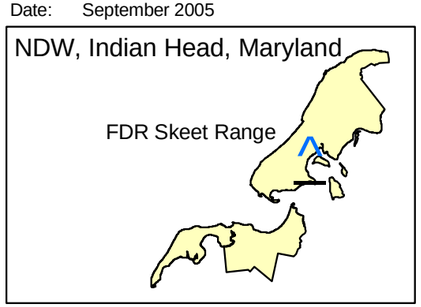
- Installation Boundary
- Structures
- Roads
- Railroads
- Contours
- Streams
- Wetlands
- FDR Skeet Range From Inventory
- Revised FDR Skeet Range Identified during PA
- J Potential Trap Houses

0 50 100 150 200Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005



Preliminary Assessment
NDW, Indian Head, Maryland

MALCOLM PIRNIE

Map 5.1-3
Munitions Characterization
FDR Skeet Range

Legend

- Installation Boundary
- FDR Skeet Range from Inventory
- Revised FDR Skeet Range Identified during PA

MEC Presence*

- Known
- Suspect

*There is no evidence of MEC Presence as determined through historical documentation, interview, and/or visual survey. Visual observations and/or historical documentation indicate that MC may be present at the site, but MC Presence has not been confirmed by sampling or other means.

0 50 100 150 200 Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005

5.2. GATE 3 BURNING GROUND

5.2.1. History and Site Description

The Gate 3 Burning Ground is approximately 0.23 acres and is located on the Indian Head Main Installation, northwest of the intersection of Strauss Ave. and E. Caffee Road, west of Strauss Avenue, and along the Potomac River shoreline. According to Ms. Heidi Morgan of NDW, IH, a potential burning ground in the area of the Pilot Plant was identified by Mr. Ivan Tominack, who is a former employee at NDW, IH. This area corresponds to the Gate 3 Burning Ground. Reportedly, the Gate 3 Burning Ground was operational between 1955 and 1961. The types and quantities of explosives brought to this area for burning are not known. More recently, an ammunition can was found in this area by Ms. Heidi Morgan. Pieces of an old stove were seen during the visual survey, as well as evidence of burned ground surface. The current conditions of the site are displayed in Figure 5.2-1. The Gate 3 Burning Ground is located within the estimated firing fan from The Valley site (discussed in Section 5.7 of this PA).

Figure 5.2-1: Current conditions of Gate 3 Burning Ground - wooded area along Potomac River.

5.2.1.1. Topography

Section 3.2 provides a general description of topography for the Main Installation. At the area known as the Gate 3 Burning Ground, the topography has a steep slope that levels off and extends to the Potomac River shoreline. Elevations at the Gate 3 Burning Ground range from 5 feet to 20 feet above msl.

5.2.1.2. Geology

Section 3.3 provides a geologic description for the Main Installation. This general description is applicable to the Gate 3 Burning Ground.

5.2.1.3.Soil and Vegetation Types

Section 3.4 provides a description of the soil and vegetation types at the Main Installation. The Gate 3 Burning Ground is surrounded by hardwood forest areas. According to the Soil Survey of Charles County, soil at the Gate 3 Burning Ground is classified as steep, gravelly land.

5.2.1.4.Hydrology

Section 3.5 provides a description of hydrology at the Main Installation. The Gate 3 Burning Ground is located adjacent to the Potomac River. Surface water runoff likely flows west-northwest towards the Potomac River. No wetlands are known to exist on the Site.

5.2.1.5.Hydrogeology

Section 3.6 provides a description of hydrogeology for the Main Installation. This information is applicable to the area of the Gate 3 Burning Ground.

5.2.1.6.Cultural and Natural Resources

General cultural and natural resources for the Main Installation are provided in Section 3.7. An archaeological reconnaissance survey of NDW, IH was conducted in 1985. None of the archaeologically significant areas identified in the archaeological reconnaissance survey were reported to be located in the Gate 3 Burning Ground area.

5.2.1.7.Endangered and Special Status Species

As described in Section 3.8, endangered or special status species are known to inhabit the NDW, IH Stump Neck Annex. Due to their proximity, the species are considered to potentially inhabit the Main Installation and thus, the Gate 3 Burning Ground.

5.2.2. Visual Survey Observations and Results

A visual survey of the Gate 3 Burning Ground was conducted on June 2, 2004. Malcolm Pirnie personnel who conducted the visual survey included Ms. Julie Grim, Ms. Rhonda Stone, Mr. Svend Egholm, Mr. Dan Hains, Ms. Alicia Lo Galbo, and Mr. Ricardo Campos. Ms. Heidi Morgan, NDW, Indian Head Environmental Office, accompanied the team. They performed

several walking transects across the range to visually inspect the location. Pieces of an old stove were seen during the visual survey, as well as evidence of burnt ground surface (Figure 5.2-2). The site has a steep slope that levels off and extends to the Potomac River shoreline. Recreational boaters were seen adjacent to this area. The visual survey revealed no evidence of MEC or MC at the site.

Figure 5.2-2: Remains of an old stove and burned ground surface

A visual depiction of the site reconnaissance route is provided on Map 5.2-1 located at the end of Section 5.2. Additional range/site details are illustrated on Map 5.2-2, also located at the end of Section 5.2.

5.2.3. Munitions and Munitions Related Materials Associated with the Site

This section describes the munitions or munitions related materials known or suspected to be at the range, including the types and estimated maximum penetration depths. This includes both MEC and non-hazardous munitions related debris (e.g., fragmentation, base plates, inert mortar fins). Potential ordnance concentration areas are presented along with a discussion on the presence of any special consideration ordnance.

Based on interviews with site personnel, MEC burned at the Gate 3 Burning Ground could potentially have included flares, pyrotechnics, solid fuse boosters, bulk explosives, propellants, and small arms ammunition.

The Gate 3 Burning Ground is overlapped by the firing fan from The Valley located at NDW, Indian Head, Main Installation. Thus, there is a potential for munitions associated with The Valley to be present at the Gate 3 Burning Ground. Technical data sheets are included in Appendix C. Refer to Section 5.7 of this PA for information on The Valley.

Based on the information obtained during the data collection process, the Gate 3 Burning Ground is not suspected to contain CWM filled munitions, electrically fuzed munitions, or DU associated munitions.

5.2.4. MEC Presence

The entire range has been subdivided and categorized into one of three levels of MEC presence including: Known MEC Areas; Suspect MEC Areas; or Areas Where No Evidence Exists to indicate that MEC is known or is suspected to be at the site. The MEC presence is discussed below. The Gate 3 Burning Ground is overlapped by the firing fan from The Valley located at NDW, Indian Head, Main Installation. Thus, there is a potential for munitions associated with The Valley to be present at the Gate 3 Burning Ground. For the purposes of the PA, only MEC presence specifically related to the Gate 3 Burning Ground is considered. Map 5.2-3 illustrates the munitions characterization of the Gate 3 Burning Ground and is provided at the end of Section 5.2.

5.2.4.1.Known MEC Areas

Based on historical documents and information obtained during the data collection process, there are no known MEC areas at the Gate 3 Burning Ground.

5.2.4.2.Suspected MEC Areas

Based on its reported use as a burning ground, the entire Gate 3 Burning Ground is a suspected MEC Area.

5.2.4.3.Areas Not Suspected to Contain MEC

There are no areas of the Gate 3 Burning Ground not suspected to contain MEC.

5.2.5. Ordnance Penetration Estimates

The depth to which munitions penetrate below the ground surface depends on many factors, including the type of soil, the angle of impact, the size of the munitions, the velocity at impact, and site-specific environmental conditions.

The munitions used at Gate 3 Burning Ground would have been placed on the ground surface and then burned. Based on this information, there is no associated penetration depth. The Gate 3 Burning Ground is overlapped by the firing fan from The Valley located at NDW, Indian Head, Main Installation. Thus, there is a potential for munitions associated with The Valley to be present at the Gate 3 Burning Ground. Refer to Section 5.7 of this PA for information on The Valley. For the purposes of the PA, the ordnance penetration depth is only considered for munitions items specifically related to the Gate 3 Burning Ground.

5.2.6. Munitions Constituents

Since evidence for this burning ground is based on personal interviews, the actual MC suspected at this site cannot be definitively determined without sampling. Based on discussions with installation personnel, surface soil sampling at the Gate 3 Burning Ground has not occurred. Review of IRP documents indicates that groundwater monitoring wells have not been installed near the site. However, suspected MC typical of burning grounds includes metals, polycyclic aromatic hydrocarbons (PAHs), TNT and other explosive residuals. The Gate 3 Burning Ground is overlapped by the firing fan from The Valley located at NDW, Indian Head, Main Installation. Thus, there is a potential for munitions associated with The Valley to be present at the Gate 3 Burning Ground. Refer to Section 5.7 of this PA for information on The Valley. For the purposes of the PA, only the munitions constituents that specifically relate to the Gate 3 Burning Ground are considered.

5.2.7. Contaminant Migration Routes

Environmental media through which MC may migrate from the Gate 3 Burning Ground include soil, groundwater, surface water, and sediment. Direct human or biota contact with surficial and subsurface soil is possible. The Gate 3 Burning Ground's proximity to the Potomac River provides possible migration routes to surface water. The majority of the area is sloped toward the creeks, and storm water discharges to surface water via overland flow. Groundwater flow in the shallow water table aquifer also likely trends towards the Potomac River; therefore, MC leaching from soils into shallow groundwater may migrate to surface water. Sediments can act as contaminant repositories, and sediment mixing and dredging can act as migration routes to surface water. MC in surface soils and sediments may migrate via plant/animal uptake. Based on a review of hydrogeological data, it is unlikely that MC in shallow groundwater would migrate to

the deeper aquifers that are used as a water supply. However, shallow groundwater is still considered a potential exposure medium for human receptors.

5.2.8. Receptors

Potential human receptors include authorized Navy personnel (military and civilian), visitors, contractors, maintenance workers, recreational river users and trespassers. Plant and animal biota are also potential receptors. Examples of ecological receptors include deer, wild turkey, and water fowl.

5.2.8.1. Nearby Populations

Nearby populations are as described in Section 5.1.8.1. Additionally, activities surrounding the Gate 3 Burning Ground include recreational boating and fishing on the Potomac River.

5.2.8.2. Buildings Near/Within Site

There are no buildings located within the Gate 3 Burning Ground. The closest structure is Building 1669 which lies on the other side of Strauss Avenue, east of the site and less than a half mile away.

5.2.8.3. Utilities On/Near Site

There are no utilities located within the Gate 3 Burning Ground. However, potable water utilities are located to the east and south of the site.

5.2.9. Land Use

The Gate 3 Burning Ground is currently an unused wooded area along the Potomac River. There is no hunting on this site.

5.2.10. Access Controls / Restrictions

No public access is authorized at NDW IH. Signs, partial fencing, locked/secured gates, login book/office check-in, and vehicle security patrol control the entire facility. There are no access

control features specific to the Gate 3 Burning Ground. Access from the water is not controlled. There are no known land use/development restrictions for the range.

5.2.11. Conceptual Site Model

A general description of a CSM is provided in Section 5.1.11. The CSM is presented in a series of information profiles that presents information about the range. The information profiles are included in Table 5.2-1 below.

Table 5.2-1: Conceptual Site Model Information Profiles – Gate 3 Burning Ground

Profile Type	Information Needs	Preliminary Assessment Findings
Range/Site Profile	Installation Name	NDW, Indian Head
	Installation Location	Indian Head, Charles County, MD
	Range/Site Name	Gate 3 Burning Ground
	Range/Site Location	The site is located on the Indian Head Main Installation near the intersection of Strauss Avenue and E. Caffee Road, along the Potomac River shoreline.
	Range/Site History	The area was reportedly used as a burning ground for explosives from approximately 1955 to 1961.
	Range/Site Area and Layout	The site is approximately 0.23 acres. It has a steep slope that levels off and extends to the shoreline.
	Range/Site Structures	The closest structure is Building 1669 which lies on the other side of Strauss Avenue, east of the site and less than half a mile away.
	Range/Site Boundaries	N: Wooded, Potomac River S: Woodlands, Potomac River W: Potomac River E: Woodlands, Strauss Avenue
	Range/Site Security	NDW, Indian Head has installation wide security and access restrictions. Once within the installation, no additional access restriction features exist for the Gate 3 Burning Ground. The site is accessible from the Potomac River.
Munitions/ Release Profile	Munitions Types	Potentially include flares, pyrotechnics, solid fuse boosters, bulk explosives, propellants, and small arms ammunition.

Table 5.2-1: Conceptual Site Model Information Profiles – Gate 3 Burning Ground		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
	Maximum Probability Penetration Depth	There is no associated penetration depth.
	MEC Density	The anticipated MEC density at the site is low.
	Munitions Debris	None anticipated.
	Associated Munitions Constituents	Primary MC of concern are metals, polycyclic aromatic hydrocarbons (PAHs), TNT, and other explosive residuals.
	Migration Routes/Release Mechanisms	Soil surface runoff; soil leaching; groundwater discharge; site maintenance; construction; excavation.
Physical Profile	Climate	Indian Head, MD has a continental-type climate with four well-defined seasons. The coldest period occurs in late January and early February, with low temperatures averaging 29ºF. July is the warmest month with average maximum temperatures of 85ºF. The normal annual precipitation is approximately 44 inches, with normal monthly precipitation varying from 2.25 (February) to 4.60 (August) inches.
	Topography	The topography at the site is an extreme slope towards the Potomac River leveling off into a relatively flat area that extends to the shoreline.
	Geology	The Indian Head Main Installation peninsula lies within the Atlantic Coastal plain physiographic province. The geology of the area is comprised of Precambrian igneous and metamorphic bedrock overlain by 500 to 600 feet of unconsolidated fluvial and marine deposits of the Potomac Group. The Potomac Group consists of, in descending order, the Patapsco, Arundel, and Patuxent Formations.
	Soil	The soils in the area of the site lie within the Potomac River basin in the Atlantic Coastal Plain and consist of gravel, sand, silt and clay. Soil erodibility is high at the site.

Table 5.2-1: Conceptual Site Model Information Profiles – Gate 3 Burning Ground		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
	Hydrogeology	The hydrogeological makeup of the Indian Head, MD area consists of a surficial aquifer and several deeper confined and semi-confined aquifers in the Patapsco and Patuxent Formations. The surficial aquifer is expected to be connected to and influenced by the surface water bodies. Regional water supplies, including that of NDW, Indian Head are obtained from the lower and middle sands of the Patapsco and Patuxent Formations of the Potomac Group. The surficial aquifer (i.e., water table) is not used for water supply at NDW.
	Hydrology	The site is located directly along the Potomac River. Drainage at the site would flow to the west-northwest towards the Potomac River.
	Vegetation	Vegetation within the surrounding area includes hardwood forests - coniferous-deciduous mix.
Land Use and Exposure Profile	Current Land Use	The site is currently vacant. Hunting is a possible use for the area.
	Current Human Receptors	Navy personnel (military and civilian), visitors, contractors, maintenance workers, recreational users, and trespassers
	Current Activities (frequency, nature of activity)	Hunting in permitted in the vicinity of the site two days per year. Hunting cannot be conducted without a permit.
	Potential Future Land Use	None reported.
	Potential Future Human Receptors	Navy personnel (military and civilian), visitors, contractors, maintenance workers, recreational users, and trespassers.
	Potential Future Land Use-Related Activities:	None reported.
	Zoning/Land Use Restrictions	None reported.
	Demographics/Zoning	Charles County population density is approximately 260 persons per square mile. NDW and its tenant commands employ approximately 3,600 military and civilian personnel.
	Beneficial Resources	American Shad, Alewife and Blueback Herring use the Potomac River, Chicamuxen Creek and Mattawoman Creek as travel routes and spawning sites.

Table 5.2-1: Conceptual Site Model Information Profiles – Gate 3 Burning Ground		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
Ecological Profile	Habitat Type	Hardwood forest area
	Degree of Disturbance	Low
	Ecological Receptors	
	Federal Endangered Species:	American Bald Eagle, rainbow snake, and the joint-vetch.
	Federal Threatened Species:	None
	State Endangered Species:	Scaly blazing-star
	State Threatened Species:	None
	Other Ecological Receptors:	Federal and state protected species are known to exist in the vicinity of the Main Installation. Ecological receptors include various flora and indigenous animals in the habitat. Deer and wild turkey are known to inhabit the area along with other mammals, birds, reptiles, and amphibians.
	Relationship of MEC/MC Sources to Habitat and Potential Receptors	Receptors can directly contact MEC/MC through surface water and surface soil, or indirectly with MC that have been incorporated into the food chain (bioaccumulated in plants and animals).

A general description of the CSM exposure pathway analysis is included in Section 5.1.11. The Gate 3 Burning Ground is overlapped by the firing fan from The Valley located at NDW, Indian Head, Main Installation. Thus, there is a potential for munitions associated with The Valley to be present at the Gate 3 Burning Ground. However, for the purposes of the PA, only MEC and/or MC associated with the Gate 3 Burning Ground is considered within the CSM exposure pathway analysis.

The nature of the activity that presumably occurred at the Gate 3 Burning Ground suggests that MEC may be present. Therefore, potentially complete pathways exist for human and ecological receptors for MEC in the surface soil. This includes receptors for hand/tread underfoot contact as well as surface intrusive work that may be conducted at the Gate 3 Burning Ground. Trespassers are not expected to perform surface intrusive work. MEC is not expected in the subsurface. An Exposure Pathway Analysis figure for MEC is presented in Figure 5.2-3.

As illustrated in Figure 5.2-4, the MC Exposure Pathway Analysis, soil impacted by MC represents a primary source medium. All human and ecological receptors have potentially complete exposure pathways for direct contact with MC in surface soil, which includes dermal contact, ingestion, and inhalation (dust). Runoff and/or erosion may transport the MC from surface soil to surface water/sediments (Potomac River), so a potentially complete pathway also exists for all human and ecological receptors of surface water/sediments through ingestion and dermal contact. Potentially complete exposure pathways exist for MC in subsurface soils (direct contact, ingestion and inhalation during intrusive work activities) for all receptors with the exception of trespassers. It is not anticipated that trespassers would come in contact with subsurface soils. Plants may accumulate MC from soil as well. Given that hunting is permitted in close proximity to the Gate 3 Burning Ground, MC entering the food chain may provide migration pathways for human and ecological receptors.

Precipitation infiltration may provide for contaminant mobility into the subsurface soil and into the shallow or surficial groundwater aquifer, which is assumed to be connected to the nearby surface water bodies. Although confining layers are expected to prevent the migration of MC to the lower aquifers used for water supply, potentially complete pathways exist for MC in shallow groundwater for human receptors.

Figure 5.2-3: MEC Exposure Pathway Analysis

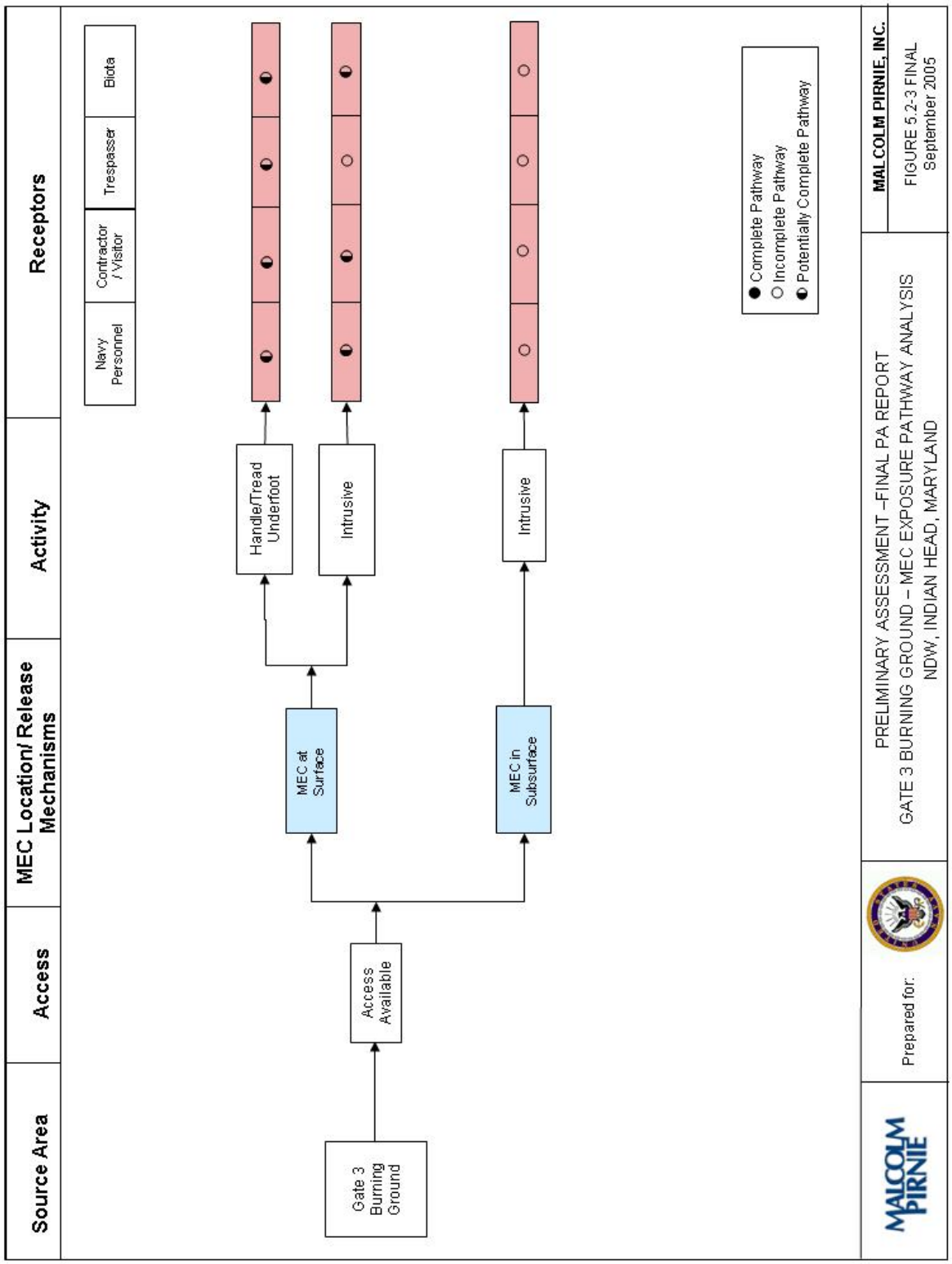
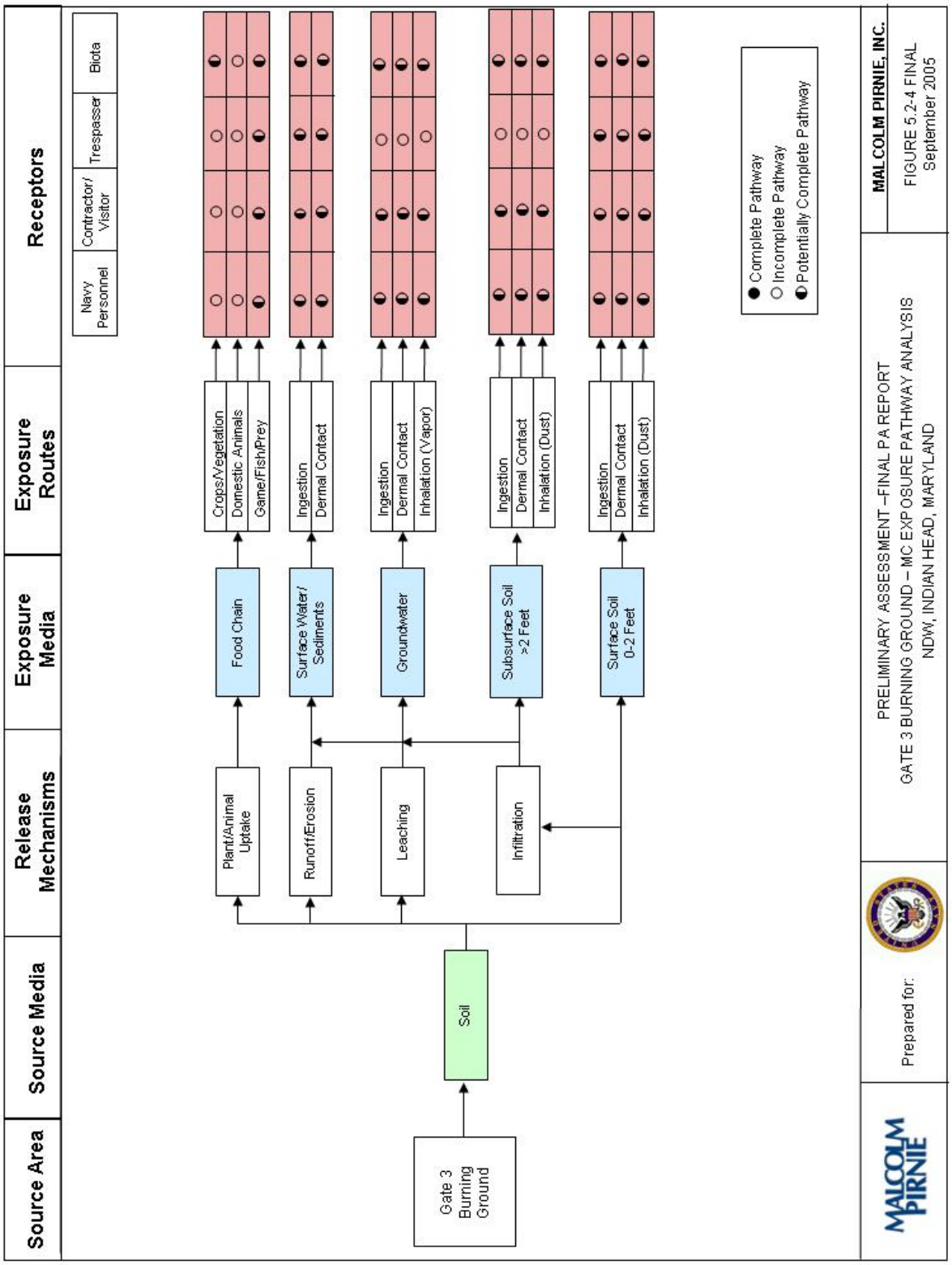


Figure 5.2-4: MC Exposure Pathway Analysis



5.2.12. Summary

From information gathered during the PA, evidence indicates that the area of the Gate 3 Burning Ground may have been used as a burning ground. Visual evidence of burning was identified during the site reconnaissance. Therefore, both MEC and MC are expected to be present at the Gate 3 Burning Ground. Based on interviews with installation personnel, potential MEC include flares, pyrotechnics, solid fuse boosters, bulk explosives, propellants, and small arms ammunition. The primary MC of concern, given the suspected nature of use, are metals, PAHs, and TNT.

Preliminary Assessment
NDW, Indian Head, Maryland

MALCOLM PIRNIE

Map 5.2-1
Visual Survey
Gate 3 Burning Ground

Legend

- Installation Boundary
- Site Reconnaissance
- Gate 3 Burning Ground

0 25 50 75 100Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005

Preliminary Assessment
NDW, Indian Head, Maryland

MALCOLM PIRNIE

Map 5.2-2
Range/Site Details
Gate 3 Burning Ground

Legend

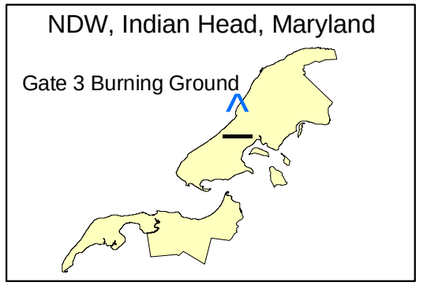
- Installation Boundary
- Structures
- Roads
- Streams
- Contours
- Gate 3 Burning Ground

0 25 50 75 100 Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005



Preliminary Assessment
NDW, Indian Head, Maryland

MALCOLM PIRNIE

Map 5.2-3
Munitions Characterization
Gate 3 Burning Ground

Legend

- Installation Boundary
- Gate 3 Burning Ground

MEC Presence*

- Known
- Suspect

*MEC Presence was determined through review of historical documentation, interviews, and/or visual survey.

0 25 50 75 100 Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005

5.3. NG SLUMS BURNING GROUND

5.3.1. History and Site Description

The NG Slums Burning Ground is a 0.3-acre range located in the southeastern extremity of the Main Installation, adjacent to the Mattawoman Creek. The suspected location lies east of Building 1216 and runs parallel to the east end of Hussey Circle Road. Originally identified under the IR program, the location of the NG Slums Burning Ground was established by NDW, IH during the Navy Inventory. Map 5.3-1 shows the assumed location of the NG Slums Burning Ground.

The NG Slums Burning Ground was reportedly established as an OB ground for NG slums. NG slums, a production disposal by-product, are created when excess NG from the production facilities was mixed with sawdust for stabilization prior to disposal, making the NG easier and safer to handle and transport. Based on interviews with former employees, the NG Slums Burning Ground is identified as IR Site 22 in the NDW, Indian Head IRP. The Navy Assessment and Control of Installation Pollutants (NACIP, the precursor to the IRP) program recommendation was that the NG Slums Burning Ground not be subject to a Confirmation Study. The current conditions of the area understood to be part of the former NG Slums Burning Grounds are shown in Figure 5.3-1.

Based on available information collected during the PA, the existence of the NG Slums Burning Ground has not been confirmed. Approved construction drawings for the NG Plant are dated 1947-1948, which is presumably when a need for an NG Slums Burning Ground was established. Two storage magazines, constructed in 1953, are located adjacent to the western and the northwestern sides of the NG Slums Burning Ground. Due to the proximity of the magazines to the suspected location of NG Slums Burning Ground, it is unlikely that NG Slums Burning Ground would be operational during the same time period. Thus, if the NG Slums Burning Ground did exist it was presumably not in operation until the late 1940s (after the construction of the NG Plant in 1948) and operated until 1953 when the magazines were built. Maps from this time period do not display the suspected location area as a burning ground; however, all other burning grounds are identified on such maps. Another burning ground located on the Main Installation, the STTP, is confirmed to have operated between 1942 and 1988. Therefore, while the NG Plant was in operation, NG slums may have been transported to the STTP for burning.

Figure 5.3-1: Current Conditions of the NG Slums Burning Grounds Area

5.3.1.1.Topography

Section 3.2 provides a general description of topography for the Main Installation. The NG Slums Burning Grounds is relatively flat with an elevation of approximately five feet above msl.

5.3.1.2.Geology

Section 3.3 provides a geologic description for the Main Installation, which is applicable to the NG Slums Burning Grounds.

5.3.1.3.Soil and Vegetation Types

Section 3.4 provides a description of the soil and vegetation types for the Main Installation. According to the *US Navy Closed, Transferred, and Transferring Range and Other Sites Questionnaire*, the predominant soil type associated with the NG Slums Burning Ground is sand-silt to sand-clay. Vegetation primarily consists of tidal emergent scrub-shrub and a coniferous-deciduous mix. Along the shoreline of the Mattawoman Creek, erosion is evident (see Figure 5.3-2).

Figure 5.3-2: Mattawoman Creek shoreline at the NG Slums Burning Ground

5.3.1.4.Hydrology

Section 3.5 provides a description of hydrology at the Main Installation. The NG Slums Burning Ground is located directly along the tidally influenced Mattawoman Creek. Drainage from the NG Slums Burning Grounds flows north-northeast to the Mattawoman Creek. An area of wetlands is located southwest of the burning ground.

5.3.1.5.Hydrogeology

Section 3.6 provides a description of hydrogeology for the Main Installation, which is applicable to the area of the NG Slums Burning Grounds.

5.3.1.6.Cultural and Natural Resources

An archaeological reconnaissance survey of NDW, IH was conducted in 1985 (see Section 3.7). None of the archaeologically significant areas identified in the archaeological reconnaissance were reported to be located in the NG Slums Burning Grounds area.

5.3.1.7.Endangered and Special Status Species

As discussed in Section 3.8, endangered species are known to exist in the general area of NDW, IH specifically on the Stump Neck Annex; however, endangered species are not reported to inhabit the Main Installation. While their presence has not been confirmed, the reported endangered and special status species are expected to inhabit the Main Installation and thus, have the potential to inhabit the NG Slums Burning Ground.

5.3.2. Visual Survey Observations and Results

The NG Slums Burning Ground visual survey was conducted on June 23, 2003. Malcolm Pirnie personnel who conducted the site visit included Ms. Julie Grim, Mr. Stephen Rice, Mr. Mike Baker, and Mr. Robert Wiley. Mr. Jorgensen, NDW, IH Environmental Office, accompanied the team. The site walk was completed by conducting transects of the area. During the walkthrough, no evidence of burning operations or MEC/MC was observed In general, vegetative cover appeared sparse, and shoreline erosion along Mattawoman Creek was evident. Building 1216 is adjacent to the former NG Slums Burning Ground area.

A visual depiction of the site reconnaissance route is provided on Map 5.3-1 located at the end of Section 5.3. Additional range/site details are illustrated on Map 5.3-2, also located at the end of Section 5.3.

5.3.3. Munitions and Munitions Related Materials Associated with the Site

This section describes the munitions or munitions related materials known or suspected to be at the range, including the types and estimated maximum penetration depths. This includes both MEC and non-hazardous munitions related debris (e.g., fragmentation, base plates, inert mortar fins). The NG Slums Burning Grounds was reportedly used for the disposal of NG. The types and quantities of accelerants used to burn the NG slums, if any, are not known. If NG is present in the soils at explosive levels, MEC may be present at the NG Slums Burning Ground. The explosive level for soils is MEC greater than 10%.

The NG Slums Burning Ground is not suspected to contain CWM filled munitions, electrically fused munitions, or DU associated munitions.

5.3.4. MEC Presence

The entire range has been subdivided and categorized into one of three levels of MEC presence including: Known MEC Areas; Suspect MEC Areas; or Areas Where No Evidence Exists to indicate that MEC is known or is suspected to be at the site. The MEC presence is discussed below. Map 5.3-3 illustrates the munitions characterization of the NG Slums Burning Ground and is provided at the end of Section 5.3.

5.3.4.1.Known MEC Areas

According to historical documents and information obtained during the data collection process, there is no documented evidence of MEC at the NG Slums Burning Ground. Therefore, there are no known MEC areas.

5.3.4.2.Suspected MEC Areas

The NG Slums Burning Ground is considered a suspect MEC area; however, the potential relative concentration or density of MEC is not known. Since the area has not been used for burning for more than 50 years, if at all, the MEC density as well as the magnitude of an explosive hazard (if present) are expected to be low.

5.3.4.3.Areas Not Suspected to Contain MEC

According to historical documents and information obtained during the data collection process, there is no evidence to confirm the presence or absence of MEC at the NG Slums Burning Ground. Therefore, there are no areas the NG Slums Burning Ground that are not expected to contain MEC.

5.3.5. Ordnance Penetration Estimates

This range was reportedly used for burning of NG slums; therefore, there is no estimated ordnance penetration depth for this range. However, due to erosion, precipitation and infiltration, NG may be present below the surface.

5.3.6. Munitions Constituents

The MC suspected to be present at this range is NG. The relative concentration of NG present is not known. No MC were observed during the visual survey. No NG was detected in sediment samples taken during the study of the Mattawoman Creek. Based on discussions with installation personnel, surface soil sampling has not occurred at the NG Slums Burning Ground. Review of IRP documents indicates that groundwater monitoring wells have not been installed near the site.

5.3.7. Contaminant Migration Routes

With the historic practice of burning NG slums, NG would have been deposited directly on the ground surface. The potential exists that NG, a miscible liquid, may have migrated through the soil column to shallow groundwater through infiltration. Therefore, NG, if present, may have adhered to soil particles in the soil column (surface and subsurface soil), as well as to have reached the surficial groundwater table. Due to the proximity of the area to the Mattawoman Creek, runoff/erosion may have transported NG to surface water. Potential migration routes include soil, groundwater and surface water/sediments. Based on a review of site hydrogeological data, it is unlikely that MC in shallow groundwater would migrate to the potable deeper aquifers that are used as a water supply. However, groundwater is still considered a potential exposure media for human receptors.

5.3.8. Receptors

Potential human receptors include authorized Navy personnel (military and civilian), visitors, contractors, maintenance workers, recreational users and trespassers. Plant and animal biota are also potential receptors. Examples of ecological receptors include deer, wild turkey, and water fowl.

5.3.8.1. Nearby Populations

Nearby populations are as discussed in Section 5.1.8.1.

5.3.8.2. Buildings Near/Within Site

There are no buildings located at the NG Slums Burning Ground. Building 1216 is located to the west. There are two magazines also located west and northwest of the NG Slums Burning Ground. The building locations are provided in Map 5.3-2.

5.3.8.3. Utilities On/Near Site

The Utilities Data Map of the Main Installation indicates no utilities present within the understood boundaries of the NG Slums Burning Ground.

5.3.9. Land Use

Historical land use reportedly included an OB area for NG slums. The area is currently open with no active or reported planned future use; however, the area is within an Upland Hunting Area, as shown on the NDW, IH Upland Hunting Map.

5.3.10. Access Controls / Restrictions

No public access is authorized at NDW, IH. Signs, partial fencing, locked/secured gates, login book/office check-in, and vehicle security patrol control the entire facility. There are no access control features specific to the NG Slums Burning Grounds. Access from the water is not controlled. There are no known land use/development restrictions for the range.

5.3.11. Conceptual Site Model

A general description of the CSM is provided in Section 5.1.11. The CSM is presented in a series of information profiles that presents information about the range. The information profiles are presented in Table 5.3-1 below.

Table 5.3-1: Conceptual Site Model Information Profiles – NG Slums Burning Ground		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
Range/Site Profile	Installation Name	NDW, Indian Head
	Installation Location	Indian Head, Charles County, MD
	Range/Site Name	NG Slums Burning Ground
	Range/Site Location	Located along the northwestern side of the Main Installation along the Mattawoman Creek near Building 1216.
	Range/Site History	Reportedly used for NG slums burning from the late 1940s until approximately 1953. There are no current reported uses of the area.
	Range/Site Area and Layout	The range is a 0.3-acre relatively flat portion of land along the banks of the Mattawoman Creek.
	Range/Site Structures	No structures are currently located at the range. Building 1216 and two magazines are located adjacent to the area.
	Range/Site Boundaries	N: Mattawoman Creek S: Hussey Circle Road (dirt access road) and Building 1216 W: Vegetation and woodlands area along the creek edge E: Vegetation and woodlands area along the creek edge
	Range/Site Security	NDW, IH has installation wide security and access restrictions. Once within the installation, no additional access restriction features exist for the NG Slums Burning Ground.
Munitions/ Release Profile	Munitions Types	None
	Maximum Probability Penetration Depth	Penetration depth not applicable. Disposal on ground surface. MC may have migrated downward.
	MEC Density	Low
	Munitions Debris	None
	Associated Munitions Constituents	NG slums
	Migration Routes/Release Mechanisms	Erosion, surface runoff to surface water, leaching to groundwater, downward mobility to subsurface soil and subsequent discharge to surface water

Table 5.3-1: Conceptual Site Model Information Profiles – NG Slums Burning Ground		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
Physical Profile	Climate	Indian Head, MD has a continental-type climate with four well-defined seasons. The coldest period occurs in late January and early February, with low temperatures averaging at 29ºF. July is the warmest month with average maximum temperatures of 85ºF. The normal annual precipitation is approximately 44 inches, normal monthly precipitation varying from 2.25 (February) to 4.60 (August) inches.
	Topography	Topography of the NG Slums Burning Grounds provides little relief and is at an elevation of approximately five feet above msl.
	Geology	The Indian Head peninsula lies within the Atlantic Coastal plain physiographic province. The geology of the area is comprised of Precambrian igneous and metamorphic bedrock overlain by 500 to 600 feet of unconsolidated fluvial and marine deposits of the Potomac Group. The Potomac Group consists of, in descending order, the Patapsco, Arundel, and Patuxent Formations.
	Soil	According to the US Navy Closed, Transferred, and Transferring Range and Other Sites Questionnaire, the predominant soil type associated with the NG Slums Burning Ground is sand-silt to sand-clay.
	Hydrogeology	The hydrogeological makeup of the Indian Head, MD area consists of a surficial aquifer and several deeper confined and semi-confined aquifers in the Patapsco and Patuxent Formations. The surficial aquifer is expected to be connected to and influenced by the surface water bodies. Regional water supplies, including that of NDW IH, are obtained from the lower and middle sands of the Patapsco and Patuxent Formations of the Potomac Group. The surficial aquifer (i.e., water table) is not used for water supply at NDW, IH.
	Hydrology	The NG Slums Burning Ground is adjacent to the Mattawoman Creek. Drainage flows north-northeast to the Mattawoman Creek. An area of wetlands is located southwest of the burning ground.
	Vegetation	Consists of tidal emergent scrub-shrub and coniferous-deciduous mix.

Table 5.3-1: Conceptual Site Model Information Profiles – NG Slums Burning Ground		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
Land Use and Exposure Profile	Current Land Use	The range is currently not used. Hussey Circle Road, located directly south of the range, is used occasionally, so vegetation is kept at a minimum. Area is located within an Upland Hunting Area, as shown on the NDW, IH 2003-2004 Hunting Map.
	Current Human Receptors	Navy personnel (military and civil servants), trespassers, visitors, maintenance workers, contractors, recreational users (hunters).
	Current Activities (frequency, nature of activity)	Infrequent activity
	Potential Future Land Use	The expected future land use of the range is to remain unchanged based on the Master Plan.
	Potential Future Human Receptors	Navy personnel (military and civil servants), visitors, maintenance workers, contractors, recreational users and trespassers
	Potential Future Land Use-Related Activities:	No change to current land use is reported.
	Zoning/Land Use Restrictions	None
	Demographics/Zoning	Charles County population density is approximately 260 persons per square mile. NDW, IH and its tenant commands employ approximately 3,600 military and civilian personnel.
	Beneficial Resources	None
Ecological Profile	Habitat Type	Emergent scrub-shrub, grassy areas
	Degree of Disturbance	Low – Hussey Circle Road is used occasionally as the area is occasionally mowed.
	Ecological Receptors	
	Federal Endangered Species:	American Bald Eagle, rainbow snake, and the joint-vetch
	Federal Threatened Species:	None
	State Endangered Species:	Scaly blazing-star
	State Threatened Species:	None

Table 5.3-1: Conceptual Site Model Information Profiles – NG Slums Burning Ground		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
	Other Ecological Receptors:	Federal and state protected species are known to exist in the vicinity of the Main Installation. Additional ecological receptors include various flora and indigenous animals in the habitat. Deer and wild turkey are known to inhabit the area along with other mammals, birds, reptiles, and amphibians.
	Relationship of MEC/MC Sources to Habitat and Potential Receptors	Ecological receptors may come into direct contact with MEC/MC in soil, and possibly surface water and/or sediment. Receptors may come into contact with MC that have been incorporated into the food chain.

A general description of the CSM exposure pathway analysis is included in Section 5.1.11.

The nature of the activity that presumably occurred at the NG Slums Burning Grounds suggests that MEC may be present; however, the density of the MEC (NG) is not known. Therefore, potentially complete pathways exist for human and ecological receptors for MEC in the surface soil. This includes receptors for hand/tread underfoot contact as well as surface intrusive work that may be conducted at the NG Slums Burning Ground. Trespassers are not expected to perform surface intrusive work. MEC is not expected in the subsurface. An Exposure Pathway Analysis figure for MEC is presented in Figure 5.3-3.

As illustrated in Figure 5.3-4, the MC Exposure Pathway Analysis, soil impacted by MC represents a primary source medium. All human and ecological receptors have potentially complete exposure pathways for direct contact with MC in surface soil, which includes dermal contact, ingestion, and inhalation (dust). Runoff and/or erosion may transport the MC from surface soil to surface water/sediments, so a potentially complete pathway also exists for all human and ecological receptors of surface water/sediments. Given that the NG Slums Burning Ground is located within an upland hunting area, human and ecological receptors have a potentially complete pathway by ingesting game/prey that have previously consumed contaminated vegetation or prey. Precipitation infiltration may provide for contaminant mobility into the subsurface soil and into the shallow or surficial groundwater aquifer, which is assumed to be connected to the nearby surface water bodies. Potentially complete exposure pathways exist

for MC in subsurface soils (direct contact, ingestion and inhalation during intrusive work activities). Although confining layers are expected to prevent the migration of MC to the lower aquifers used for water supply, potentially complete pathways exist for MC in shallow groundwater for human receptors.

A graphical illustration of the details of the conceptual site model is included as Figure 5.3-5.

Figure 5.3-3: MEC Exposure Pathway Analysis

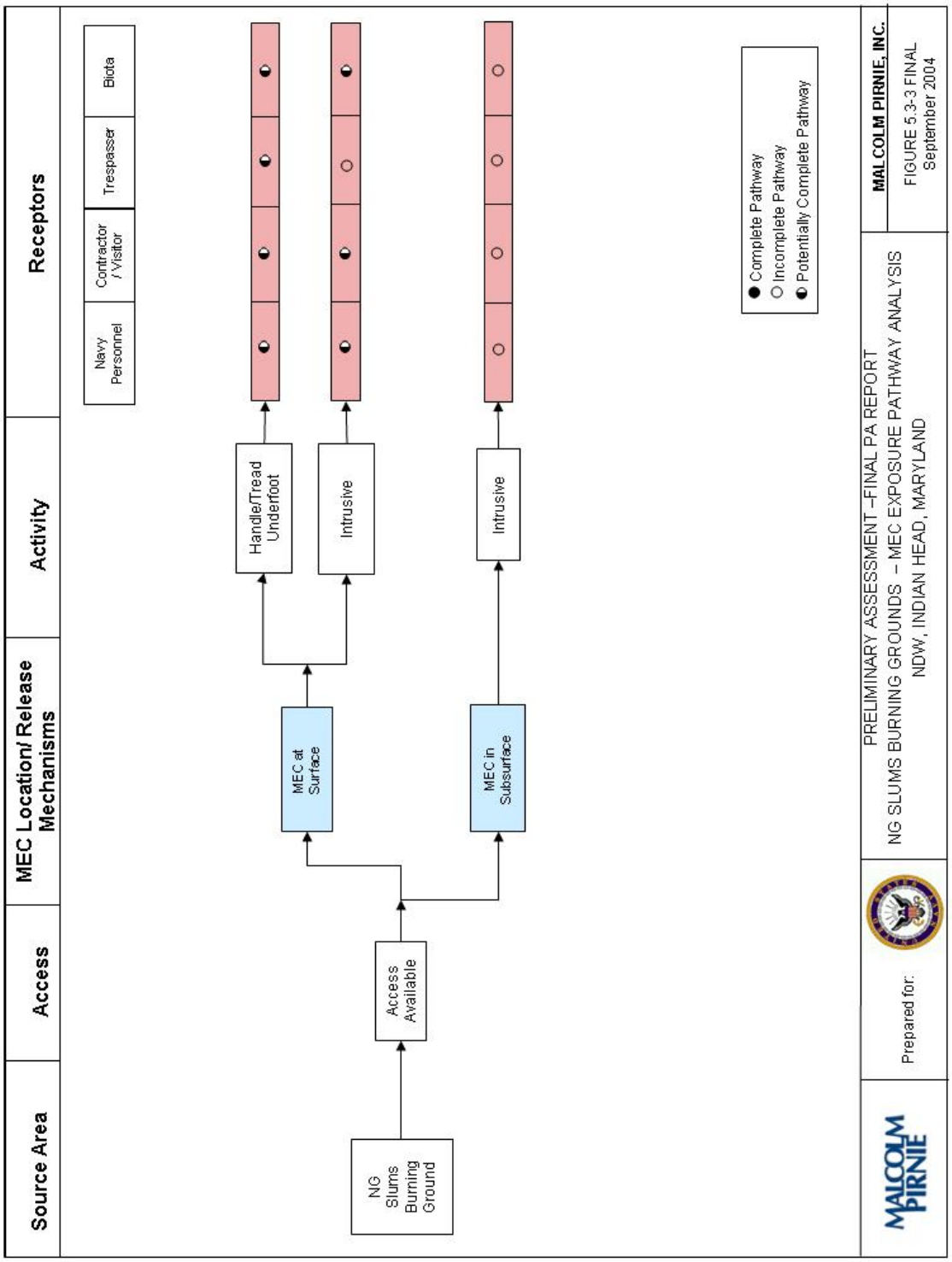


Figure 5.3-4: MC Exposure Pathway Analysis

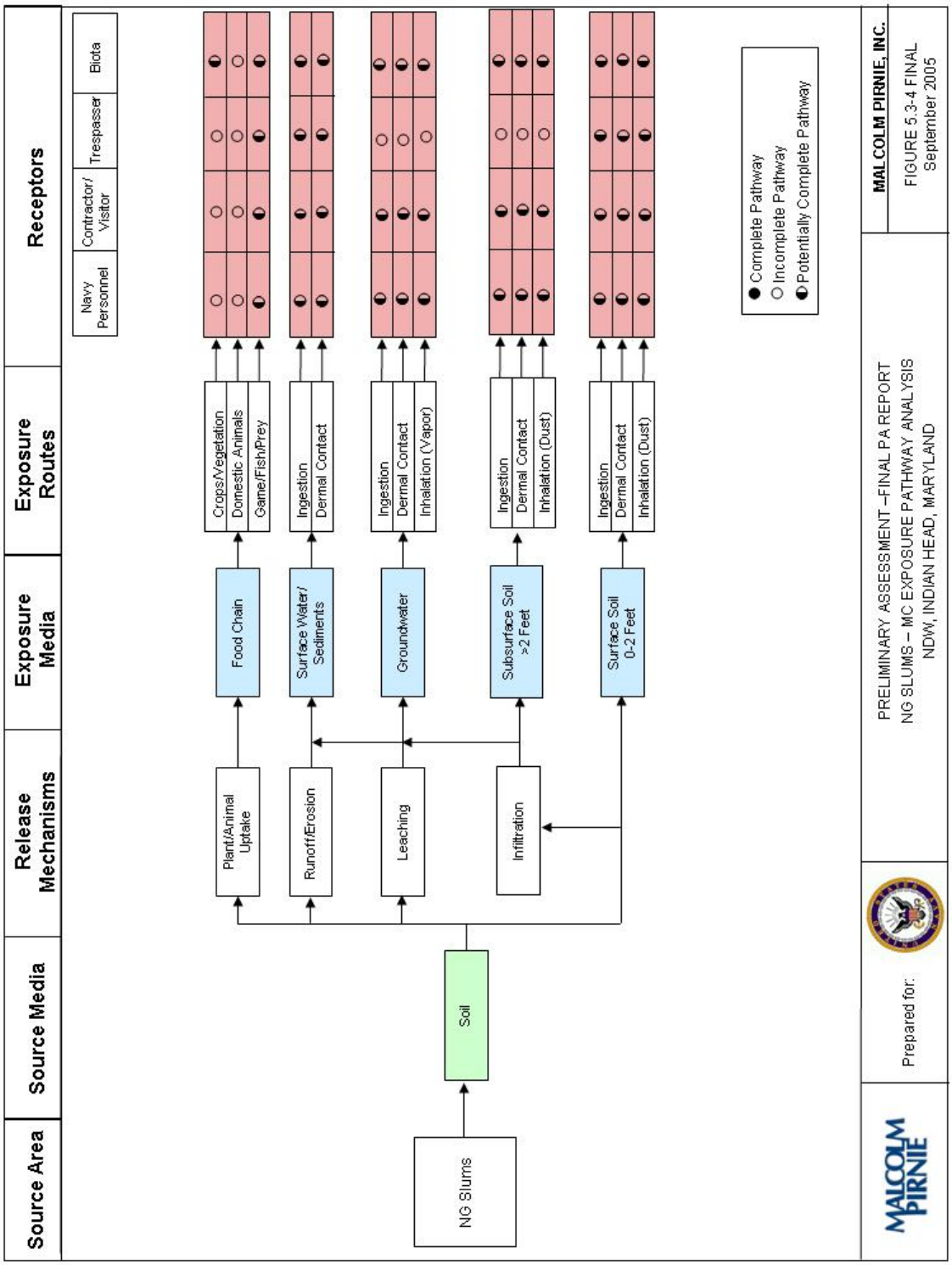
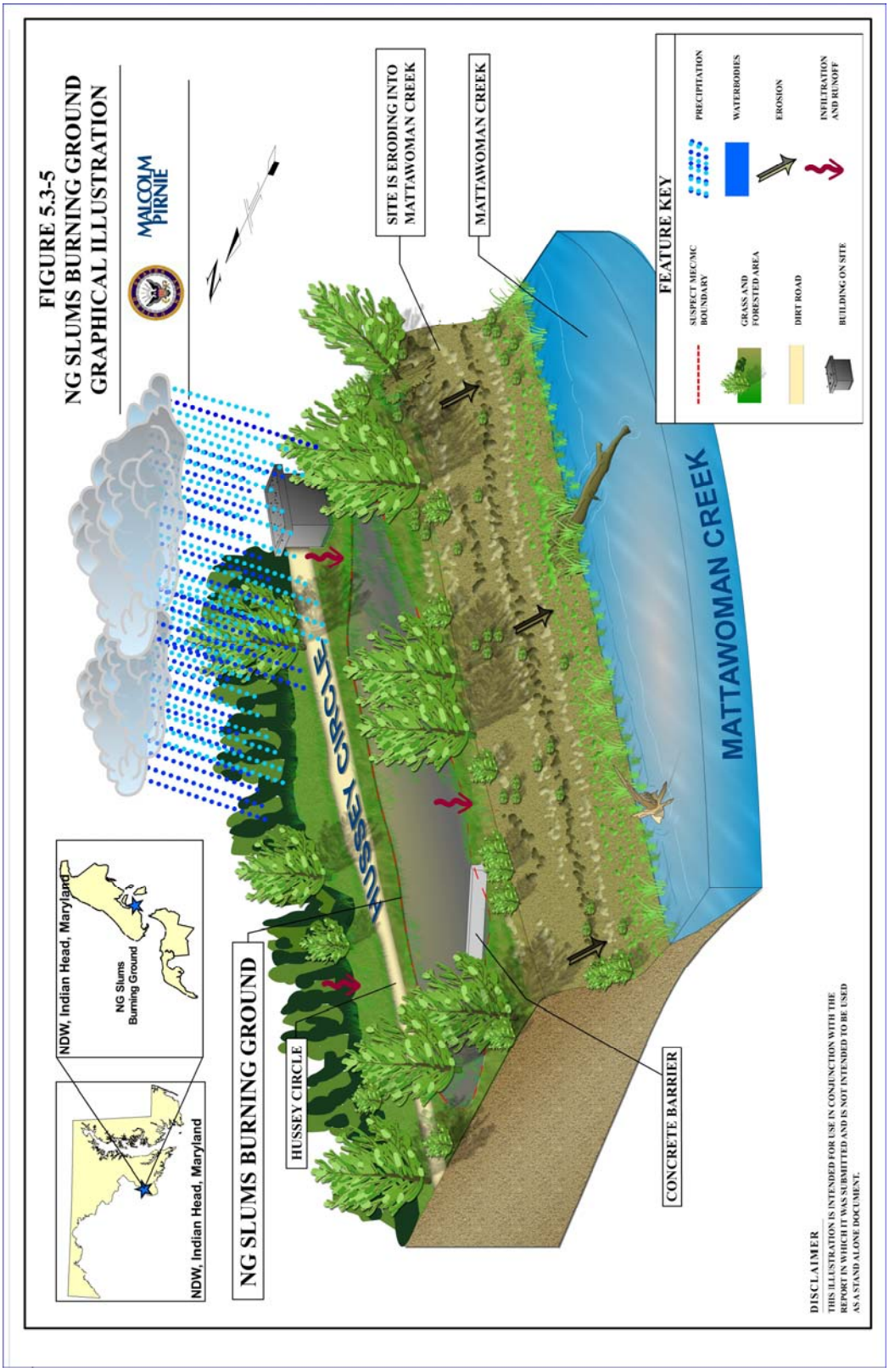


Figure 5.3-5: NG Slums Graphical Illustration



5.3.12. Summary

The NG Slums Burning Ground (IR Site 22) is a 0.3-acre range located on the southeastern shore of the Main Installation adjacent to the Mattawoman Creek. Although listed in the Navy Range Inventory, the existence of this range has not been confirmed through information collected during this PA. The reported location lies east of Building 1216 and runs parallel to the east end of Hussey Circle Road. The NG Slums Burning Ground was presumably used as an OB ground for NG slums generated at the NG production facilities from the late 1940s through 1953; however, as stated previously, the existence of the burning ground is suspect. If OB occurred at the NG Slums Burning Ground, MC associated with this activity would be NG. NG is also considered MEC. However, the concentrations of NG and associated breakdown products, if any, are not known.

Preliminary Assessment
NDW, Indian Head, Maryland

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Map 5.3-1
Visual Survey
NG Slums Burning Ground

Legend

- Installation Boundary
- NG Slums Burning Ground
- Site Reconnaissance

0 25 50 75 100 Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005

Preliminary Assessment
NDW, Indian Head, Maryland

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Map 5.3-2
Range/Site Details
NG Slums Burning Ground

Legend

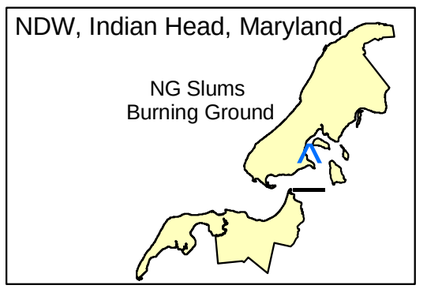
- Installation Boundary
- Structures
- Roads
- Railroads
- Contours
- Streams
- Wetlands
- NG Slums Burning Ground

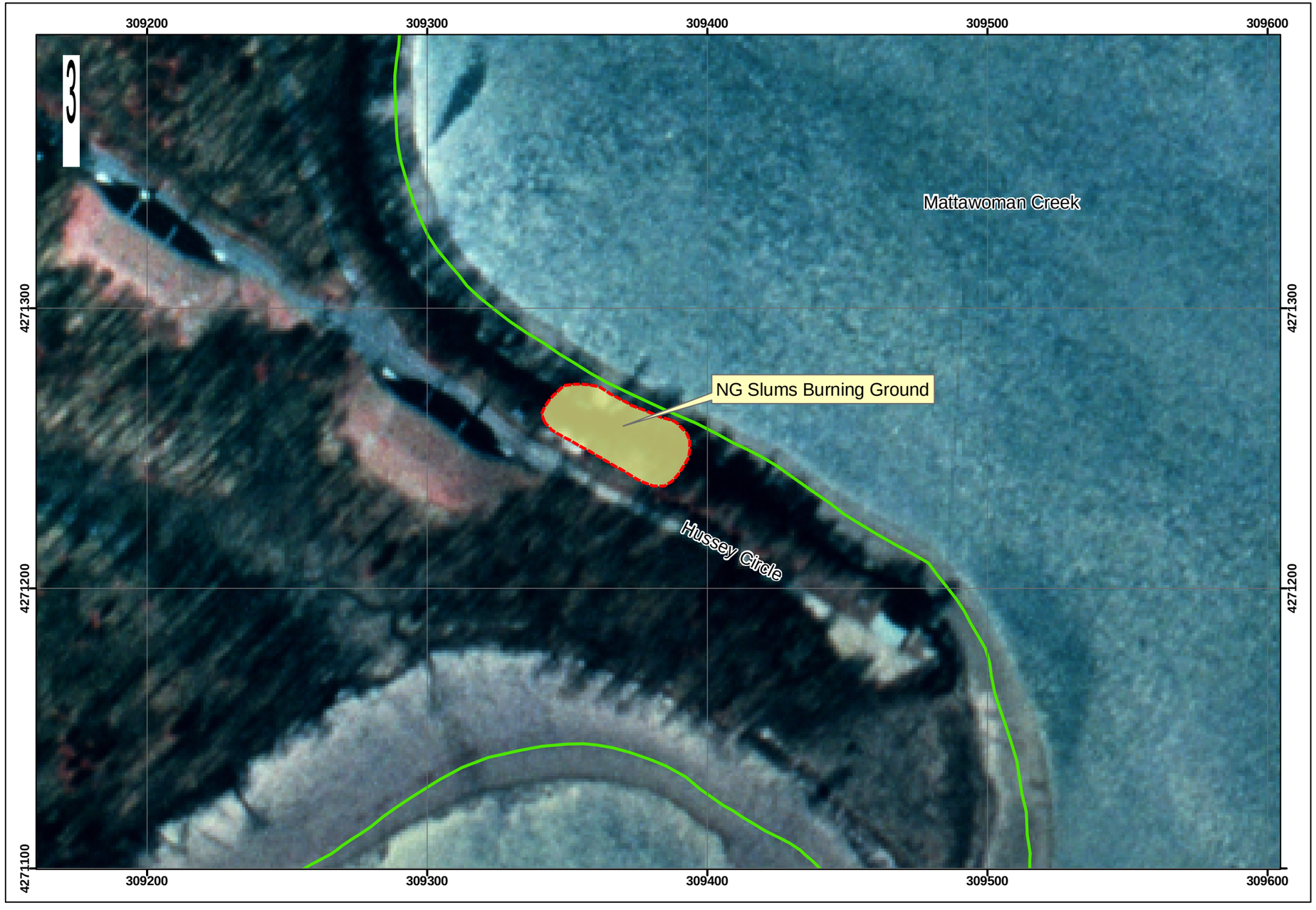
0 25 50 75 100 Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005





Preliminary Assessment
NDW, Indian Head, Maryland

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Map 5.3-3
Munitions Characterization
NG Slums Burning Ground

Legend

- Installation Boundary
- NG Slums Burning Ground

MEC Presence

- Known
- Suspect

MEC Presence was determined through review of historical documentation, interviews, and/or visual survey.

0 25 50 75 100 Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005

5.4. SAFETY THERMAL TREATMENT POINT

5.4.1. History and Site Description

The Safety Thermal Treatment Point (STTP) is located at the end of a small peninsula that extends from the Main Installation into the confluence of the Mattawoman Creek and the Potomac River. The STTP is located at the end of Old Burn Point Way. According to the 1982 Initial Assessment Study, the STTP is a man-made peninsula constructed of sand, fill material, rocket motor casings, empty cartridges, and coal fly ash. Initially, the STTP was identified as a 1.3-acre range in the Navy Range Inventory. The boundaries of the range were adjusted to account for a small area of recent sediment deposition on the southern point of the peninsula, which increased the size of STTP to 1.6 acres. The boundary change is reflected in Map 5.4-1. On the same peninsula north of the STTP is an active test point. The test point uses a maximum of 100 lbs 1.1 explosive, which corresponds to a fragmentation distance of 5,362 ft. This potential fragmentation zone fully encompasses the STTP. Current testing occurs within enclosed chambers; however, at the time of the range survey other types of explosive testing were being proposed outside of the chamber. The peninsula on which the STTP and the active test point are located is illustrated in Figure 5.4-1.

Figure 5.4-1: Aerial view of STTP at Main Installation.

OB of waste pyrotechnics and single base, double base, and composite propellants was performed at the STTP starting in 1942 following the abandonment of the original burning ground. The

STTP was initially set up for two separate uses. The tip of the STTP peninsula and the area 150 feet inland was the primary burn area used for OB of munitions. Materials were burned on the ground surface or in an open top, steel thermal treatment vessel. The secondary burn area was used for munitions testing, including deflagration-to-detonation testing and pierce testing.

Between 1942 and 1988, OB occurred on a weekly basis. Waste munitions were stored at temporary storage points before being transported to the STTP for disposal. All types of propellants manufactured or disassembled at NDW, IH including CAD and PAD items, were burned at the STTP until the 1950s at a rate of approximately 40-50 pounds per week. Water or solvent wet wastes were burned with oil in 55-gallon drums. In 1954, the operation of the STTP changed, and the burning of propellants was moved to the Strauss Avenue Thermal Treatment Point, which is still active. The burning of CAD/PADs, primers, less sensitive explosives, and various other pyrotechnics at rates up to 25,000 pounds per year continued at the STTP through 1988. Difficult to burn ordnance materials were also burned at the STTP, including propellants contaminated with glass, and water solutions containing pyridine and phthalic anhydride.

The STTP is designated as SWMU 20 under the installation's RCRA program. In 1993, a study was conducted at the STTP in order to determine whether a clean closure of the range was feasible under RCRA. As part of this site characterization, soil and groundwater samples were collected. The Characterization Report submitted in 1995 outlines the results of this study, which concluded that the reported concentrations of explosives and metals within the soil and groundwater were at levels that would prohibit closure without further action. Details of the sampling results are presented and discussed further in Section 5.4.6.

5.4.1.1.Topography

Section 3.2 provides a general description of topography for the Main Installation. The STTP is flat with an elevation of five feet above msl, sloping towards the Mattawoman Creek and the Potomac River.

5.4.1.2.Geology

Regional geology for NDW, IH is provided in Section 3.3. The STTP is a man-made peninsula. It is composed of mostly fill material.

5.4.1.3.Soil and Vegetation Types

Section 3.4 provides a description of the soil and vegetation types for the Main Installation. The STTP is covered with grass, bushes and trees. There is a small wetland area on the northeast portion of the range, as shown in Figure 5.4-2.

Figure 5.4-2: Wetland area vegetation on the STTP.

5.4.1.4.Hydrology

Section 3.5 provides a description of hydrology at the Main Installation. The Potomac River and Mattawoman Creek dominate the STTP hydrology. In addition, an approximately 1.25-acre wetland area is located on the northeast edge of the range and extends within the range boundaries. Surface water runoff occurs in the direction of the Potomac River and Mattawoman Creek or northeast to the wetland. The STTP is located within a 100-year flood plain. There are documented occurrences of hurricanes that brought the tide up over the entire peninsula.

5.4.1.5.Hydrogeology

Section 3.6 provides a description of hydrogeology for the Main Installation, which is applicable to the area of the STTP. As the STTP is man-made and extends into the Mattawoman Creek-Potomac River confluence, the surficial water table is expected to be directly connected to these

surface water bodies. The STTP is located near potable well #15, located up gradient and approximately 1000 feet east of the range, which accesses the lower Patapsco aquifer.

5.4.1.6.Cultural and Natural Resources

The STTP is man-made dating from 1942. An archaeological reconnaissance survey of NDW, IH was conducted in 1985 (see Section 3.7). None of the archaeologically significant areas identified in the archaeological reconnaissance were located in the STTP area.

5.4.1.7.Endangered and Special Status Species

As described in Section 3.8, endangered or special status species are known to inhabit the NDW, IH Stump Neck Annex. Due to their proximity, the species are considered to potentially inhabit the Main Installation and thus, the STTP.

5.4.2. Visual Survey Observations and Results

A visual survey of the STTP was conducted on June 23, 2003. Present during the visual survey were Ms. Grim, Mr. Rice, Mr. Wiley and Mr. Baker of Malcolm Pirnie Inc. Mr. Jorgensen, NDW, IH Environmental Office, accompanied the team. Visual observations provided for a 100% survey. No evidence of explosives or MEC was observed during the visual survey.

A large cylindrical steel unit, shown in Figure 5.4-3, is the former burn tank located in the primary burn area of STTP. The tank is approximately eight feet high and ten feet in diameter and was used to minimize emissions of ash and debris during the burning process. In addition, a free standing metal frame, a steel deflection shield, and miscellaneous explosives testing equipment are located on range. The 15-foot by 15-foot steel deflection shield was reported to have been positioned to block flying debris from the burn tank from reaching the Potomac River and Mattawoman Creek. Figure 5.4-4 provides another view of the STTP, showing the miscellaneous equipment stored there.

Figure 5.4-3: Steel burn tank located on STTP.

Figure 5.4-4: Miscellaneous equipment at the STTP.

A visual depiction of the site reconnaissance route is provided on Map 5.4-1 located at the end of Section 5.4. Additional range/site details are illustrated on Map 5.4-2, also located at the end of Section 5.4.

5.4.3. Munitions and Munitions Related Materials Associated with the Site

This section describes the munitions or munitions related materials known or suspected to be at the range, including the types and estimated maximum penetration depths. This includes both MEC and non-hazardous munitions related debris (e.g., fragmentation, base plates, inert mortar fins). Potential ordnance concentration areas are presented along with a discussion on the presence of any special consideration ordnance.

The STTP was used for OB/OD of projectiles, CAD/PADs, primers, less sensitive explosives, high explosives and various other pyrotechnics (e.g., squibs, igniters, caps, black powder) at rates up to 25,000 pounds per year between the early 1940s and 1988. Waste pyrotechnics, single base, double base, and composite propellants were burned at the STTP through 1954. Additional items burned on-site include propellants contaminated with glass, and water solutions containing pyridine and pthalic anhydride. Residue from burnt CAD items was periodically transferred to the Caffee Road Decontamination Burn Point for disposal. Technical data ordnance sheets are provided in Appendix C.

According to Mr. Perk, a Production Engineer retired from Indian Head, all material was burned directly on the ground when the STTP was first constructed. Scrap propellants were put in pits in the ground and ignited. New soil would be brought in periodically as needed. Burn pans were added on-site in 1980. A few instances occurred in which the steel deflection shield was not able to prevent ejected materials from leaving the area. These incidences were mainly caused by burning of NG solvents or plastic bonded explosives in bulk form.

The 1982 Initial Assessment study performed by the Naval Energy and Environmental Support Activity reports that sometime in the late 1970s, five gallons of waste solvents were spilled on the STTP, reaching surface water. In addition, it was reported that during that time period, metal items from the site were occasionally ejected into the Mattawoman Creek and the Potomac River during OB.

Based on the information obtained during the data collection process, no CWM filled munitions, electrically fused munitions, or DU associated munitions were found or are expected to be found at the STTP.

5.4.4. MEC Presence

The entire range has been subdivided and categorized into one of three levels of MEC presence including: Known MEC Areas; Suspect MEC Areas; or Areas Where No Evidence Exists to indicate that MEC is known or is suspected to be at the site. The MEC presence is discussed below. Map 5.4-3 illustrates the munitions characterization of the STTP and is provided at the end of Section 5.4.

5.4.4.1. Known MEC Areas

According to historical documents and information obtained during the data collection process, there is no evidence of MEC at the STTP. Therefore, there are no areas of known MEC contamination at the STTP.

5.4.4.2. Suspected MEC Areas

Because OB and testing of ordnance items occurred at the STTP, all areas of the range are suspected to contain MEC. Kickouts and fragment projectile distances are estimated following the "New Methods for Determine Blast and Fragmentation Distance Ranges for EOD Operations/Incidents" by the NAVEODTECHDIV, Indian Head, MD. The maximum fragmentation zone associated with the types of munitions disposed or tested at STTP is illustrated on Map 5.4-2. This zone is the area in which MEC fragments and/or MC may be found. For the STTP, this zone encompasses 232.3 acres; however, no MEC fragments have reportedly been found within this area.

5.4.4.3. Areas Not Suspected to Contain MEC

There are no areas at the STTP not suspected to contain MEC.

5.4.5. Ordnance Penetration Estimates

The depth to which munitions penetrate below the ground surface depends on many factors, including the type of soil, the angle of impact, the size of the munition, the velocity at impact, and site-specific environmental conditions. Over the years, the DoD has studied and modeled munitions penetration depths and has issued various guidance and technical documents on the subject. For the purposes of this PA, maximum probable penetration depths are estimated following guidance listed in the latest draft (July 2002) of the DoD Directive on Explosives Safety issued by the DDESB [*DoD Directive 6055.9* (*DoD Ammunition and Explosives Safety Standards*)]. The Directive refers to *TM 5.855.1* and *NAVFAC P-1080*.

The majority of ordnance items at the STTP would not have penetrated the ground surface as the range was used for OB, and no firing of munitions took place. Potential penetration would be associated with fragmentation and kick-outs during OB. Penetration depth would be low (less than two feet) for OB/OD and testing.

5.4.6. Munitions Constituents

MC that may be present at the STTP include:

- TNT
- RDX
- Composition A
- Composition B
- Composition C
- Torpex
- PETN
- Dynamite
- Nitrocellulose
- Cordite
- Perchlorate
- Metals

Lead contamination is a result of propellant disposal operations, while nickel and cadmium result from OB of CADs. Based on the construction of the STTP peninsula with fill material, other metals are expected as well.

During a 1993 characterization of the range, MC were detected in the soil and groundwater. Concentrations in soil and groundwater were above EPA Region III risk-based cleanup levels or background levels. Soil samples were collected from eight locations on the range (shown on

Figure 5.4-5), as well as a background sample off-site. Samples were collected from the top 18 inches of the soil horizon. Groundwater was sampled at three locations on-site as well as a background location off-site. Well locations are numbers W1, W2 and W3 as shown on Figure 5.4-5. W1 was positioned at the location of the steel vessel (treatment unit), also shown on Figure 5.4-5. Groundwater samples were collected using temporary sand point wells. Soil and groundwater were tested for the following analytes: explosives, VOCs, SVOCs, total metals, TCLP metals, sulfide, cyanide, and nitrate-nitrite.

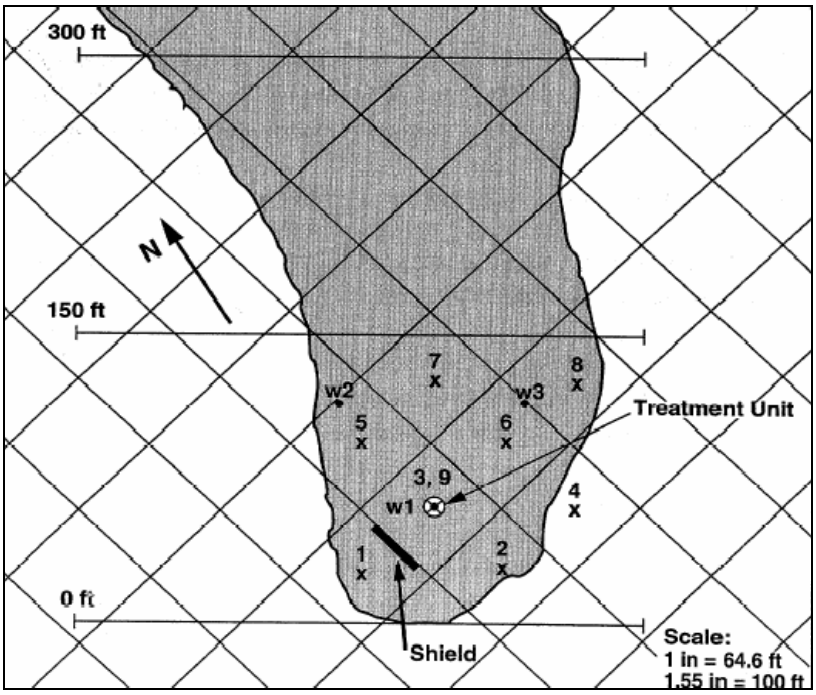


Figure 5.4-5: Location of soil and groundwater samples from the 1995 Characterization Report performed for the STTP.

Soil samples contained elevated levels of metals, explosives, volatiles, and semivolatiles when compared to background samples. The highest concentration of metals occurred near the steel burn tank. Metals detected at levels five times higher than the background samples included: barium, cadmium, chromium, lead, mercury, and nickel. The explosives most commonly occurring on-site at elevated levels were octahydro-1,3,5,7-tetranitro-1,3,5,7-tetraocine (HMX), 2,4-dinitrotoluene (DNT) and NG. These results are summarized in Table 5.4-1.

Table 5.4-1: Summary of soil sample results (milligram/kilogram) at the STTP								
Analyte	**# 1**	**# 2**	**# 3**	**# 4**	**#5**	**#6**	**#7**	**#8**
Arsenic	16.5	2.9	6.9	0.70	0.79	5.1	6.8	2.8
Barium	53.5	382	1,550	11.2	6.2	67.5	84.9	31.3
Beryllium	0.27	0.26	0.35	ND	ND	0.33	0.20	0.22
Cadmium	1.9	14.8	6.6	0.32	ND	0.84	0.31	0.38
Chromium	14.9	44.6	101	5.8	1.9	48.1	21.8	9.7
Lead	48.8	188	287	76.8	4.1	1,010	522	280
Manganese	75.9	298	198	382	86.7	131	485	65.6
Mercury	0.24	1.6	0.13	174	ND	3.8	0.54	4.4
Nickel	13.6	38.5	55.5	0.16	1.6	70.4	5.3	4.7
DNT	ND	ND	ND	ND	ND	ND	6.0	ND
DN	ND	ND	1.8	ND	ND	ND	ND	ND
Benzo(a) pyrene	ND	ND	ND	ND	ND	ND	ND	ND
HMX	13	ND	ND	ND	ND	ND	ND	4.3
NG	ND	ND	ND	ND	ND	180	ND	1.6

ND = Not Detected

Groundwater samples were also found to have elevated levels of metals, explosives, volatiles, and semivolatiles when compared to background samples. Samples from W1 had the highest concentrations of toxic metals, including lead, mercury, beryllium and cadmium. Samples from W2 had the lowest contaminant concentrations. Explosives and organics were detected in all samples at low levels. Only two explosives were detected in the groundwater samples: HMX and TNT. These results are summarized in Table 5.4-2.

From the soil and groundwater sampling performed, there do not appear to be any patterns in the occurrence of explosives within the STTP.

Table 5.4-2: Summary of Groundwater Sample Results (micrograms/liter) at the STTP			
Analyte	**W1**	**W2**	**W3**
Antimony	ND	ND	ND
Arsenic	34.6	2.2	35.9
Beryllium	1.9	ND	ND
Cadmium	5.4	ND	ND
Lead	5,110	25.6	316
Manganese	825	338	224
Mercury	22	ND	ND
Thallium	ND	ND	ND
TNT	840	ND	ND
Cyanide	212	ND	10.6
Pyridine	ND	ND	33
Bis(2-ethylhexyl) phthalate	ND	ND	5
HMX	ND	ND	1.1
TNT	0.84	ND	ND

ND = Not Detected

5.4.7. Contaminant Migration Routes

Migration of contamination from the STTP is influenced by the interconnection of direct infiltration from soil to groundwater and surface runoff/erosion to the Mattawoman Creek and Potomac River. Contaminants sorbed to surface soil may be mobilized, during extended periods of precipitation or storm surges that may cover the point and erode the surface soil. Surface water runoff may transport contaminants to the wetland area on the northeast side of the range.

Based on a review of hydrogeological data, it is unlikely that MC in shallow groundwater would migrate to the deeper aquifers that are used as a water supply. However, shallow groundwater is still considered a potential exposure medium.

5.4.8. Receptors

Potential human receptors include authorized Navy personnel (military and civilian), visitors, contractors, maintenance workers, recreational river users and trespassers. Plant and animal biota are also potential receptors. Examples of ecological receptors include deer, wild turkey, and water fowl. Reportedly, an osprey nest is located within the boundaries of STTP.

5.4.8.1. Nearby Populations

Nearby populations are as described in Section 5.1.8.1. Additionally, land uses surrounding the STTP include recreational boating and fishing on the Potomac River and Mattawoman Creek. No residential properties are located within two miles of the STTP.

5.4.8.2. Buildings Near/Within Site

Buildings 1441, 1248, 1249, 1538, and 1367 border the STTP to the north along Old Burn Point Way. There are no buildings or structures located on the STTP.

5.4.8.3. Utilities On/Near Site

The STTP is connected to the electrical and potable water systems of NDW, IH.

5.4.9. Land Use

The STTP peninsula was built between approximately 1940 and 1942, after which the OB of waste pyrotechnics, single base, double base, and composite propellants was initiated. Between 1942 and 1988, OB occurred on a weekly basis. In 1954, the burning of propellants was moved to another range. The STTP was then used for burning of CAD/PADs, primers, less sensitive explosives, and various other pyrotechnics until December 1988. OB occurred only on the primary burn area, an area including the first 150 feet of the peninsula point. The secondary burn area covered the remainder of the range and was used for munitions testing. There is no reported planned change to the current use of the STTP. An active test point is located directly north of the STTP with a fragmentation zone that may envelop the entire STTP.

According to the 2003-2004 NDW, IH Hunting Map, the STTP is located within a designated waterfowl blind.

5.4.10. Access Controls / Restrictions

No public access is authorized at NDW, IH. Signs, partial fencing, locked/secured gates, login book/office check-in, and vehicle security patrol control the entire facility. There are no access control features specific to the STTP. Access from the water is not controlled. No land use/development restrictions are known for the range.

According to the 1990 Master Plan Update, the STTP is located within two explosive safety quantity distance (ESQD) arcs generated by production, testing, and storage facilities located on Indian Head peninsula. The ESQD arcs that affect the STTP are the 1,800-foot missile hazard distance arc and the 1,250-foot inhabited distance arc centered around Building 754. Construction on the STTP is prohibited by NDW, IH as a safety measure for all former waste sites and ESQD arc areas.

5.4.11. Conceptual Site Model

A general description of the CSM is provided in Section 5.1.11. The CSM is presented in a series of information profiles that presents information about the range. The information profiles are presented in Table 5.4-3 below.

Table 5.4-3: Conceptual Site Model Information Profiles – STTP

Profile Type	Information Needs	Preliminary Assessment Findings
Range/Site Profile	Installation Name	NDW, Indian Head
	Installation Location	Indian Head, Charles County, MD
	Range/Site Name	STTP
	Range/Site Location	The STTP is a small man-made peninsula extending into the confluence of the Potomac River and the Mattawoman Creek.

Table 5.4-3: Conceptual Site Model Information Profiles – STTP		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
	Range/Site History	Explosive thermal treatment and testing of projectiles, bulk propellant, bulk high explosives, demolition charges, CAD/PADs, primers, less sensitive explosives, and various other pyrotechnics from the late 1940s until 1988.
	Range/Site Area and Layout	1.6 acres (approximately)
	Range/Site Structures	Metal structures included a blast shield, burn tank, and miscellaneous testing equipment. No buildings are currently present. An active test point with several buildings is located north of STTP.
	Range/Site Boundaries	N: Active test point (Buildings 1441, 1248, 1249, 1538, 1367) S: Mattawoman Creek W: Potomac River E: Mattawoman Creek
	Range/Site Security	NDW, IH security patrols the area. Access from the Potomac River and the Mattawoman Creek is not controlled. There is no site specific security.
Munitions/ Release Profile	Munitions Types	• Projectiles • CAD/PADs • Bulk propellant • High explosives • Primers • Pyrotechnics
	Maximum Probability Penetration Depth	Penetration depth would be low (less than two feet) for OB/OD and testing.
	MEC Density	Low to moderate. The STTP was used for OB/OD and testing.
	Munitions Debris	No debris of MEC were identified during the site visit.

Table 5.4-3: Conceptual Site Model Information Profiles – STTP		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
	Associated Munitions Constituents	• High explosives could include TNT, RDX, Composition A, Composition B, Composition C, Torpex, PETN and Dynamite • Propellants could include nitrocellulose, cordite, perchlorate • Metals Sampling was conducted in 1993; the soil and groundwater was reported to contain elevated levels of explosives and metals.
	Migration Routes/Release Mechanisms	Potential release mechanisms would include surface water runoff, erosion, infiltration, site maintenance, and intrusive work.
Physical Profile	Climate	Indian Head, MD has a continental-type climate with four well-defined seasons. The coldest period occurs in late January and early February, with low temperatures averaging at 29ºF. July is the warmest month with average maximum temperatures of 85ºF. The normal annual precipitation is approximately 44 inches, normal monthly precipitation varying from 2.25 (February) to 4.60 (August) inches.
	Topography	The STTP is generally flat, sloping slightly towards the Potomac River and the Mattawoman Creek.
	Geology	The Indian Head peninsula lies within the Atlantic Coastal plain physiographic province. The geology of the area is comprised of Precambrian igneous and metamorphic bedrock overlain by 500 to 600 feet of unconsolidated fluvial and marine deposits of the Potomac Group. The Potomac Group consists of, in descending order, the Patapsco, Arundel, and Patuxent Formations. The STTP is a man made peninsula, composed of sand and fill material.
	Soil	STTP consists of silty sand and fill material.
	Hydrogeology	The groundwater table in the STTP ranges from just beneath the surface to five feet bgs.

Table 5.4-3: Conceptual Site Model Information Profiles – STTP		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
	Hydrology	Surface water runoff is released to the Mattawoman Creek. The STTP is located on a man made peninsula at nearly msl.
	Vegetation	The STTP is well vegetated with grasses, brush and trees. A small wetland area exists at the northeast edge of the area.
Land Use and Exposure Profile	Current Land Use	The STTP is currently vacant. An active test point is located on the northern portion of the peninsula. The potential fragmentation zone for this test point may extent over STTP.
	Current Human Receptors	Navy personnel (military and civilian), contractors/visitors, maintenance workers, recreational users, and trespassers
	Current Activities (frequency, nature of activity)	Current activities at the STTP include light ground maintenance
	Potential Future Land Use	No planned change from current use is reported
	Potential Future Human Receptors	Navy personnel, contractors/visitors, and trespassers
	Potential Future Land Use-Related Activities:	There is no expected change in land use activities
	Zoning/Land Use Restrictions	Construction is prohibited.
	Demographics/Zoning	Charles County population density is approximately 260 persons per square mile. NDW, IH and its tenant commands employ approximately 3,600 military and civilian personnel. No residential properties are known to exist within two miles of the STTP
	Beneficial Resources	The STTP is located near potable well #15, located up gradient and east of the range, which accesses the lower Patapsco aquifer.
Ecological Profile	Habitat Type	STTP is primarily grass with surrounding bushes and trees along with a small wetland area on the northeast portion of the range.
	Degree of Disturbance	Low: The range is currently maintained but unused
	Ecological Receptors	
	Federal Endangered Species:	American Bald Eagle, rainbow snake, sensitive joint-vetch

Table 5.4-3: Conceptual Site Model Information Profiles – STTP		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
	Federal Threatened Species:	None
	State Endangered Species:	Scaly blazing-star
	State Threatened Species:	None
	Other Ecological Receptors:	Federal and state protected species are known to exist in the vicinity of the Main Installation. Ecological receptors include various flora and indigenous animals in the habitat. Deer and wild turkey are known to inhabit the area along with other mammals, birds, reptiles, and amphibians.
	Relationship of MEC/MC Sources to Habitat and Potential Receptors	Soil and groundwater samples confirmed the presence of explosives and metals at the STTP. Receptors can directly contact MEC/MC through surface water and surface soil, or indirectly with MC that have been incorporated into the food chain (bioaccumulated in plants and animals).

A general description of the CSM exposure pathway analysis is included in Section 5.1.11.

Historical use indicates that MEC may be present in the surface soils at the STTP. As such, a potentially complete exposure pathway exists for MEC in the subsurface and surface soil as illustrated in Figure 5.4-6. Potential receptors include both human and ecological receptors. Exposure routes include direct contact through handle/tread underfoot as well as intrusive activities such as excavation. Trespassers are not expected to perform intrusive work.

As illustrated in Figure 5.4-7, the MC Exposure Pathway Analysis, soil and surface water/sediments impacted by MC represent a primary source medium. A potentially complete exposure pathway exists for surface soil, surface water and sediments for all human and ecological receptors. Exposure routes include direct contact, ingestion, and inhalation. Direct human or biota contact with subsurface soil is possible if the soil is disturbed through excavation or drilling activities, creating possible migration routes/mechanisms for constituent impacted soils. Direct human or biota contact with surface soil may also be possible. The food chain also represents an exposure medium through plant/animal uptake for biota (including game such as deer and wild turkey). Hunting is permitted near to the range during certain periods of the year and by permit only. Since the area is partially located on a wetland area there are also potential

pathways for ecological ingestion by biota on range, and dermal contact with surface water/sediments for both human and ecological receptors. In this case, human receptors may include trespassers, Navy Personnel, visitors, and the current tenants of the area. Precipitation infiltration may provide for contaminant mobility into the subsurface soil and into the shallow or surficial groundwater aquifer, which is assumed to be connected to the nearby surface water bodies. Although confining layers are expected to prevent the migration of MC to the lower aquifers used for water supply, potentially complete pathways exist for MC in shallow groundwater for human receptors.

A graphical illustration of the details of the conceptual site model is included as Figure 5.4-8.

Figure 5.4-6: MEC Exposure Pathway Analysis

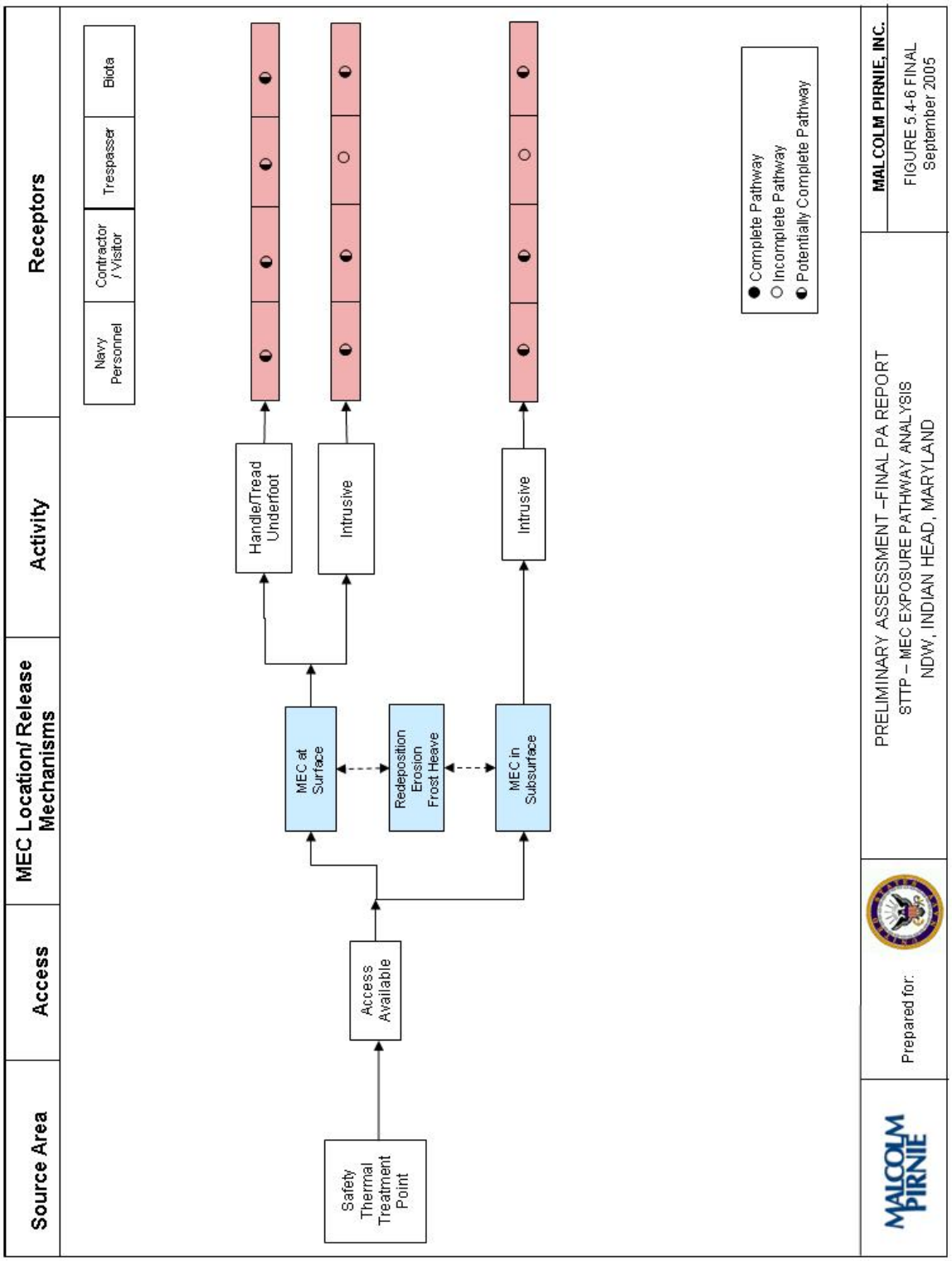


Figure 5.4-7: MC Exposure Pathway Analysis

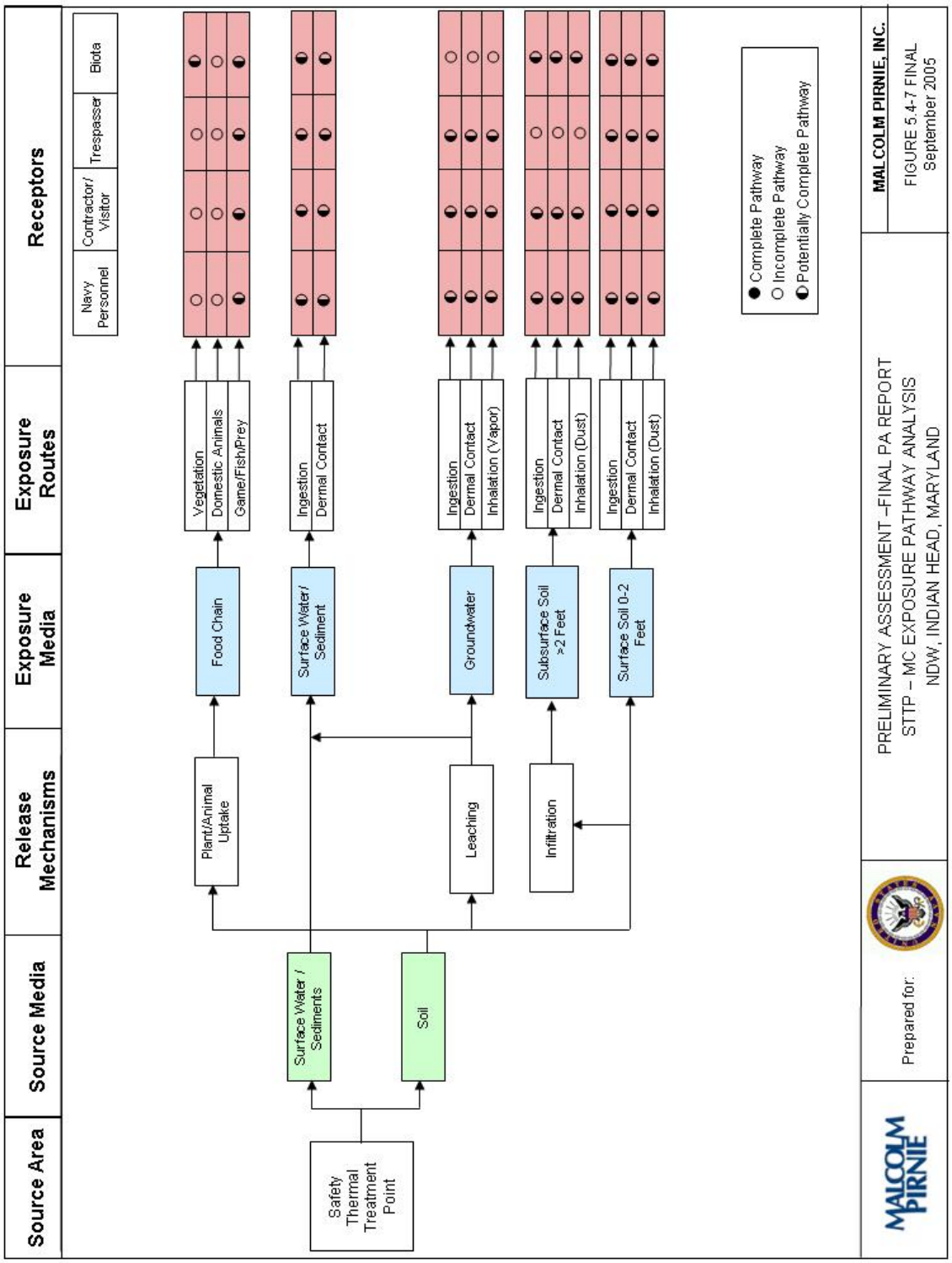
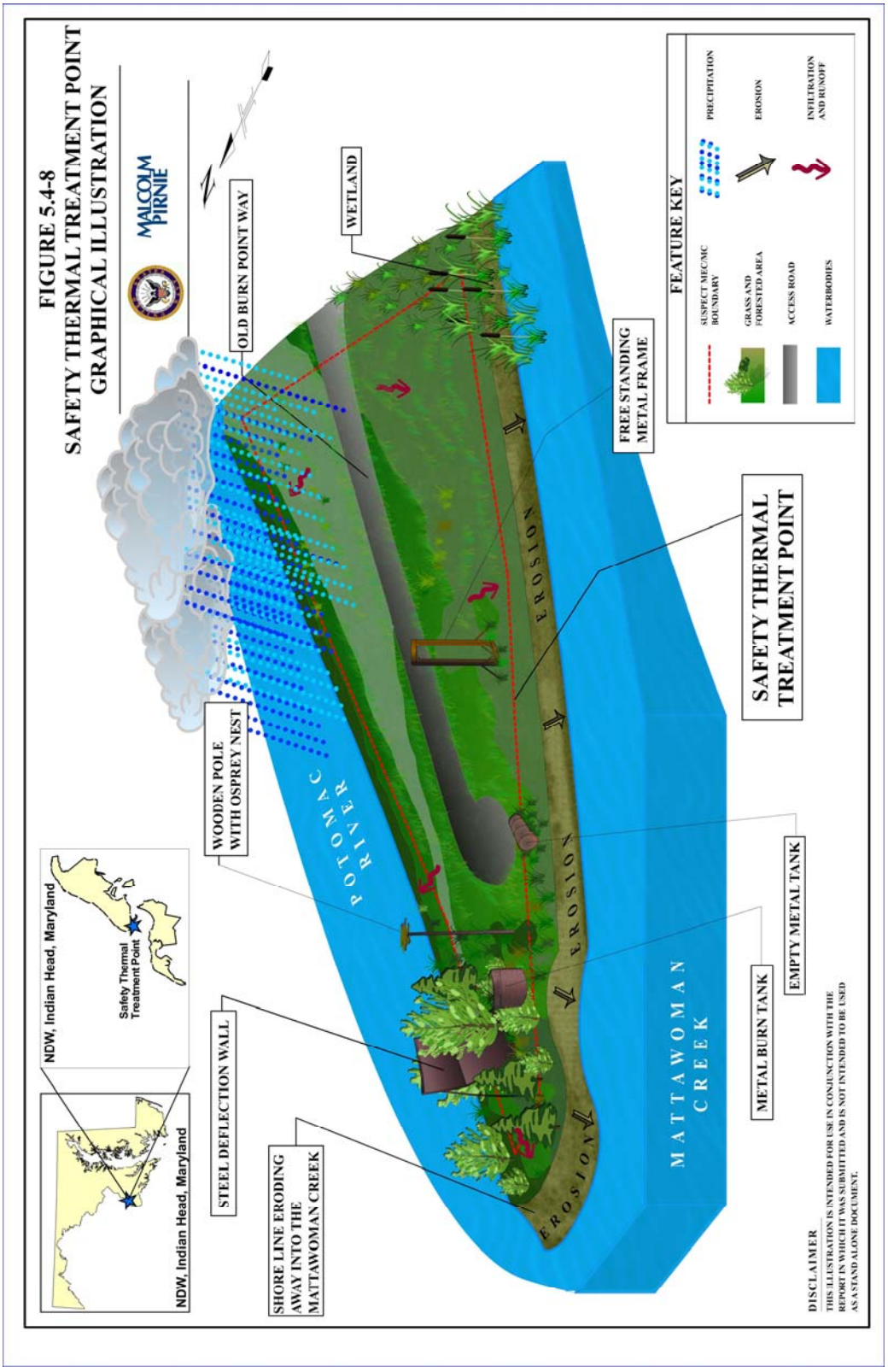


Figure 5.4-8: STTP Graphical Illustration



5.4.12. Summary

The STTP is a 1.6-acre range located at the end of a small peninsula extending from the southern tip of the Main Installation at the confluence of the Mattawoman Creek and the Potomac River. The boundaries of STTP were altered from those originally identified during the Navy Range Inventory due to a change in the size of the peninsula resulting from deposition. The man-made peninsula is composed of sand, fill material, rocket motor casings, empty cartridges, and fly ash from a coal burning plant. The STTP was operational from 1942 until 1988 for the OB of projectiles, CAD/PADs, primers, high explosives and various other pyrotechnics. Based on the former use of this area, both MEC and MC are suspected at this range. Potential MC may include TNT, RDX, Compositions A, B, & C, torpex, PETN, dynamite, propellants, and metals.

Preliminary Assessment
NDW, Indian Head, Maryland

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Map 5.4-1
Visual Survey
Safety Thermal Treatment Point

Legend

- Installation Boundary
- Safety Thermal Treatment Point From Inventory
- Revised Safety Thermal Treatment Point Identified during PA
- Site Reconnaissance

0 15 30 45 60Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005

Preliminary Assessment
NDW, Indian Head, Maryland

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Map 5.4-2
Range/Site Details
Safety Thermal Treatment Point

Legend

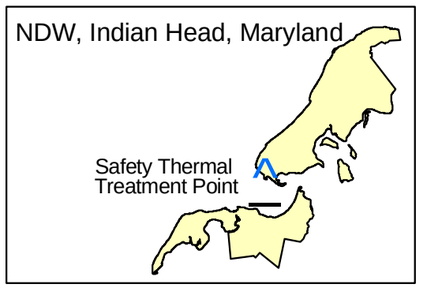
- Installation Boundary
- Structures
- Roads
- Contours
- Streams
- Wetlands
- Safety Thermal Treatment Point From Inventory
- Revised Safety Thermal Treatment Point Identified during PA
- Fragmentation Zone

0 15 30 45 60Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005



Preliminary Assessment
NDW, Indian Head, Maryland

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Map 5.4-3
Munitions Characterization
Safety Thermal Treatment Point

Legend

- Installation Boundary
- Revised Safety Thermal Treatment Point Identified during PA

MEC Presence

- Known
- Suspect

MEC Presence was determined through review of historical documentation, interviews, and/or visual survey.

0 15 30 45 60Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005

5.5. SINGLE BASE PROPELLANT GRAINS SPILL AREA

5.5.1. History and Site Description

The Single Base Propellant Grains Spill Area is 52-acres located in the northeastern portion of the Main Installation of NDW, IH, south of East Farnum Road. The Single Base Propellant Grains Spill Area was used in the loading and transporting of propellant from the former production area. The single base powder production area at NDW, Indian Head was established in 1899. From a review of historical installation maps, the railroad was extended to the production area between 1927 and 1942. The railroad line was used to transport the single base grains from the production area. The Single Base Propellant Grains Spill Area is located along this former rail line, adjacent to the powder production area. The railroad line was abandoned in the late 1980s. Releases of single base propellant grains during transportation may have occurred in this area between 1927 and the late 1980s. An aerial photograph of the site is provided in Figure 5.5-1.

Figure 5.5-1: Aerial photograph of the Single Base Propellant Grains Spill Area.

Single base propellant grains produce little to no smoke and consist primarily of nitrocellulose, which is formed from the reaction between cellulose and nitric acid. Burn rates were controlled by modifying the amount of nitrogen (generally 10-13% by weight) in the mixture. Other stabilizers may have been added to single base propellant grains, including diphenylamine, also a

common fungicide used in crop applications; however, these stabilizers were reported to typically be added at concentrations of only up to one percent by weight.

Single base nitrocellulose propellants, whose shape is designed to provide the desired burn characteristics, are generally stable; however, based on available Material Safety Data Sheets (MSDS), under certain conditions they may present a flammable or explosive risk.

Currently, the site is an open grassy area crossed by abandoned railroad tracks formerly used to transport propellants to numerous buildings, which are now either vacant or used for general equipment storage. This area is reported to include two designated wildlife grazing areas. Figure 5.5-2 depicts the observed conditions of the area during the June 2003 site visit. During Malcolm Pirnie's site reconnaissance, single base propellant grains were observed on the ground surface along the foundation of Building 188 (see Section 5.5.2).

Figure 5.5-2: Former railroad tracks and buildings

This area was investigated in the 1983 Initial Assessment Study of Naval Ordnance Station, Indian Head under the IR Program (IR Site 10). The report indicated that no further action was recommended. The investigation was limited and no analytical sampling was conducted to support no further action. The no further action recommendation was based on the low risk to human health and the environment from nitrocellulose.

5.5.1.1.Topography

Section 3.2 provides a general description of topography for the Main Installation. The topography of the Single Base Propellant Grains Spill Area can be described as generally flat with little relief. Elevation of the area is approximately 100 feet above msl.

5.5.1.2.Geology

Section 3.3 provides a geologic description for the Main Installation, which is applicable to the Single Base Propellant Grains Spill Area.

5.5.1.3.Soil and Vegetation Types

Section 3.4 provides a description of the soil and vegetation types at the Main Installation. According to the *US Navy Closed, Transferred, and Transferring Range and Other Sites Questionnaire*, the predominant soil type associated with the Single Base Propellant Grains Spill Area is sand-silt/sand-clay. The vegetation at the area consists of open grasses and shrubs.

5.5.1.4.Hydrology

Section 3.5 provides a description of hydrology at the Main Installation. The Single Base Propellant Grains Spill Area is located in the middle of the Main Installation. An unnamed tributary to the Mattawoman Creek lies in the eastern portion of the site. There are no known wetlands at the area.

5.5.1.5.Hydrogeology

Section 3.6 provides a description of hydrogeology for the Main Installation, which is applicable to the area of the Single Base Propellant Grains Spill Area. It is assumed that shallow groundwater flow from the Single Base Propellant Grains Spill Area follows topography and is connected to the area's dominant surface water bodies (the Mattawoman Creek and Potomac River).

5.5.1.6.Cultural and Natural Resources

An archaeological reconnaissance survey and a survey of historic buildings at NDW, IH were conducted in 1985 (see Section 3.7). While none of the archaeologically significant areas identified in the archaeological survey were located within the Single Base Propellant Grains Spill Area, the area is recorded to contain historic places/buildings.

5.5.1.7.Endangered and Special Status Species

As discussed in Section 3.8, endangered species are known to exist in the general area of NDW, IH specifically on the Stump Neck Annex. Due to their proximity, the species are considered to potentially inhabit the Main Installation and thus, the Single Base Propellant Grains Spill Area.

5.5.2. Visual Survey Observations and Results

The Single Base Propellant Grains Spill Area was visually observed on June 23, 2003 by Malcolm Pirnie personnel, including Ms. Grim, Mr. Rice, Mr. Baker, and Mr. Robert Wiley. In addition, Mr. Jorgensen, NDW, IH Environmental Office, accompanied the Malcolm Pirnie team. Methods used during the site walk were as follows: a perimeter walk was conducted around the site, followed by a modified "W" walked within the borders of the perimeters. Site coverage was estimated at 40 percent walked with 100 percent of the site visually observed. During the visual survey, single base propellant grains were observed on the ground surface outside Building 188 (see Figure 5.5-3). A visual depiction of the site reconnaissance route is provided on Map 5.5-1 located at the end of Section 5.5. Additional site details are illustrated on Map 5.5-2, also located at the end of Section 5.5.

Figure 5.5-3: Single base propellant grain observed at Building 188.

5.5.3. Munitions and Munitions Related Materials Associated with the Site

This section describes the munitions or munitions related materials known or suspected to be at the site, including the types and estimated maximum penetration depths. This includes both MEC and non-hazardous munitions related debris (e.g., fragmentation, base plates, inert mortar fins). Potential ordnance concentration areas are presented along with a discussion on the presence of any special consideration ordnance.

Available documents and the visual site survey support that single base propellant grains were spilled as a result of rail transport. Single base propellant grains, a popular propelling charge that provides for an efficient smokeless powder, are comprised primarily of nitrocellulose. Nitrocellulose is made from the reaction of nitric acid with cellulose (cotton linters or purified wood pulp). Sulfuric acid is added to remove water and increase the reaction rate. As previously noted, under certain condition these propellants may present a flammable or explosive hazard. Technical data sheets are included in Appendix C.

The Single Base Propellant Grains Spill Area is not suspected to contain CWM filled munitions, electrically fuzed munitions, or DU associated munitions.

5.5.4. MEC Presence

The entire range has been subdivided and categorized into one of three levels of MEC presence including: Known MEC Areas; Suspect MEC Areas; or Areas Where No Evidence Exists to indicate that MEC is known or is suspected to be at the site. The MEC presence is discussed below. Map 5.5-3 illustrates the munitions characterization of the Single Base Propellant Grains Spill Area and is provided at the end of Section 5.5.

5.5.4.1. Known MEC Areas

Single base propellant grains, classified as propellants, were observed on the ground surface outside Building 188. Therefore, MEC is known to exist in this area. Although MEC is known to exist in the area, explosive soils (*i.e.*, MEC greater than 10%) are not expected at the site.

5.5.4.2. Suspected MEC Areas

Based on the historic use of the area for the transport of propellants over a more than 30-year period, the entire area is a suspected MEC area.

5.5.4.3. Areas Not Suspected to Contain MEC

As MEC was observed on the ground surface, there are no areas at the Single Base Propellant Grains Spill Area not suspected to contain MEC.

5.5.5. Ordnance Penetration Estimates

Ordnance penetration guidelines are not applicable to loose propellant grains. Single base propellant grains spilled on the ground surface are expected to be found on the ground surface or within the immediate soil horizon.

5.5.6. Munitions Constituents

MC associated with single base propellants grains include nitrates and diphenylamine, which are commonly used to control burning rates and as stabilizers.

5.5.7. Contaminant Migration Routes

Single base propellant grains are not soluble, and based on their size, are not considered able to be transported through the soil column. Grains could be transported by overland flow during periods of high precipitation and released in surface water. Direct contact at the ground surface is considered the mostly likely exposure scenario. MC (i.e., nitrates or diphenylamine) could infiltrate to subsurface soils. Precipitation infiltration may also provide for contaminant mobility through the subsurface to the shallow or surficial groundwater aquifer, which is assumed to be connected to the nearby surface water bodies. Based on a review of hydrogeological data, it is unlikely that MC in shallow groundwater would migrate to the deeper aquifers that are used as a water supply. However, shallow groundwater is still considered a potential exposure media.

5.5.8. Receptors

Potential human receptors include authorized Navy personnel (military and civilian), visitors, contractors, maintenance workers, recreational users and trespassers. Plant and animal biota are also potential receptors. Examples of ecological receptors include deer, wild turkey, and water fowl.

5.5.8.1. Nearby Populations

Nearby populations are as discussed in Section 5.1.8.1.

5.5.8.2.Buildings Near/Within Site

There are sixteen buildings located within the site boundaries: Buildings 174-178, 180, 181, 183, 187, 188, 190, 204, 206-208, and 210. The majority of the buildings are vacant; however, a few are used for storage. Rail sidings divide the area, running parallel with Powder Line Road.

5.5.8.3.Utilities On/Near Site

Electrical lines, sewer lines, and water lines run through the Single Base Propellant Grains Spill Area.

5.5.9. Land Use

Historic use included the rail transfer of single base propellant grains from the production facility. The Single Base Propellant Grains Spill Area is currently not used, with the exception of several storage buildings. In addition, it is reported that two designated wildlife grazing areas are located within the boundaries of the site. According to the 2003-2004 Indian Head Hunting Map, the site is also located within an Upland Hunting Area. The former railroad tracks are no longer operational. Open fields, trees, grass, and roads surround the Single Base Propellant Grains Spill Area. Open fields and Benson Road border the site on the east; Carpenter Road borders the site on the south; several buildings are located to the west; and East Farnum Road borders the site on the north.

5.5.10. Access Controls / Restrictions

No public access is authorized at NDW, IH. Signs, partial fencing, locked/secured gates, login book/office check-in, and vehicle security patrol control the entire facility. There are no access control features specific to the Single Base Propellant Grains Spill Area. No land use/development restrictions are known for the site.

5.5.11. Conceptual Site Model

A general description of the CSM is provided in Section 5.1.11. The CSM is presented in a series of information profiles that presents information about the range. The information profiles are presented in Table 5.5-1 below.

Table 5.5-1: Conceptual Site Model Information Profiles – Single Based Propellant Grains Spill Area		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
Range/Site Profile	Installation Name	NDW, Indian Head
	Installation Location	Indian Head, Charles County, MD
	Range/Site Name	Single Base Propellant Grains Spill Area
	Range/Site Location	The site is located on the northeast side of the Main Installation, south of East Farnum Road.
	Range/Site History	Formerly part of the single base propellant production area, beginning in 1943 through the late 1980s. A railroad across the site was used to transport propellant from the installation.
	Range/Site Area and Layout	Consisting of approximately 52 acres, stretches along the railroad and Powder Line Road. Most buildings located within the site are vacant and are surrounded by a generally flat gravel landscape. Grasses and shrubs surround the gravel areas. Two designated wildlife grazing areas are located within the site.
	Range/Site Structures	Buildings 174, 175, 176, 177, 178, 180, 181, 183, 187, 188, 190, 204, 207, 206, 208, 210.
	Range/Site Boundaries	N: East Farnum Road S: Carpenter Road W: Dry House Road E: Benson Road
	Range/Site Security	NDW, IH has installation wide security and access restrictions. Once within the installation, no additional access restriction features exist for the Single Base Propellant Grains Spill Area.
Munitions/ Release Profile	Munitions Types	Propellant; explosive and flammable hazard
	Maximum Probability Penetration Depth	Surface only (< one foot).
	MEC Density	Low. Grains observed on the ground surface by Building 188.
	Munitions Debris	None
	Associated Munitions Constituents	Nitrates and diphenylamine
	Migration Routes/Release Mechanisms	Surface runoff; site maintenance; construction; excavation

Table 5.5-1: Conceptual Site Model Information Profiles – Single Based Propellant Grains Spill Area

Profile Type	Information Needs	Preliminary Assessment Findings
Physical Profile	Climate	Indian Head, MD has a continental-type climate with four well-defined seasons. The coldest period occurs in late January and early February, with low temperatures averaging at 29ºF. July is the warmest month with average maximum temperatures of 85ºF. The normal annual precipitation is approximately 44 inches, normal monthly precipitation varying from 2.25 (February) to 4.60 (August) inches.
	Topography	The Single Base Propellant Grains Spill Area is relatively flat, sloping slightly to the southeast.
	Geology	The Indian Head peninsula lies within the Atlantic Coastal plain physiographic province. The geology of the area is comprised of Precambrian igneous and metamorphic bedrock overlain by 500 to 600 feet of unconsolidated fluvial and marine deposits of the Potomac Group. The Potomac Group consists of, in descending order, the Patapsco, Arundel, and Patuxent Formations.
	Soil	According to the US Navy Closed, Transferred, and Transferring Range and Other Sites Questionnaire, the predominant soil type associated with the Single Base Propellant Grains Spill Area is sand-silt/sand-clay.
	Hydrogeology	The hydrogeological makeup of the Indian Head, MD area consists of a surficial aquifer and several deeper confined and semi-confined aquifers in the Patapsco and Patuxent Formations. The surficial aquifer is expected to be connected to and influenced by the surface water bodies. Regional water supplies, including that of NDW, IH are obtained from the lower and middle sands of the Patapsco and Patuxent Formations of the Potomac Group. The surficial aquifer (i.e., water table) is not used for water supply at NDW, IH.
	Hydrology	An unnamed tributary to the Mattawoman Creek lies in the eastern portion of the Single Base Propellant Grains Spill Area. There are no known wetlands at the area.
	Vegetation	Grasses and shrubs

Table 5.5-1: Conceptual Site Model Information Profiles – Single Based Propellant Grains Spill Area		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
Land Use and Exposure Profile	Current Land Use	Some buildings on the site are utilized for storage; however, the remaining buildings and railroad are abandoned. Two designated wildlife grazing areas exist in the area.
	Current Human Receptors	Navy personnel (military and civilian), contractors, visitors, maintenance workers, recreational users, and trespassers
	Current Activities (frequency, nature of activity)	Infrequent activity
	Potential Future Land Use	Possible location for storage of munitions or office storage
	Potential Future Human Receptors	Navy personnel, trespassers, and contractors. These receptors would include construction workers (if intrusive subsurface work is necessary) and maintenance and operations workers (if the site use changes)
	Potential Future Land Use-Related Activities:	Possible location for storage of munitions or office storage.
	Zoning/Land Use Restrictions	None known
	Demographics/Zoning	Charles County population density is approximately 260 persons per square mile. NDW, IH and its tenant commands employ approximately 3,600 military and civilian personnel.
	Beneficial Resources	Historical buildings
Ecological Profile	Habitat Type	New/old field species and forested habitats.
	Degree of Disturbance	Moderate – Activities at the site include moderate disturbance (e.g., mowing [which may encourage some wildlife species], infrequent use for storage).
	Ecological Receptors	
	Federal Endangered Species:	American Bald Eagle, rainbow snake, and the joint-vetch
	Federal Threatened Species:	None
	State Endangered Species:	Scaly blazing-star
	State Threatened Species:	None

Table 5.5-1: Conceptual Site Model Information Profiles – Single Based Propellant Grains Spill Area		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
	Other Ecological Receptors:	Ecological receptors include various flora and animals typical of hardwood forest habitats. Deer and turkey are known to inhabit the area along with other mammals, birds, reptiles, and amphibians.
	Relationship of MEC/MC Sources to Habitat and Potential Receptors	Ecological receptors may come into direct contact with MEC (in surface soils).

A general description of the CSM exposure pathway analysis is included in Section 5.1.11.

At the Single Base Propellant Grains Spill Area, historic and visual evidence indicate that MEC are present; therefore, a complete exposure pathway exists for MEC. The Exposure Pathway Analysis figure for MEC is provided in Figure 5.5-4. As illustrated in the figure, surface soils containing MEC represent a source medium. A complete exposure pathway exists for surface soil through direct contact and surface intrusive activities for both human and ecological receptors. Trespassers are not expected to perform surface intrusive work. The presence of single base propellant grains on the ground surface has the potential to present a flammable and/or explosive risk from direct contact. Single base propellant grains are not expected in the subsurface.

As illustrated in Figure 5.5-5, the MC Exposure Pathway Analysis, soil impacted by MC represents a primary source medium. Single grains were released directly to the ground surface in documented spills in this area. A potentially complete pathway exists for all human and ecological receptors for ingestion, dermal contact, and inhalation. Although single grains are not soluble in water and therefore cannot be transported by infiltration, the associated MC (nitrates and diphenylamine) may be transported to the subsurface soil and surficial groundwater by infiltration. Potentially complete pathways exist at Single Base Propellant Grains Spill Area for subsurface soil for all receptors except trespassers. It is not anticipated that trespassers would come in contact with subsurface soils. As the Single Base Propellant Grains Spill Area is located within an upland hunting area, the food chain also represents an exposure medium through plant/animal uptake for biota (including game such as deer and wild turkey). Although confining layers are expected to prevent the migration of MC to the lower aquifers used for water supply, potentially complete pathways exist for MC in shallow groundwater for human receptors.

Figure 5.5-4: MEC Exposure Pathway Analysis

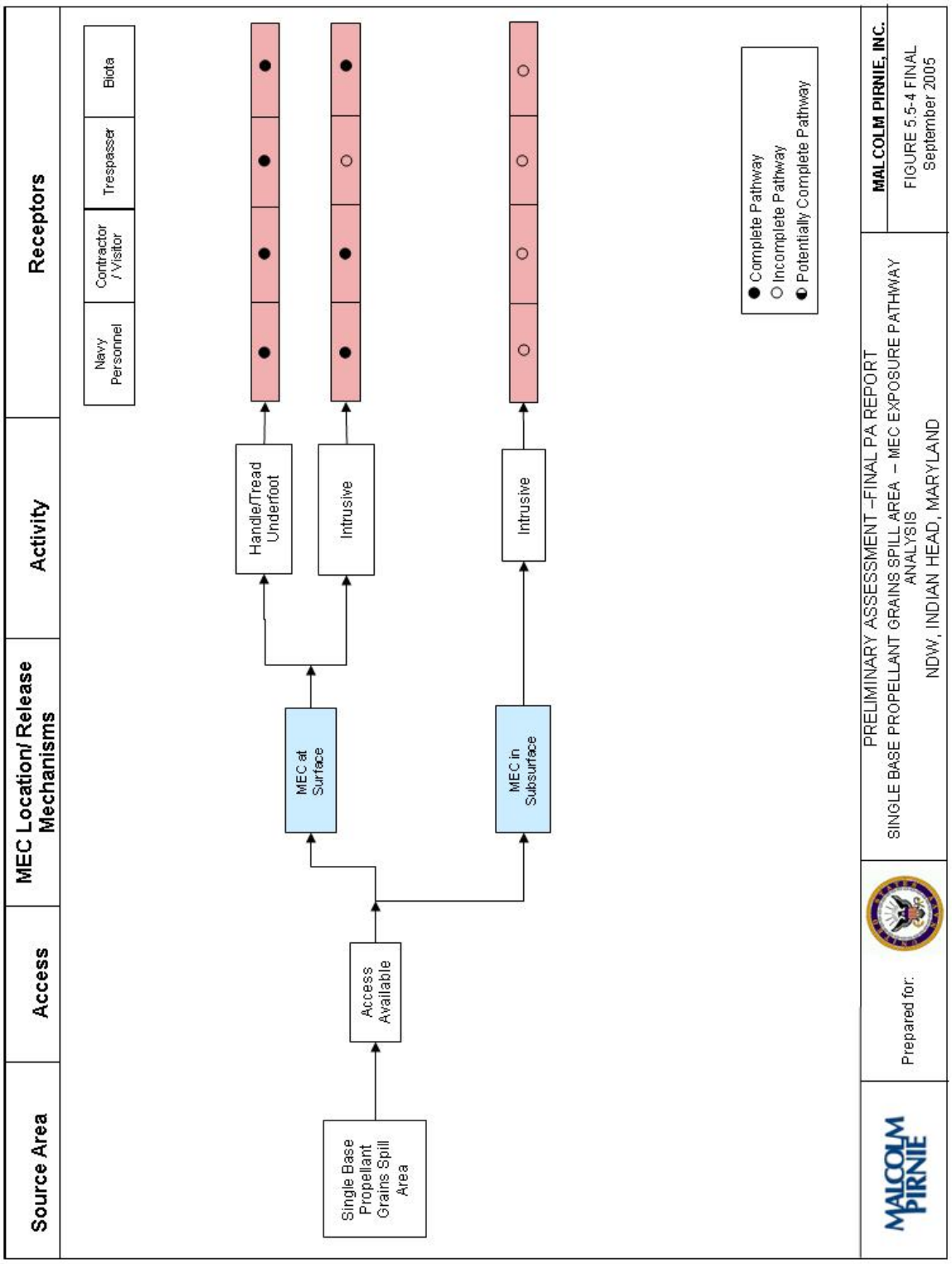
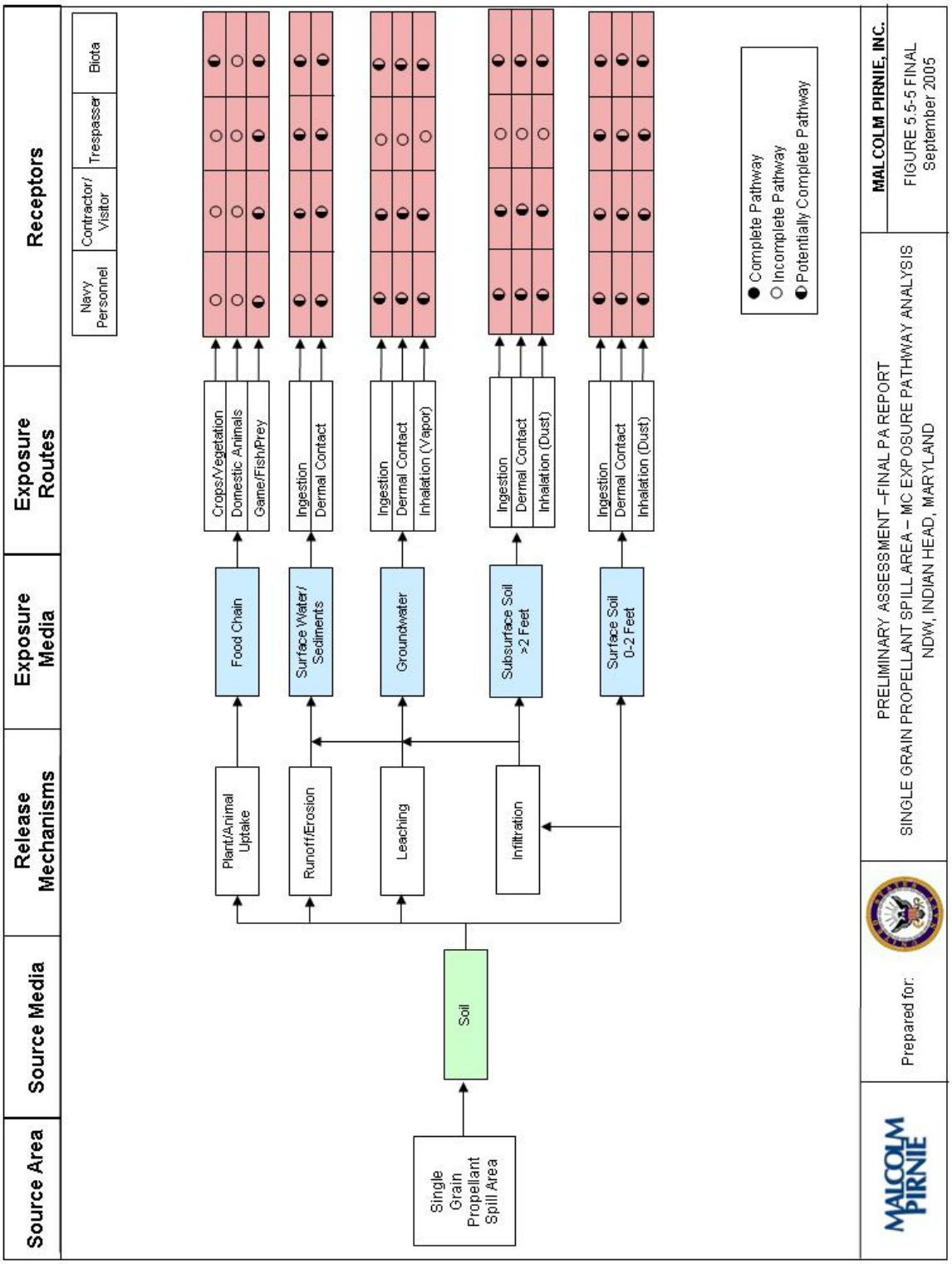


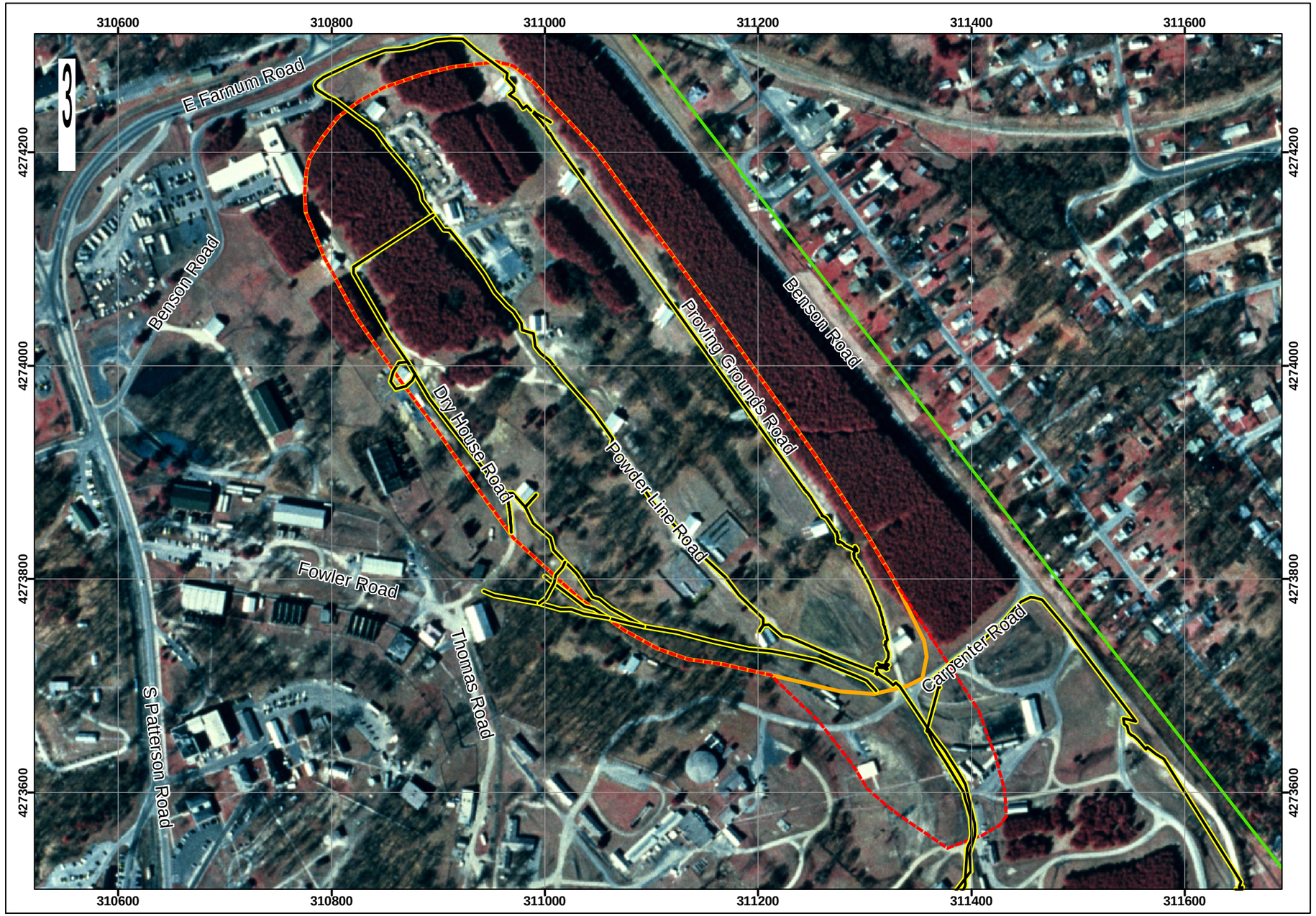
Figure 5.5-5: MC Exposure Pathway Analysis



5.5.12. Summary

The Single Base Propellant Grains Spill Area is located in the northeastern portion of the Main Installation at NDW, IH. The 52-acre area was used from 1943 through the late 1980s in the loading and transporting of propellant grains from the former production area. During the site visit conducted as part of this PA, single base grains, an explosive used as a smokeless propellant, were observed on the ground surface at Building 188. Based on information available, including nitrocellulose MSDS sheets, these materials are considered explosive and flammable hazards. The Single Base Propellant Grains Spill Area is considered a Known MEC Area as grains have been observed by installation personnel and during the visual survey. MC associated with the single base grains include nitrates and diphenylamine, which may be soluble in water and therefore transported to subsurface soil, groundwater, and surface water. Therefore, associated MC may also reside at the Single Base Propellant Grains Spill Area.

Preliminary Assessment
NDW, Indian Head, Maryland



Map 5.5-1
Visual Survey
Single Base Propellant Grains Spill Area

Legend

- Installation Boundary
- Single Base Propellant Grains Spill Area From Inventory
- Revised Single Base Propellant Grains Spill Area Identified during PA
- Site Reconnaissance

0 50 100 150 200 Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
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Date: September 2005

Preliminary Assessment
NDW, Indian Head, Maryland

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Map 5.5-2
Range/Site Details
Single Base Propellant Grains Spill Area

Legend

- Installation Boundary
- Structures
- Railroads
- Roads
- Streams
- Contours
- Single Base Propellant Grains Spill Area From Inventory
- Revised Single Base Propellant Grains Spill Area Identified during PA

0 50 100 150 200Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

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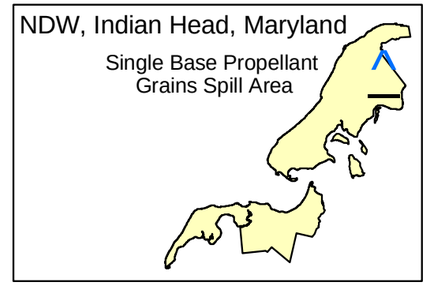

Preliminary Assessment
NDW, Indian Head, Maryland

Map 5.5-3
Munitions Characterization
Single Base Propellant Grains Spill Area

Legend

- Installation Boundary
- Revised Single Base Propellant Grains Spill Area
- Identified during PA

MEC Presence

- Known
- Suspect

MEC Presence was determined through review of historical documentation, interviews, and/or visual survey.

0 50 100 150 200 Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
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5.6. SOUTHWESTERN PISTOL RANGE

5.6.1. History and Site Description

The Southwestern Pistol Range was identified on a 1942 installation map as a "target range" as shown in Figure 5.6-1. It is currently a large clearing with overgrown grass adjacent to the Potomac River shoreline. The site is approximately 1.3 acres and is located at the western end of Indian Head Main Installation peninsula between Drop Tower Drive and Pump House Lane. This site is southwest of Building 739. According to the installation, an osprey nest was seen adjacent to this site. The area is designated as a wildlife field, and erosion was prevalent along the shoreline. A hill is located along the northeastern portion of the range, and it is expected that shooting occurred into the hill. The Southwestern Pistol Range is located within the estimated boundary of the firing fan from the The Valley site (see Section 5.7 of this PA).

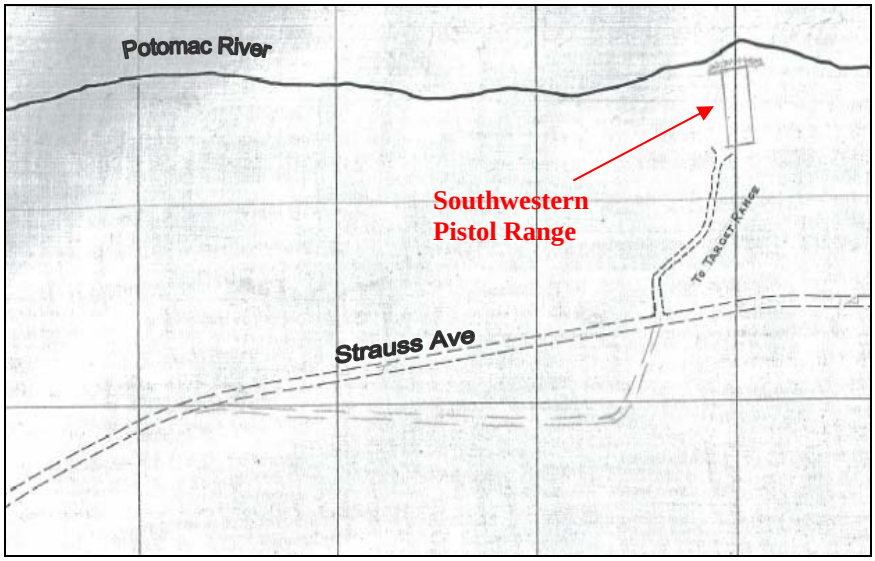


Figure 5.6-1: 1942 installation map with location of Southwestern Pistol Range.

5.6.1.1. Topography

Section 3.2 provides a general description of topography for the Main Installation. At the area known as the Southwestern Pistol Range, the topography of the majority of the area is relatively flat with an extreme slope towards Potomac River. Elevation at the Southwestern Pistol Range ranges from 25 feet to 10 feet above msl.

5.6.1.2.Geology

Section 3.3 provides a geologic description for the Main Installation. This general description is applicable to the Southwestern Pistol Range.

5.6.1.3.Soil and Vegetation Types

Section 3.4 provides a description of the soil and vegetation types at the Main Installation. The Southwestern Pistol Range is a cleared grassy area surrounded by hardwood forest. According to the Soil Survey of Charles County, soils at the Southwestern Pistol Range are classified as a mix of steep gravelly land and an Elkton silt loam.

5.6.1.4.Hydrology

Section 3.5 provides a description of hydrology at the Main Installation. The Southwestern Pistol Range is located adjacent to the Potomac River. No wetlands are known to exist at the range.

5.6.1.5.Hydrogeology

Section 3.6 provides a description of hydrogeology for the Main Installation. This information is applicable to the Southwestern Pistol Range area.

5.6.1.6.Cultural and Natural Resources

An archaeological reconnaissance survey of NDW, Indian Head was conducted in 1985 (see Section 3.7). None of the archaeologically significant areas identified in the archaeological reconnaissance survey were reported to be located in the Southwestern Pistol Range area.

5.6.1.7. Endangered and Special Status Species

As discussed in Section 3.8, endangered and special status species are reported to exist at the Stump Neck Annex of NDW. The reported endangered and special status species are expected to inhabit the Main Installation and thus, have the potential to

Figure 5.6-2: Designated wildlife field at Southwestern Pistol Range

inhabit the Southwestern Pistol Range. The Southwestern Pistol Range is a designated wildlife area (see Figure 5.6-2).

5.6.2. Visual Survey Observations and Results

A visual survey of the Southwest Pistol Range was conducted on June 2, 2004. Malcolm Pirnie personnel who conducted the visual survey included Ms. Julie Grim, Ms. Rhonda Stone, Mr. Svend Egholm, Mr. Dan Hains, Ms. Alicia Lo Galbo, and Mr. Ricardo Campos. Ms. Heidi Morgan, NDW Indian Head Environmental Office, accompanied the team. Based on the suspected location of this site shown on the 1942 installation map, several areas were walked to determine the exact location of the former pistol range. An area was located that had been cleared of trees approximately 50 to 60 years ago that is in the vicinity of the suspected site location. This area was determined to be the most probable location for the former pistol range. Several walking transects were conducted across the area to visually inspect the location. The site consists of a cleared grassy field surrounded by hardwood forest (see Figure 5.6-3). A hill is located along the northeastern portion of the site, which is the suspected target area.

Figure 5.6-3: Current conditions of the Southwest Pistol Range.

Small arms are not considered MEC. No MC or evidence of munitions use was observed during the range visit. However, it is possible that MC may be present in the surficial soil horizon.

A visual depiction of the site reconnaissance route is provided on Map 5.6-1. Additional range/site details are illustrated on Map 5.6-2.

5.6.3. Munitions and Munitions Related Materials Associated with the Site

This section describes the munitions or munitions related materials known or suspected to be at the range, including the types and estimated maximum penetration depths. This includes both

MEC and non-hazardous munitions related debris (e.g., fragmentation, base plates, inert mortar fins). Potential ordnance concentration areas are presented along with a discussion on the presence of any special consideration ordnance.

According to the Army Technical Manuals on small arms ranges (AR 750-10, TM 9-855), the maximum range for .a 22-cal pistol is 4,500 feet with a muzzle velocity of 1,100 feet per second. The maximum range for a .45-cal pistol is 4,800 feet with a muzzle velocity of 802 feet per second. The SDZ for a .45-cal pistol range extends downrange from each end of each firing line at a 5° angle for 4,800 feet. An additional SDZ, also originating from end of each firing line, extends downrange at a 25° angle for 3,600 feet. An example of a typical SDZ for a pistol range is provided in Figure 5.6-4.

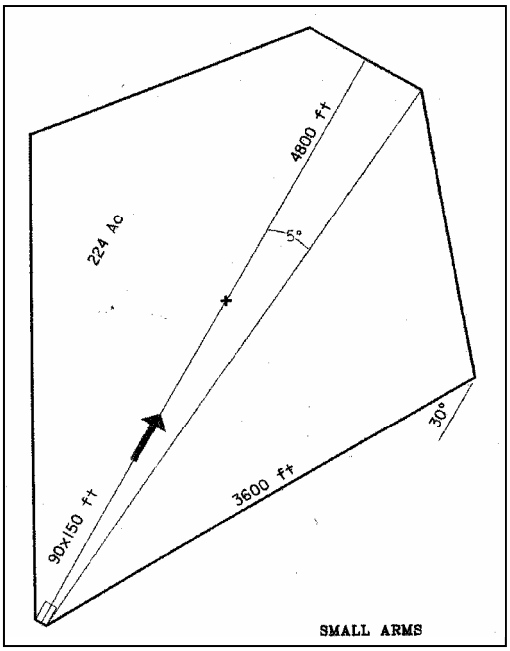


Figure 5.6-4: SDZ for a typical .45-cal pistol range

The SDZ for the Southwestern Pistol Range is shown on Map 5.6-2. Detailed records of the types and quantities of small arms ammunition used at the Southwestern Pistol Range were not available. However, the following small arms ammunition was likely used at the Southwestern Pistol Range: .22-cal, 9-mm, .45-cal, and .50-cal. Although it is likely that firing at the Southwestern Pistol Range was directed into a hill, a generic SDZ for a .50 cal small arms range, as directed by the Army Technical Manuals, was used for Map 5.6-2. The hill at the range is

located approximately 70 meters north of the firing line; however, the location of the firing line and the orientation of the SDZ is estimated. Technical data sheets for small caliber ammunition are provided in Appendix C.

The Southwestern Pistol Range is overlapped by the firing fan from The Valley located at NDW, Indian Head, Main Installation. Thus, there is a potential for munitions associated with The Valley to be present at the Southwestern Pistol Range. Technical data sheets are included in Appendix C. Refer to Section 5.7 in the Final PA Report for the Main Installation, Indian Head for information on The Valley.

Based on the information obtained during the data collection process, the Southwestern Pistol Range is not suspected to contain CWM filled munitions, electrically fuzed munitions, or DU associated munitions.

5.6.4. MEC Presence

The Southwestern Pistol Range has been assessed based on the likelihood of MEC contamination and assigned to one of three categories: (1) Known MEC Area; (2) Suspect MEC Area; or (3) Area Where No MEC Evidence Exists. The Southwestern Pistol Range is overlapped by the firing fan from The Valley located at NDW, Indian Head, Main Installation. Thus there is a potential for munitions associated with The Valley to be present at the Southwestern Pistol Range. Technical data sheets are included in Appendix C. Refer to Section 5.7 in this PA for information on The Valley. For purposes of this PA, only MEC presence specifically related to the Southwestern Pistol Range is considered in this section. Map 5.6-3 illustrates the munitions characterization of the Southwestern Pistol Range and is provided at the end of Section 5.6.

5.6.4.1.Known MEC Areas

Based on historical documents and information obtained during the data collection process, there is no evidence of MEC at the Southwestern Pistol Range as only pistols were used. Therefore, there are no known MEC areas.

5.6.4.2.Suspected MEC Areas

Based on historical documents and information obtained during the data collection process, there is no evidence of MEC at the Southwestern Pistol Range as only pistols were used. Therefore, there are no suspected MEC areas.

5.6.4.3.Areas Not Suspected to Contain MEC

Based on historical documents and information obtained during the data collection process, there is no evidence of MEC at the Southwestern Pistol Range as only pistols were used. Therefore, the entire Southwestern Pistol Range is not suspected to contain MEC.

5.6.5. Ordnance Penetration Estimates

The depth to which munitions penetrate below the ground surface depends on many factors, including the type of soil, the angle of impact, the size of the munitions, the velocity at impact, and site-specific environmental conditions.

For small arms ranges, the Interstate Technology and Regulatory Council (ITRC) has prepared a document titled, "Characterization and Remediation of Soils at Closed Small Arms Firing Ranges", dated January 2003, to provide information on the general layout of small arms ranges, as well as information on areas that may be impacted with MC and/or MEC as a result of range use and the characteristics of the munitions used. According to the ITRC guidance, the penetration depth of small arms on the range floor is one foot or less. The document states that rounds that impact the range floor are typically a flat trajectory that fell short of or missed the target, or those resulting from ricochet, and these fragments are usually found within the top six inches of soil. Penetration depths within the side of the hill may vary depending on the soil type and other conditions but are expected to be up to one foot or more.

The Southwestern Pistol Range is overlapped by the firing fan from The Valley located at NDW, Indian Head, Main Installation. Thus, there is a potential for munitions associated with The Valley to be present at the Southwestern Pistol Range. The ordnance penetration depth associated with munitions fired from The Valley is provided in Section 5.7.5.

5.6.6. Munitions Constituents

Small arms ammunition is mainly comprised of lead (approximately 85 percent by weight of the projectile). As such, the primary MC of concern associated with small arms ranges is lead. Metallic lead is insoluble in water, but in the geochemical environment of most ranges it may slowly convert to other oxidized forms. Depending on the environment (e.g., soil characteristics, pH, and organic matter present), oxidation products can become mobile. However, lead mobility is effectively controlled by adsorption under the majority of conditions found on small arms ranges. In general, an exponential decline in lead concentrations has been observed in very short vertical distances due to adsorption or exchange reactions with clays, metal oxides, or organic matter in the soil. As such, lead mobility is not likely to be an issue at most ranges.

Other MC may include antimony, arsenic, copper, zinc, and constituents associated with black or smokeless powder. However, these constituents are less likely to be of concern since they are either present in the ammunition item in only minor amounts/concentrations or are typically consumed when the item is fired. Based on discussions with installation personnel, surface soil sampling at the Southwestern Pistol Range has not occurred. Review of IRP documents indicates that groundwater monitoring wells have not been installed near the site.

The Southwestern Pistol Range is overlapped by the firing fan from The Valley located at NDW, Indian Head, Main Installation. Thus, there is a potential for munitions associated with The Valley to be present at the Southwestern Pistol Range. Refer to Section 5.7 in the Final PA Report for the Main Installation, Indian Head for information on The Valley. For the purposes of the PA, only the munitions constituents that specifically relate to the Southwestern Pistol Range are considered.

5.6.7. Contaminant Migration Routes

Environmental media through which MC may migrate from the Southwestern Pistol Range include soil, groundwater, surface water, and sediment. Direct human or biota contact with surficial and subsurface soil is possible. The Southwestern Pistol Range's proximity to the Potomac River provides possible migration routes to surface water. The majority of the area is sloped toward the Potomac River, and storm water discharges to surface water via overland flow. Groundwater flow in the shallow water table aquifer also likely trends towards the Potomac River; therefore, MC leaching from soils into shallow groundwater may migrate to surface water. Based on a review of hydrogeological data, it is unlikely that MC in shallow groundwater would

migrate to the deeper aquifers that are used as a water supply. However, shallow groundwater is still considered a potential exposure media. Sediments can act as contaminant repositories, and sediment mixing and dredging can act as migration routes to surface water. MC in surface soils and sediments may migrate via plant/animal uptake.

5.6.8. Receptors

Potential human receptors include authorized Navy personnel (military and civilian), visitors, contractors, maintenance workers, recreational river users and trespassers. Plant and animal biota are also potential receptors. Examples of ecological receptors include deer, wild turkey, and water fowl.

5.6.8.1. Nearby Populations

Nearby populations are as described in Section 5.1.8.1.

5.6.8.2. Buildings Near/Within Site

There are no buildings located within the Southwestern Pistol Range. However, Buildings 717, 716, and 715 are located along Strauss Avenue, which is located to the east of the range. Also, Building 739 is located to the northeast of the range. Numerous buildings are located within the SDZ (see Figure 5.6-2).

5.6.8.3. Utilities On/Near Site

No utilities are located within Southwestern Pistol Range; however, electric and potable water utilities are located to the east of the range.

5.6.9. Land Use

The site is currently an unused open field. According to the 2003-2004 Main Installation Hunting Map, the site is located within an upland hunting area.

5.6.10. Access Controls / Restrictions

No public access is authorized at NDW, IH. Signs, partial fencing, locked/secured gates, login book/office check-in, and vehicle security patrol control the entire facility. There are no access control features specific to the Southwestern Pistol Range. Access from the water is not controlled. There are no known land use/development restrictions for the range.

5.6.11. Conceptual Site Model

A general description of the CSM is provided in Section 5.1.11. The CSM is presented in a series of information profiles that presents information about the range. The information profiles are presented in Table 5.6-1 below.

Table 5.6-1: Conceptual Site Model Information Profiles – Southwestern Pistol Range

Profile Type	Information Needs	Preliminary Assessment Findings
Range/Site Profile	Installation Name	NDW, Indian Head
	Installation Location	Indian Head, Charles County, MD
	Range/Site Name	Southwestern Pistol Range
	Range/Site Location	The site is located at the western end of the Indian Head Main Installation peninsula, between Drop Tower Drive and Pump House Lane, southwest of the Building 739 and northeast of drop tower.
	Range/Site History	The area was identified in a 1942 installation map as a "target range".
	Range/Site Area and Layout	The site is a 1.3 acre cleared area with grass. A hill is located along the northeastern portion of the site, which is the suspected target area. No information was found regarding the actual layout and orientation of the range.
	Range/Site Structures	Building 739 is located northeast of the site.
	Range/Site Boundaries	N: Potomac River, Building 739 S: Drop tower W: Drop Tower Drive, Potomac River E: Pump House Lane
	Range/Site Security	NDW has installation wide security and access restrictions. Once within the installation, no additional access restriction features exist for the Southwestern Pistol Range. The site is accessible from the Potomac River.
Munitions/ Release Profile	Munitions Types	The site was reportedly used for small arms (pistol) training. The site is also overlapped by The Valley firing fan.

Table 5.6-1: Conceptual Site Model Information Profiles – Southwestern Pistol Range		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
	Maximum Probability Penetration Depth	Six inches or less for small arms. Ordnance penetration depths for munitions fired from The Valley can be found in Section 5.7.5.
	MEC Density	None anticipated
	Munitions Debris	None anticipated
	Associated Munitions Constituents	Primary MC of concern is lead from shot. Other associated MC may include antimony, arsenic, copper, nickel, and lead styphnate/lead azide.
	Migration Routes/Release Mechanisms	Soil surface runoff; soil leaching; groundwater discharge; site maintenance; construction; excavation
Physical Profile	Climate	Indian Head, MD has a continental-type climate with four well-defined seasons. The coldest period occurs in late January and early February, with low temperatures averaging at 29ºF. July is the warmest month with average maximum temperatures of 85ºF. The normal annual precipitation is approximately 44 inches, normal monthly precipitation varying from 2.25 (February) to 4.60 (August) inches.
	Topography	The topography at the Southwestern Pistol Range is relatively flat with an extreme slope towards the Potomac River.
	Geology	The Indian Head peninsula lies within the Atlantic Coastal plain physiographic province. The geology of the area is comprised of Precambrian igneous and metamorphic bedrock overlain by 500 to 600 feet of unconsolidated fluvial and marine deposits of the Potomac Group. The Potomac Group consists of, in descending order, the Patapsco, Arundel, and Patuxent Formations.
	Soil	Potomac River basin the Atlantic Coastal Plain and consists of gravel, sand, silt, and clay. Soil erodibility is high at the range.

Table 5.6-1: Conceptual Site Model Information Profiles – Southwestern Pistol Range		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
	Hydrogeology	The hydrogeological makeup of the Indian Head, MD area consists of a surficial aquifer and several deeper confined and semi-confined aquifers in the Patapsco and Patuxent Formations. The surficial aquifer is expected to be connected to and influenced by the surface water bodies. Regional water supplies, including that of NDW, are obtained from the lower and middle sands of the Patapsco and Patuxent Formations of the Potomac Group. The surficial aquifer (i.e., water table) is not used for water supply at NDW.
	Hydrology	Surface runoff flows west into the Potomac River.
	Vegetation	The Southwester Pistol Range consists of a grassy field with a surrounding area of coniferous-deciduous mix.
Land Use and Exposure Profile	Current Land Use	The Southwestern Pistol Range is currently vacant, and is designated as a wildlife area. Pump House Lane runs along the eastern border of the range. Hunting is a possible use for the area.
	Current Human Receptors	Navy personnel (military and civilian), visitors, contractors, maintenance workers, recreational users, and trespassers
	Current Activities (frequency, nature of activity)	Pump House Lane borders the range to the east; site maintenance, hunting.
	Potential Future Land Use	None reported
	Potential Future Human Receptors	Navy personnel (military and civilian), visitors, trespassers, and contractors. These receptors would include construction workers (if intrusive work is necessary) and maintenance and operations workers (if the range use changes) as well as recreational users.
	Potential Future Land Use-Related Activities:	Moderate activity. No reported future plans for the area.
	Zoning/Land Use Restrictions	None reported
	Demographics/Zoning	Charles County population density is approximately 260 persons per square mile. NDW and its tenant commands employ approximately 3,600 military and civilian personnel.
	Beneficial Resources	None

Table 5.6-1: Conceptual Site Model Information Profiles – Southwestern Pistol Range		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
Ecological Profile	Habitat Type	Grassy lands surrounded by coniferous-deciduous mix.
	Degree of Disturbance	Moderate; based on considerable shoreline erosion.
	Ecological Receptors	
	Federal Endangered Species:	American Bald Eagle, rainbow snake, sensitive joint-vetch
	Federal Threatened Species:	None
	State Endangered Species:	Scaly blazing-star
	State Threatened Species:	None
	Other Ecological Receptors:	Federal and state protected species are known to exist in the vicinity of the Main Installation. Ecological receptors include various flora and indigenous animals in the habitat. Deer and wild turkey are known to inhabit the area along with other mammals, birds, reptiles, and amphibians.
	Relationship of MEC/MC Sources to Habitat and Potential Receptors	Receptors can directly contact MC through surface water and surface soil, or indirectly with MC that have been incorporated into the food chain (bioaccumulated in plants and animals).

A general description of the CSM exposure pathway analysis is included in Section 5.1.11. The following CSM exposure pathways analysis focuses only on the Southwestern Pistol Range and does not consider impacts from The Valley firing fan. For the exposure pathway analysis for The Valley, refer to Section 5.7.11.

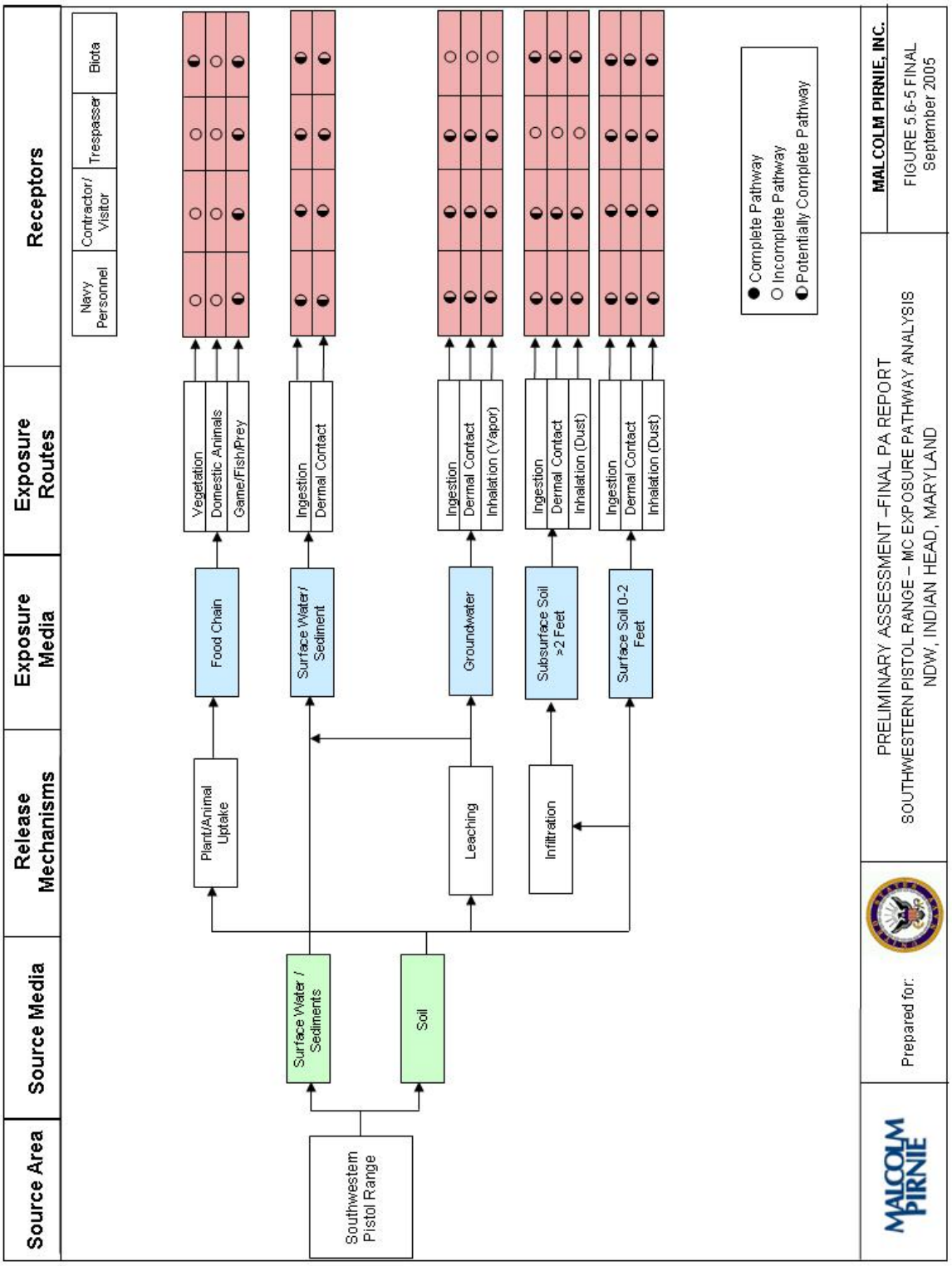
For the Southwestern Pistol Range, historic and visual evidence indicate that MEC are not present. Therefore, no complete exposure pathways exist for MEC. As such, no exposure pathway analysis was completed for MEC. However, MC may be present; therefore, potential MC exposure pathways do exist. The MC exposure pathway analysis for MC at the Southwestern Pistol Range is presented in Figure 5.6-5.

As illustrated in Figure 5.6-5, soil and surface water/sediments represent a primary source medium for MC. Lead shot may have been deposited on the ground surface. Based on the

estimated fan for the pistol range, lead could also have been directly released to surface water. Therefore, in surface soils and surface water/sediments, potentially complete exposure pathways exist for the ingestion, direct contact and inhalation of lead for human and animal receptors. Plants may accumulate MC as well. Given that the Southwestern Pistol Range is located within a designated wildlife area and potential hunting area, MC entering the food chain may provide migration pathways for human and ecological receptors.

Precipitation infiltration may provide for lead mobility through the subsurface to the shallow or surficial groundwater aquifer, which is assumed to be connected to the nearby surface water bodies, which are used recreationally. Potentially complete exposure pathways exist for MC in subsurface soils (direct contact, ingestion and inhalation during intrusive work activities). Although confining layers are expected to prevent the migration of MC to the lower aquifers used for water supply, potentially complete pathways exist for MC in shallow groundwater for human receptors.

Figure 5.6-5: MC Exposure Pathway Analysis



5.6.12. Summary

From information gathered during the PA, the Southwestern Pistol Range may have been used as a target range. The primary MC of concern, given the suspected nature of use, is lead from bullets. The combination of potential MC presence, access to the area, and migration pathways indicate that potentially complete MC exposure pathways exist. Since only small arms are reported to have been used at the Southwestern Pistol Range, and MEC are not associated with small arms, no MEC is expected to be present.

Preliminary Assessment
NDW, Indian Head, Maryland

MALCOLM PIRNIE

Map 5.6-1
Visual Survey
Southwestern Pistol Range

Legend

- Installation Boundary
- Site Reconnaissance
- Southwestern Pistol Range

0 30 60 90 120Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
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Preliminary Assessment
NDW, Indian Head, Maryland

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Map 5.6-2
Range/Site Details
Southwestern Pistol Range

Legend

- Installation Boundary
- Structures
- Roads
- Streams
- Contours
- Southwestern Pistol Range
- Firing Line
- Target Area
- Potential Surface Danger Zone

0 30 60 90 120Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
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NDW, Indian Head, Maryland

Preliminary Assessment
NDW, Indian Head, Maryland

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Map 5.6-3
Munitions Characterization
Southwestern Pistol Range

Legend

- Installation Boundary
- Southwestern Pistol Range

MEC Presence*

- Known
- Suspect

*There is no evidence of MEC Presence as determined through historical documentation, interview, and/or visual survey. Visual observations and/or historical documentation indicate that MC may be present at the site, but MC Presence has not been confirmed by sampling or other means.

0 30 60 90 120Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
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5.7. THE VALLEY

5.7.1. History and Site Description

The Valley is located adjacent to the Potomac River on the northwest portion of the Main Installation at NDW, IH. The Valley, listed as IR site number 29, is approximately 21 acres and was used from 1891 to 1921 for Navy gun proving and from 1940 through 1944 for jet propulsion research. Figure 5.7-1 depicts The Valley's current condition as observed during the site visit. Figure 5.7-2 is an aerial photograph showing the location of The Valley. Map 5.7-1 illustrates The Valley and its current features (e.g., Potomac River, roads, buildings).

Figure 5.7-1: Current view of The Valley

Prior to the 1890s, The Valley was a tidal marshland. In the 1890s, it was identified by the Bureau of Ordnance as an ideal location for testing both armor and guns, since the hills on each side would absorb shots and potential explosions of new types of gun barrels. There were two firing points located within The Valley (Map 5.7-7). One firing point was located on the northern side, where long-range guns were fired across The Valley south toward primary impact areas at Stump Neck Annex and the Potomac River. The second firing point was located along the southern side of The Valley, where short-range guns were fired across The Valley into the north butt along the northeast hillside. The distance from one side of The Valley to the other was approximately 400 feet, which enabled precision and accuracy testing of short-range guns. The

primary impact areas of the short-range gun were sand butts with armor plates positioned against hillsides of The Valley.

Figure 5.7-2: Aerial photograph of The Valley.

Long-range guns were fired from the northern firing point south toward the Potomac River. The primary impact areas for long-range gun proving were the Potomac River and the acquired land (i.e., Stump Neck); however, due to the increasing gun distance and experimental firing, impacts also occurred as far south as Quantico, Virginia. A 1916 Range Map identifies the potential impact areas of firing for long-range guns. Eight safety lookout points were established along both sides of the Potomac River to observe and identify the positions where shots landed and to notify "all clear" before test firing from The Valley. These eight lookouts or observation stations are shown on Map 5.7-4. The firing fan for the Valley overlaps approximately 130 acres of the Main Installation. Thus, there is a potential for munitions associated with The Valley to be present at other Main Installation ranges identified in this PA. The Valley's firing fan is shown on Map 5.7-5.

Historical documentation dated February 1, 1911 entitled, "Ranges at the Naval Proving Ground," stated that the line of fire down the Potomac River observed from the eight observation stations, allowing for drift, passed within 1,000 yards of Chopawamsic Island on the west and about 500 yards from Budd's Ferry on the east. Frequently, while using this range, the projectiles landed within 1,000 yards of Quantico. The observed line of fire passed over the entire length of

the Stump Neck Annex, within about 125 yards to the of west of the living quarters of the Marine detachment at the rifle range at Winthrop, directly over the observation station at Chicamuxen and landed about 200 yards east of the observation station at Chicamuxen. Ordinarily, the flight of projectiles was regular and smooth; however, due to occasional inefficient shell bands, guns in which the rifling had become worn, or other causes, the flight of projectiles were erratic. When projectiles were erratic, they would "wobble badly or tumble" causing them to fall very short and/or ricochet widely in either direction. Because of erratic projectiles, the entire Stump Neck area and the land beyond Budd's Ferry were considered danger zones.

The Valley was also used to test steel armor plates for shipboard use. The sections of armor plates measured eight by ten feet and weighed up to 25 tons. The armor plates were offloaded at the dock and moved by crane and a short railway track into the appropriate testing location. Shells tested ranged from four to ten inches in diameter. In addition, The Valley was used for testing of experimental guns, which led to modifications and improvements derived from repeated test firing of the weapons. Powder testing was conducted to determine explosive force, deterioration in storage, and other characteristics.

The *1890 Naval Proving Ground Naval Powder Factory Naval Propellant Plant People and Events from the Past*, dated 1961, documented that errant shells impacted some residential portions of Virginia during this period (see Figure 5.7-3).

38

started breakfast. After the cereal began to bubble, she took it from the burner and went up the stairs to make sure her boys were getting dressed. Suddenly windows began to break and the sound of splintering wood filled the house. Mrs. Swann ran down the stairs to find that a proving ground shell had gone through the parlor and kitchen, then out the side of the house onto the porch. Keeping calm, she returned to her children and waited for Dr. Patterson, who was in charge of the grounds, to arrive.

The Watchbox

Large guns continued to arrive by barge from the Navy Yard, even when the Indian Head range was considered safe for a maximum of seventeen thousand yards. Not long after the Swann farmhouse was shelled, a shot was fired across the Potomac into Virginia. No scoldings came from the other shore the rest of the day, or the next, so the episode was considered closed. In a week, a letter arrived from the Navy Department with a copy of correspondence received from one Molly Skinner of a rural address, Virginia. It seems her cow had been grazing in a pasture when a large shell had exploded within several yards of her. Now, Molly Skinner claimed that the cow would not give any milk. The Department ordered an investigation to take place immediately.

The next morning the Station launch pulled away from the dock with Dr. and Mrs. Patterson, Captain Lackey, and the Patterson children, Warren and Anna on board. The boat took the party to Quantico where a horse and buggy awaited them. After a ride across the Virginia countryside, the group came to the Skinner farm. True enough, a rather sick-looking cow stood in the

Figure 5.7-3: Excerpt from document identifying shots fired in residential portions of Virginia

Several pictures and maps depict The Valley during testing. The book entitled Praising The Bridge That Brought Me Over stated that an 1891 crisis between the United States and Chile and the 1895 Venezuelan boundary dispute led to increased preparedness for naval war. During this Chilean crisis, guns positioned at The Valley along the Potomac River were readied to protect Washington, D.C. from naval attack. Figure 5.7-4 shows a stockpile of cannon balls along the river's edge at The Valley, which demonstrates their existence at the range. Table 5.7-1 contains a summary of The Valley's history.

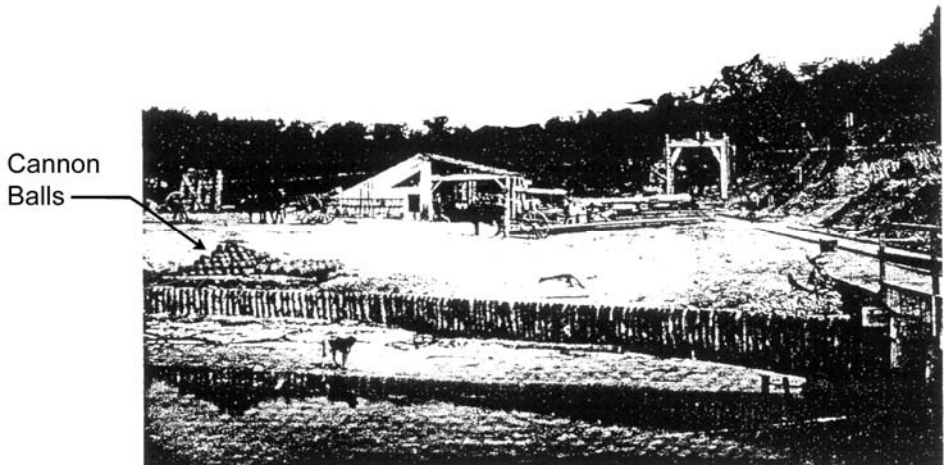


Figure 5.7-4: 1891 View of cannon ball stockpile at The Valley

Table 5.7-1: History of The Valley	
Time Period	**Significant Events**
1890	Marshlands were drained to ensure suitability for testing, and the range was prepared for testing. Hills on both sides of the valley were cut away to make room for gun platforms and to clear a line of fire down the river. A dock was constructed to receive guns, armor plates, supplies and equipment from boats, and a partial railway was constructed to move those items from boats to the specified area within The Valley.
January 1891	The first gun proof testing was conducted. Gun proving was a quality check for manufactured guns prior to being issued for use within the Navy. Gun proving ensured the reliability (e.g., firing consistency, design) of guns.
1891	"Acceptance testing" was performed, in which guns, mounts, shells, and/or armor were tested to determine whether they met specifications. Most testing included short-range guns. M.T. Irwin farm (Mt. Pleasant farm) was purchased to ensure no debris from testing would impact non governmental land. M.T. Irwin farm was located atop the northern hillside of The Valley.
1891-1918	Gun proving and research, development and testing of shells, guns, and armor plates continued. Breakwater was built in 1901. In 1911, eight observation stations were established. Observation stations were specific locations where people were positioned to identify where projectiles landed associated with the firing of medium caliber guns including 10-inch, 12-inch and 14-inch guns. These stations included High Point, Quantico, Fairfax, and Cock Pit in Virginia and Bomb Proof, Indian Head, Mattawoman, Stump Neck, Chicamuxen, and Budd's Ferry in MD.
1918	Because of an enormous increase in proof work, numerous improvements at The Valley were necessary, requiring additional land. The Fritz Peuter property on Stump Neck was purchased. A new gun battery was constructed, in addition to a concrete firing shelter. The Valley was continually used for

	proof work, including fuzes that were fired from the newly installed battery.
1919	Due to an ever-increasing tempo in range testing and decreasing ability to provide safety on the Potomac River and surrounding areas, it was decided to transfer all gun proving activities to Dahlgren, Virginia. The transfer of activities to Dahlgren was gradual, and completion required an extended period.
1920-1922	All major caliber work, except for firing into gun butts, had been transferred to Dahlgren. The only remaining work conducted at The Valley was small gun firing tests that were suited to the facilities at the range. The gun batteries had been put out of commission. The Valley was primarily an ordnance laboratory, with continual experimental small caliber gun and powder design and testing. Mines and other experimental ordnance features (e.g., primers, fuzes, powder) were tested either on land in The Valley or in the Potomac River. Documentation indicates that practically all forms of Naval ordnance used over the past thirty years had been tested and/or developed at The Valley.
1922-1940	Minimal to no work on the range. All proving activities transferred to Dahlgren. The focus of the installation switched from testing to smokeless powder production. No documentation indicates the range's exact use during this period, but it is assumed to have been used as a transportation location to and from the installation, as well as a shipping and receiving dock for products and supplies via the Potomac River.
1940-1944	The range housed the Jet Propulsion Research Laboratory. Small-scale jet propulsion tests were conducted during this time. No documentation was found to indicate activities associated with the Jet Propulsion Research Laboratory; however, it is assumed that engine research was the primary activity, with no specific ordnance.
1944-Present	The Valley range has been redeveloped into the Dashiell Marina with a Navy conference center. The range is currently used for recreational boat access to the Potomac River and for Navy conference meetings. The Potomac River remains a recreational and transportation avenue. Associated impact areas were never addressed and are used for a variety of installation activities.

5.7.1.1.Topography

Section 3.2 provides a general description of topography for the Main Installation. The Valley is located along the Potomac River shoreline on the northwestern side of the Main Installation and has a relatively low topographic profile. The topography of The Valley is characterized by 90 to 105 foot bluffs bounding a low-lying area. During construction of The Valley, the hills on both sides of the valley were cut away, and the earth from these cuttings was used in leveling out the valley. The Valley is a relatively flat, low-lying area that gradually slopes towards the Potomac River to the west. Two steep embankments bound The Valley to the northeast and southeast. The elevation at the range varies from five to ten feet above msl, according to the slope in the low-lying area.

5.7.1.2.Geology

Section 3.3 provides a geologic description for the Main Installation. This general description is applicable to The Valley.

5.7.1.3.Soil and Vegetation Types

Section 3.4 provides a description of the soil and vegetation types at Indian Head and the Main Installation. The primary soil type located at The Valley is Sassafras sandy loam, zero to two percent slopes. The Sassafras sandy loam profile consists of nearly level to moderately sloping, deep, well-drained soils on uplands. These soils form in loose deposits of loamy and sandy sediment of marine and alluvial origin. This soil may contain small areas where the surface layer is siltier that other Sassafras sandy loam soil types. The surface layer (eight to 15 inches thick) is friable sandy loam or fine sandy loam. The surface layers are underlain by friable sandy clay loam. These soils have subsoil that is moderately permeable and have high moisture capacity. Slope and hazard of further erosion are primary limitations associated with this soil.

The primary soil type of the bluffs bounding The Valley is gravelly land, steep consisting of gravelly deposits of soil material. This soil type may have previously been a different profile but, if so, the previous profiles have been so severely eroded that they cannot be identified. The gravel content ranges from 20 to 80 percent, by volume. Most of the gravel is quartz pebbles that are smooth, rounded to subangular, and mostly less than two inches in diameter. Slopes range from about 15 to 50 percent.

Vegetation at The Valley consists of limited mowed grass and a small amount of shrubbery along the shoreline and drainage swale. The land around The Valley is heavily wooded with vegetation types typical to the installation as described in Section 3.4. The land along the shoreline of the Potomac River is contained by a retaining wall to aid in the prevention of erosion. Shrubbery was observed along the retaining wall and into the river (Figure 5.7-5). No evidence of stressed vegetation was observed at the range. The hills bounding the range were densely wooded and could not be fully investigated.

Figure 5.7-5: View of vegetation along the Potomac River at the west side of The Valley

5.7.1.4.Hydrology

Section 3.5 provides a description of hydrology at the Main Installation. The Valley is located directly adjacent to the Potomac River and within the river's flood plain. Drainage at the range flows to the west-southwest direction towards the Potomac River. Surface water flows overland towards an unnamed drainage swale located at the bottom of the valley topography or to the Potomac River. According to NDW, IH personnel, The Valley was formerly a freshwater wetland; however, according to area GIS mapping obtained from the installation and visual observation, no wetlands are currently located at The Valley.

5.7.1.5.Hydrogeology

Section 3.6 provides a description of hydrogeology for the Main Installation, which is applicable to the area of The Valley.

5.7.1.6.Cultural and Natural Resources

An archaeological reconnaissance survey of NDW, IH was conducted in 1985 (see Section 3.7). None of the archaeologically significant areas identified in the archeological reconnaissance were located in The Valley area.

An armor plate (Figure 5.7-6) that was used during testing at The Valley during the early 19th Century is located at the edge of the Potomac River, along with the earliest known picture of testing activities at The Valley.

Figure 5.7-6: View of Monument of Former Test Armor Plate used at The Valley

5.7.1.7.Endangered and Special Status Species

As discussed in Section 3.8, endangered species are known to exist at the Stump Neck Annex and potentially at the Indian Head Main Installation and the Valley.

5.7.2. Visual Survey Observations and Results

The Valley site visit was conducted on June 23, 2004 by Malcolm Pirnie personnel, including Ms. Grim, Mr. Rice, Mr. Baker and Mr. Wiley of Malcolm Pirnie Inc. Mr. Jorgensen, NDW, IH Environmental Office, accompanied the team. During the site reconnaissance, the data collection team was able to visually observe approximately 90% of the range. The visual survey of the range was completed by utilizing a modified W-pattern following along Torrense Road and transecting the edge of the woodlands located on the bounding hillsides of the range. A visual depiction of the site reconnaissance route is provided on Map 5.7-1 located at the end of Section 5.7. The visual survey included the area surrounding the installation's wastewater treatment plant to the northeast of the area displayed on the maps because information on the historical boundary

of the Valley was limited, so a larger area was surveyed to be conservative. The visual survey was completed in this area to determine whether any surface evidence of MEC/MC was visible to help define the actual range boundaries. Additional range/site details are illustrated on Map 5.7-2, also located at the end of Section 5.7.

No MEC, MC or evidence of munitions used was observed during the visual survey.

The Valley appears significantly different than photographs of the range while it was in use, such as the 1915 panoramic view of The Valley (Figure 5.7-7) located at the range as part of a monument. The picture shows The Valley as it was during the time of testing.

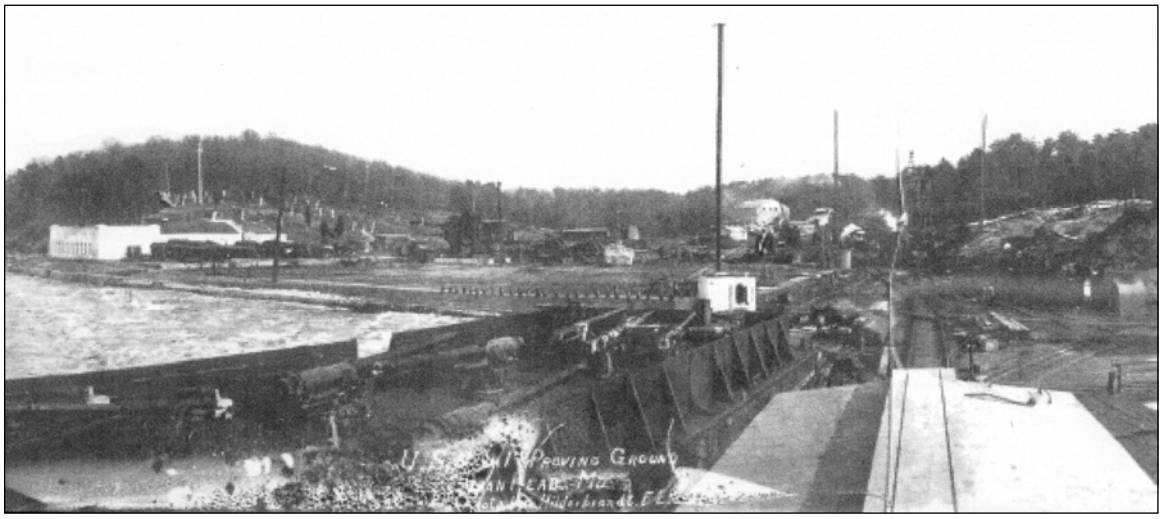


Figure 5.7-7: 1915 Panoramic View of The Valley

5.7.3. Munitions and Munitions Related Materials Associated with the Site

This section describes the munitions or munitions related materials known or suspected to be at The Valley, including types and estimated maximum penetration depths. This includes both MEC and non-hazardous munitions related debris (e.g., fragmentation, base plates, inert mortar fins). Potential ordnance concentration areas are presented along with a discussion on the presence of any special consideration ordnance.

According to historical documentation, practically all forms of Naval ordnance used from the 1890s until the 1920s had been tested and/or developed at The Valley. Historical documentation states that various calibers of guns (1-inch through 16-inch) were proved at The Valley with various projectiles, including AP shells. Tested shells contained different types of explosive fillers, including black powder, smokeless powder, brown prismatic powder, emmensite, joveite, wet gun cotton, randite and other high explosives (e.g., Thorite). In addition to projectile testing and gun proving, cartridges cases, fuzes, primers, firing devices and gun implements were also tested.

Two specific explosion examples that occurred at The Valley illustrate an extensive fragmentation radius associated with the range. The 1897 Annual Report documents a 10 inch A/P projectile exploded on impact with a steel armor plate. The report states that fragmentation from the plate and shell were spread over ¼ mile. The 1897 report also documents a gun with loaded Gathmaun projectile exploded simultaneously on the battery due to excessive pressure build up in the gun. The projectile contained 307 pounds of gun cotton. The wreckage/debris was thrown more than 1 mile away. MEC and related debris may be located within this documented 1 mile historical fragmentation area as shown in Map 5.7-6.

Types and Quantities of Munitions

Records detailing specific types and quantities of munitions tested were limited. Identified records listed items such as the number of guns proved, powder lots sampled, and/or number of projectiles used, but documentation did not indicate specific explosive types and quantities to determine the amount of MEC that may be located within the areas associated with The Valley. Listed below are some quantities of explosive powders that were used during testing activities at The Valley, which were found in historical documentation. This list, however, is not exhaustive and is not intended to be all inclusive.

The 1892 Annual Report contained information of two specific shells filled with 42 pounds of explosive powder and 42 pounds of emmensite (high explosive). In addition, the following types and amounts of powder were documented during testing activities:

- 1894 Annual Report - Powder expended during testing: 56,981 pounds
- 1897 Annual Report - Powder expended during testing: 50,000 pounds, including:
  - Wet gun cotton: 47 pounds
  - Shell Powder: 220.25 pounds

  - Randite: 4 pounds and 3.2 ounces
  - Joveite: 10.75 pounds
  - Picric acid: 2 pounds
- 1901 Annual Report - Powder: 46 pounds
- 1901 Annual Report - Powder: 350 pounds
- 1919 Annual Report - Smokeless powder: 831, 033 pounds
- 1920 Annual Report - Smokeless powder: 419,607 pounds

In addition to the testing conducted at The Valley, a high explosive magazine was destroyed by fire in 1894. According to the 1894 Annual Report documentation of the subsequent investigation, the fire caused the destruction of the wood magazine and burned all combustible articles within a 100-foot radius. The report does not pinpoint the exact location of the wood magazine. No other references were found with information on this explosion. The following high explosives were destroyed:

- 740 pounds of emmensite
- "unknown explosive" (probably ammonite)
- 500 pounds of wet gun cotton
- 264 pounds of Troisforf
- 170 pounds of Leonard
- 75 pounds of M.N.2
- 45 pounds of M.N.3
- 100 pounds of M.N.6
- 24 pounds of M.N.7
- 64 pounds of M.T. 3
- 2.5 pounds of K-4
- 8.5 pounds of K-7
- 8.5 pounds of K-8
- 130 pounds of K-8
- 80 pounds of Walsrode
- 4 pounds of Weidig
- 53 pounds of Leonard

5.7.4. MEC Presence

The 1892 Annual Report indicates that a system of sand butts was created that assisted in easy recovery of projectiles. The July 1920 Annual Report states that "for the first time in 15-20 years, the whole Valley has been thoroughly cleaned up"; however, this pertained to surface appearance conditions rather than official removal of potential MEC. Unsightly piles of plates and shell scrap were removed. Hundreds of tons of valuable fragments were shipped to the Naval Ordnance Plant, South Charleston, West Virginia. Numerous plates containing good impacts had been salvaged, and one new plate that had never been used was found entirely "buried in the mud". This information demonstrates the potential for buried MEC and/or associated debris at the range. No additional documentation was found identifying an official recovery effort of MEC at The Valley, including during the redevelopment of the Dashiell Marina in the 1990s.

Personnel interviews revealed that no remnants of historical testing were found at the range during the marina redevelopment. Even though no cleanup has occurred at The Valley, a few MEC items have been recovered throughout the last several years. Personnel interviews revealed the following:

- Mr. Cox indicated that several live 0.50-caliber wrench rounds (casings only) were discovered during the redevelopment of The Valley (approximately late 1990s).
- Mr. Cox also stated that live and inert ordnance was uncovered from the new breakwater and renovation to the extension of the existing breakwater (approximately 1994). The actual type of ordnance and ultimate disposal of these items was unknown.
- Ms. Morgan stated that there was one MEC response reported at the marina and two responses near the housing area on the hill.
- Lieutenant Porter, Mr. Pero, and Mr. Stewart each noted that a few years ago (late 1990s), an eight-inch projectile was discovered near Building 54.
- Mr. Dalton stated that old shells and cannons were uncovered at the marina four to six times throughout the 1990s. None of the projectiles were live. Some projectiles also have been found on the riverbank.
- Mr. Dalton also stated that inert projectiles were found on the Potomac River bank, upstream (between the marina and the EOD dock) during the 1990s.
- Mr. Bossart indicated that inert mine casings were discovered while tilling in the area in the 1990s.
- Mr. Bossart also stated that inert material was identified between the dock and the marina during the 1990s. It is currently used as rip rap on the banks of the river to prevent erosion.
- An EOD incident report documented a request to recover an Anti-Submarine Rocket (ASROC) test rocket motor in the Potomac River. The item was launched into the river during testing. Small parts of the outer shell were recovered, and the whole inner "crucifix" was recovered, intact in, October 2002.

- An EOD incident report stated that construction workers on the Potomac River bank found ASROC projectiles. Two unfired highly corroded MK46 Mod 1 were also recovered. The items were assumed to be solid inert test rounds, due to their weight.

The entire range has been subdivided and categorized into one of three levels of MEC presence including: Known MEC Areas; Suspect MEC Areas; or Areas Where No Evidence Exists to indicate that MEC is known or is suspected to be at the site. The MEC presence is discussed below. Map 5.7-3 illustrates the munitions characterization of the FDR Skeet Range and is provided at the end of Section 5.7.

5.7.4.1. Known MEC Areas

Because no MEC was identified during Malcolm Pirnie's visual survey, there are no known MEC areas associated with this range.

5.7.4.2. Suspected MEC Areas

Based on historical evidence and site personnel interviews, the entire area of The Valley is a Suspected MEC area. Personnel interviews indicated that munitions have been discovered and recovered at the range, and no official cleanup of the range has been conducted. The fragmentation zone of the range is at least a one-mile radius around The Valley based on the 1894 gun explosion. Additional suspected MEC areas associated with the range include any located within the firing fan identified on Map 5.7-4, water areas not included in the PA of other ranges, and any area on the main installation located within a one-mile radius of the firing points located at The Valley. Map 5.7-3 illustrates the munitions characterization of The Valley and is provided at the end of Section 5.7.

5.7.4.3. Areas Not Suspected to Contain MEC

Based on historical evidence and site personnel interviews, there are no areas identified where no evidence exists to suspect MEC associated with this range.

5.7.5. Ordnance Penetration Estimates

The depth to which munitions penetrate below the ground surface depends on many factors, including the type of soil, the angle of impact, the size of the munitions, the velocity at impact, and site-specific environmental conditions.

Because test firing occurring at The Valley was fired into prepared butts, estimates for indirect fired ordnance penetration depths are overly conservative. However, the estimated penetration depths for the munitions tested and/or developed at The Valley range from four to 12 feet.

5.7.6. Munitions Constituents

No surface or subsurface sampling has been conducted at The Valley to determine what specific MC exist at the range. Based on the history of the range, which involved testing an assortment of Naval ordnance, potential MC present at The Valley could include metals, various explosives, and various chemicals associated with pyrotechnics, such as perchlorate and propellants. For a partial list of known explosives used at the range, refer to Section 5.7.3.

5.7.7. Contaminant Migration Routes

Environmental media through which MC may migrate from The Valley include soil and surface water. Direct human or biota contact with surficial and subsurface soil is possible. The Valley's proximity to the Potomac River and unnamed drainage swale provides possible migration routes to surface water. The majority of the range area slopes towards the river, and storm water discharges to surface water via overland flow. Groundwater flow in the shallow water table also likely trends towards the Potomac River; therefore, MC can leach from soils into shallow groundwater and migrate to surface water. River sediments can act as contaminant repositories, and sediment mixing and river dredging can act as migration routes to surface water. MC in surface soils and river sediments may migrate to potential ecological receptors via plant/animal uptake. Based on a review of hydrogeological data, it is unlikely that MC in shallow groundwater would migrate to the deeper aquifers that are used as a water supply. However, shallow groundwater is still considered a potential exposure media.

5.7.8. Receptors

Potential human receptors include authorized Navy personnel (military and civilian), visitors, contractors, maintenance workers, recreational river users and trespassers. Plant and animal biota are also potential receptors. Examples of ecological receptors include deer, wild turkey, and water fowl.

5.7.8.1. Nearby Populations

Nearby populations are as discussed in Section 5.1.8.1.

5.7.8.2. Buildings Near/Within Site

Buildings 48, 54, 62, 100, 253, 254 and 1469 are located in the vicinity of The Valley. Buildings 48 and 54 are currently used for inert storage. Buildings 62 and 254 are used by the Navy as conference facilities. Building 100 is a Navy utility building. Building 1469 is the installation's wastewater treatment plant. In addition to these buildings, a small reporting shack is located at the range.

A small wooden walk bridge over the swale connects the gravel area to Buildings 62, 100, 253 and 254. Additional Navy buildings were identified along Torrense Road, but are not included in the actual boundaries of the range. These buildings include those associated with the installation's wastewater treatment plant. Remnants of old foundations were also observed outside of the range boundary near the wastewater treatment plant.

5.7.8.3. Utilities On/Near Site

The Valley previously contained underground chronograph wires running across its east end. The underground wires were replaced with overhead wires; however, no documentation was found to indicate that the underground wires have been removed. Telephone lines also historically existed at the range. Historical sewage drains (six inch terra cotta pipe drain) were also previously located at The Valley. Historical underground steam pipes leading to two former steam capstans on opposite sides of the valley previously existed. Historical utilities may still be present at the range.

The current sewer discharge drains for the installation run underground at the Valley and discharge to the Potomac River. The installation's sewage treatment plant is located near The Valley. Overhead electrical and telephone utility wires were observed during the visual survey.

5.7.9. Land Use

The Valley was used as a range from 1891 through 1921. From 1921 to 1940, the range activities were transferred to Dahlgren, Virginia, after which no additional gun proving activities occurred.

From 1940 until 1944, the range was used as a jet propulsion testing laboratory. After 1944, the range was no longer used for documented MEC activities, and the range began to be used for recreational access to the Potomac River only. Today, the range houses a monument, a boat launch ramp, a reporting shack, Dashiell Marina, Buildings 48, 54, 62, 100, 253, and 254 and a gravel road (Torrense Road). The area surrounding the boat launch and marina is gravel covered. Figure 5.7-8 shows a view of The Valley with boat launch ramp, reporting shack, and Torrense Road. The future land use of the range is expected to remain the same as its current use.

Figure 5.7-8: Current view of The Valley

5.7.10. Access Controls / Restrictions

No public access is authorized at NDW, IH. Signs partial fencing, locked/secured gates, login book/office check-in, and vehicle security patrol control the entire facility. There are no access control features specific to The Valley. Access from the water is not controlled. Reportedly, hunting is only permitted two days a year at the range. No additional land use/development restrictions are known for The Valley.

5.7.11. Conceptual Site Model

A general description of the CSM is provided in Section 5.1.11. The CSM is presented in a series of information profiles that presents information about the range. The information profiles are presented in Table 5.7-2 below.

Table 5.7-2: Conceptual Site Model Information Profiles – The Valley		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
Range/Site Profile	Installation Name	NDW, Indian Head
	Installation Location	Indian Head, Charles County, MD
	Range/Site Name	The Valley
	Range/Site Location	Adjacent to the Potomac River at the northwest portion of the northern peninsula (Indian Head)
	Range/Site History	Reportedly used from 1891 through 1921 for research, development, evaluation, prototype design modification, and specification testing of guns, powder, armor and shells and again from 1940 through 1944 for jet propulsion research. Since then, the range has been used for conference facilities, storage and recreation.
	Range/Site Area and Layout	Firing points for the Navy's gun proving ground faced south towards targets at Stump Neck and Marine Corps Barracks Quantico down the Potomac River. Targets were also located on the range proper. An unnamed drainage swale runs through the center of the area.
	Range/Site Structures	Current structures include several Navy buildings, a boat launching ramp, a reporting shack, various telephone poles, a marina with numerous docked boats, a walking bridge over the drainage swale, a monument and a test wall. Navy buildings are used for conference centers or storage.
	Range/Site Boundaries	N: Potomac River and woodlands S: Woodlands E: Torrense Road leading to the installation, wastewater treatment plant, Building 54 W: Potomac River
	Range/Site Security	NDW, IH has installation wide security and access restrictions. Once within the installation, no additional access restriction features exist for The Valley.
Munitions/ Release Profile	Munitions Types	Various projectiles associated with 1", 3", 4", 5", 6", 7", 8", 10", 12" and 14" guns, cannon balls (1891-1921), mines, fuzes, primers, etc.
	Maximum Probability Penetration Depth	Due to the fact that munitions were fired, it is anticipated that the penetration depth would be up to approximately 12 feet.
	MEC Density	Records indicate that some range related debris

Table 5.7-2: Conceptual Site Model Information Profiles – The Valley		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
		has been recovered/removed from the range, so it is anticipated that munitions and/or related debris still remain at the range.
	Munitions Debris	None observed during PA site visit.
	Associated Munitions Constituents	Potential MC associated with The Valley range primarily include metals, explosives, chemicals such as perchlorate, and propellants.
	Migration Routes/Release Mechanisms	Erosion/redeposition, surface runoff, groundwater discharge, leaching, frost heave. Human intervention: site maintenance, construction, excavation, river dredging.
Physical Profile	Climate	Indian Head, MD has a continental-type climate with four well-defined seasons. The coldest period occurs in late January and early February, with low temperatures averaging at 29ºF. July is the warmest month with average maximum temperatures of 85ºF. The normal annual precipitation is approximately 44 inches, normal monthly precipitation varying from 2.25 (February) to 4.60 (August) inches.
	Topography	The Valley is a relatively flat, low lying area that gradually slopes towards the Potomac River to the west. Two steep to rolling hills bound The Valley to the northeast and southeast. The elevation at the range varies from five to ten feet above msl according to the slope in the low-lying area.
	Geology	The Indian Head peninsula lies within the Atlantic Coastal plain physiographic province. The geology of the area is comprised of Precambrian igneous and metamorphic bedrock overlain by 500 to 600 feet of unconsolidated fluvial and marine deposits of the Potomac Group. The Potomac Group consists of, in descending order, the Patapsco, Arundel, and Patuxent Formations.
	Soil	The primary soil type located at The Valley is Sassafras sandy loam, zero to two percent slopes. These soils have subsoil that is moderately permeable and have high moisture capacity. Slope and hazard of further erosion are primary limitations associated with this soil.
	Hydrogeology	The hydrogeological makeup of the Indian Head, MD, area consists of a surficial aquifer and several deeper confined and semi-confined

Table 5.7-2: Conceptual Site Model Information Profiles – The Valley		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
		aquifers in the Patapsco and Patuxent Formations. The surficial aquifer is expected to be connected to and influenced by the surface water bodies. Regional water supplies, including that of NDW area, obtained from the lower and middle sands of the Patapsco and Patuxent Formations of the Potomac Group. The surficial aquifer (i.e., water table) is not used for water supply at NDW.
	Hydrology	The Valley is adjacent to the Potomac River and within the river's flood plain. Drainage flows to the west-southwest towards the Potomac River. There is an unnamed drainage swale located at the bottom of the valley topography.
	Vegetation	Vegetation at The Valley consists of limited mowed grass and a small amount of wild weeds along the shoreline and drainage swale. The land around The Valley is heavily wooded with vegetation types typical to the installation as described in Section 3.4.
Land Use and Exposure Profile	Current Land Use	The range is currently used as a boat launching area for access to the Potomac River, a marina and for Navy conference meetings and storage.
	Current Human Receptors	Navy personnel (military and civilian), maintenance workers, visitors, trespassers, contractors, and recreational users.
	Current Activities (frequency, nature of activity)	Current activities include frequent vegetation clearing, grass cutting, driving, and human activity related to recreational uses of the Potomac River.
	Potential Future Land Use	Future land use is expected to remain the same as current land use.
	Potential Future Human Receptors	Navy personnel, visitors, trespassers, contractors. These receptors would include construction workers (if intrusive subsurface work is necessary) and maintenance and operations workers (if the ranges use changes).
	Potential Future Land Use-Related Activities:	Potential future land use is expected to remain the same as current land use activities.
	Zoning/Land Use Restrictions	Hunting is only permitted two days a year.
	Demographics/Zoning	Charles County population density is approximately 260 persons per square mile. NDW, IH and its tenant commands employ

Table 5.7-2: Conceptual Site Model Information Profiles – The Valley		
Profile Type	**Information Needs**	**Preliminary Assessment Findings**
		approximately 3,600 military and civilian personnel.
	Beneficial Resources	None
Ecological Profile	Habitat Type	Improved areas with mowed lawn. Mature forest surrounds the range.
	Degree of Disturbance	High-Activities at the range include a high level of disturbance (i.e., vegetation is kept minimal; area is heavily used for boat and vehicle traffic).
	Ecological Receptors	
	Federal Endangered Species:	American Bald Eagle, rainbow snake, and the joint-vetch
	Federal Threatened Species:	None
	State Endangered Species:	Scaly blazing-star
	State Threatened Species:	None
	Other Ecological Receptors:	Federal and state protected species are known to exist in the vicinity of the Main Installation. Additional ecological receptors include various flora and indigenous animals in the habitat. Deer and wild turkey are known to inhabit the area along with other mammals, birds, reptiles, and amphibians.
	Relationship of MEC/MC Sources to Habitat and Potential Receptors	Ecological receptors may come into direct contact with MEC/MC in soil, and possibly surface water and/or sediment. Receptors may come into contact with MC that have been incorporated into the food chain.

A general description of the CSM exposure pathway analysis is included in Section 5.1.11.

For The Valley, historic evidence indicates that MEC and MC may be present; therefore, complete or potentially complete exposure pathways exist for MEC and MC. An MEC Exposure Pathway Analysis for The Valley is presented in Figure 5.7-9. The MC Exposure Pathway Analysis for The Valley is presented in Figure 5.7-10.

The MEC Exposure Pathway Analysis figure illustrates several potentially complete exposure pathways for receptors. A potential for MEC to be present at the range and accessed by range receptors through surface and subsurface soils is possible. Human receptors (Navy personnel,

contractors/visitors, and trespassers) may contact MEC at the surface during recreational activities at the range such as walking, hiking, and hunting. Contractors and Navy personnel have the potential to be exposed to MEC in the subsurface during intrusive activities. It is not anticipated that trespassers would come in contact with subsurface soils. Ecological receptors (biota) at the range may disturb surface soils during foraging, nesting or other natural activities in which they may come in contact with MEC.

Metals, explosives, perchlorate and other chemicals may still exist on the surface and subsurface of The Valley. Therefore, in surface soils, potentially complete exposure pathways exist for MC for human and ecological receptors via ingestion, direct contact or inhalation. Plants may accumulate MC as well. As hunting is permitted on a limited basis within The Valley, MC entering the food chain may provide migration pathways for human and ecological receptors. Precipitation infiltration may provide for MC mobility through the subsurface to the shallow or surficial groundwater aquifer, which is assumed to be connected to nearby surface water bodies. Nearby surface water bodies are utilized for recreational purposes. Potentially complete exposure pathways exist for MC in subsurface soils (direct contact, ingestion and inhalation during intrusive work activities), as well as in surface water and sediments (direct contact and ingestion). Although confining layers are expected to prevent the migration of MC to the lower aquifers used for water supply, potentially complete pathways exist for MC in shallow groundwater for human receptors.

A graphical illustration of the details of the conceptual site model is included as Figure 5.7-11.

Figure 5.7-9: MEC Exposure Pathway Analysis

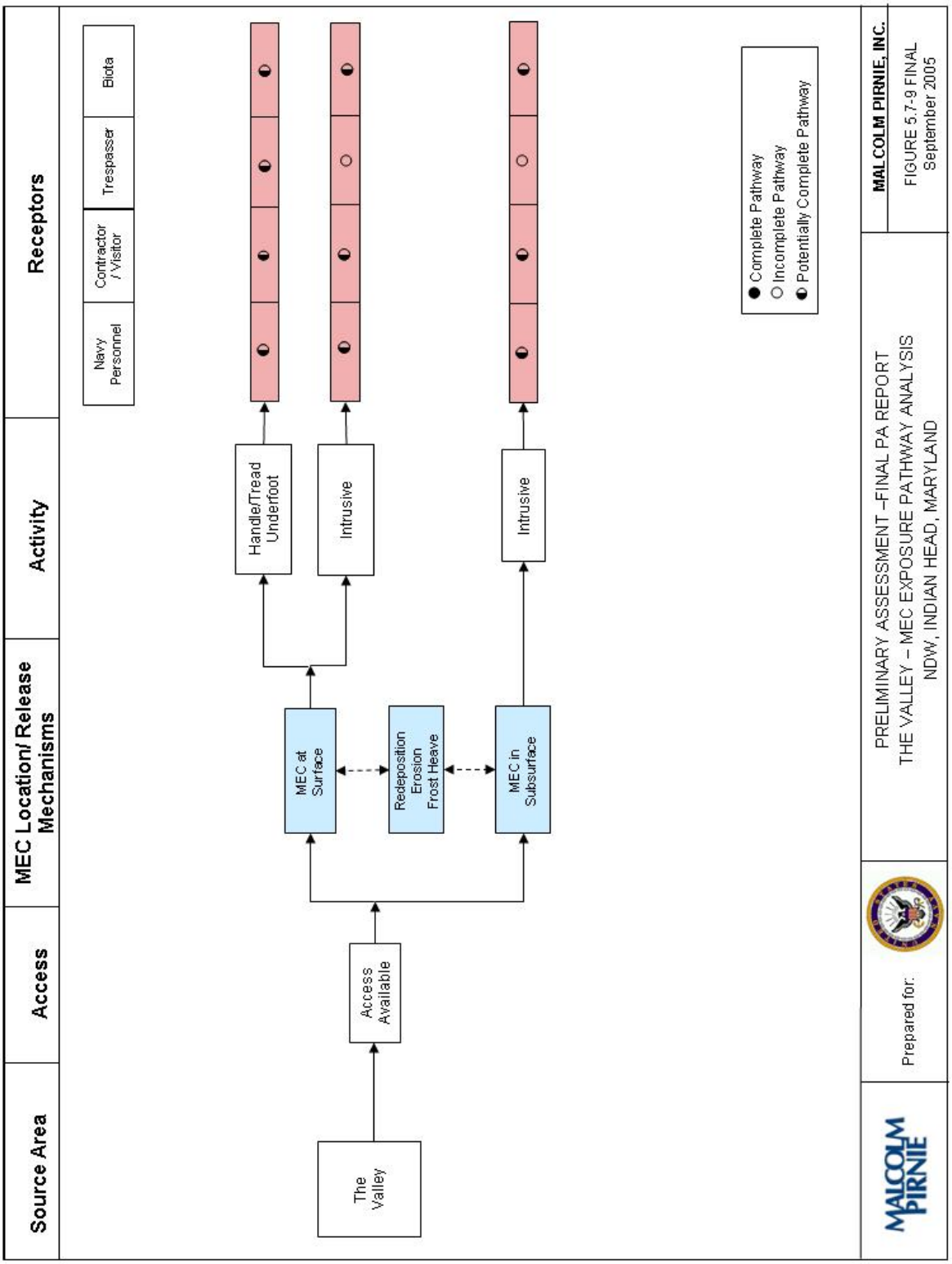


Figure 5.7-10: MC Exposure Pathway Analysis

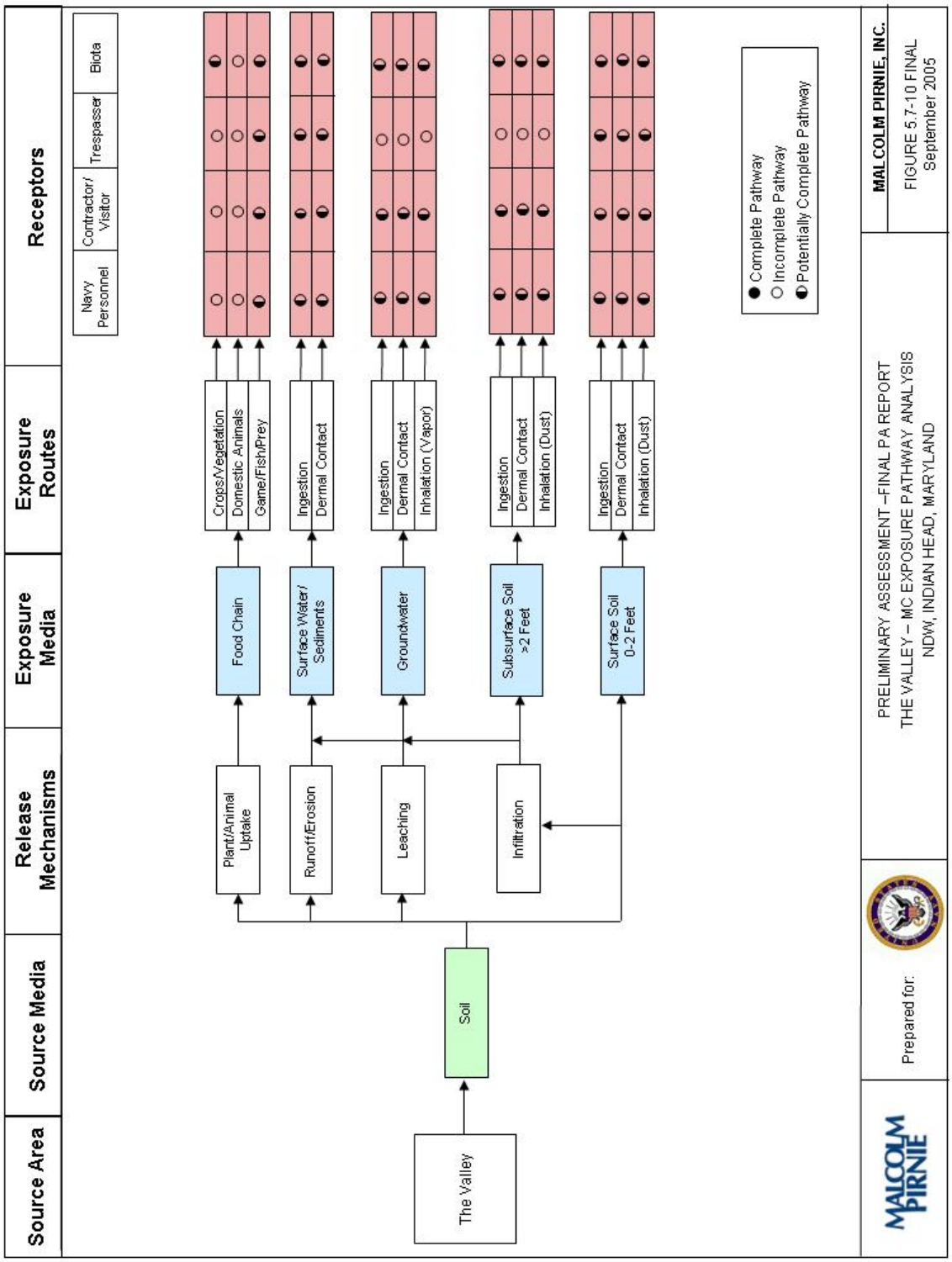
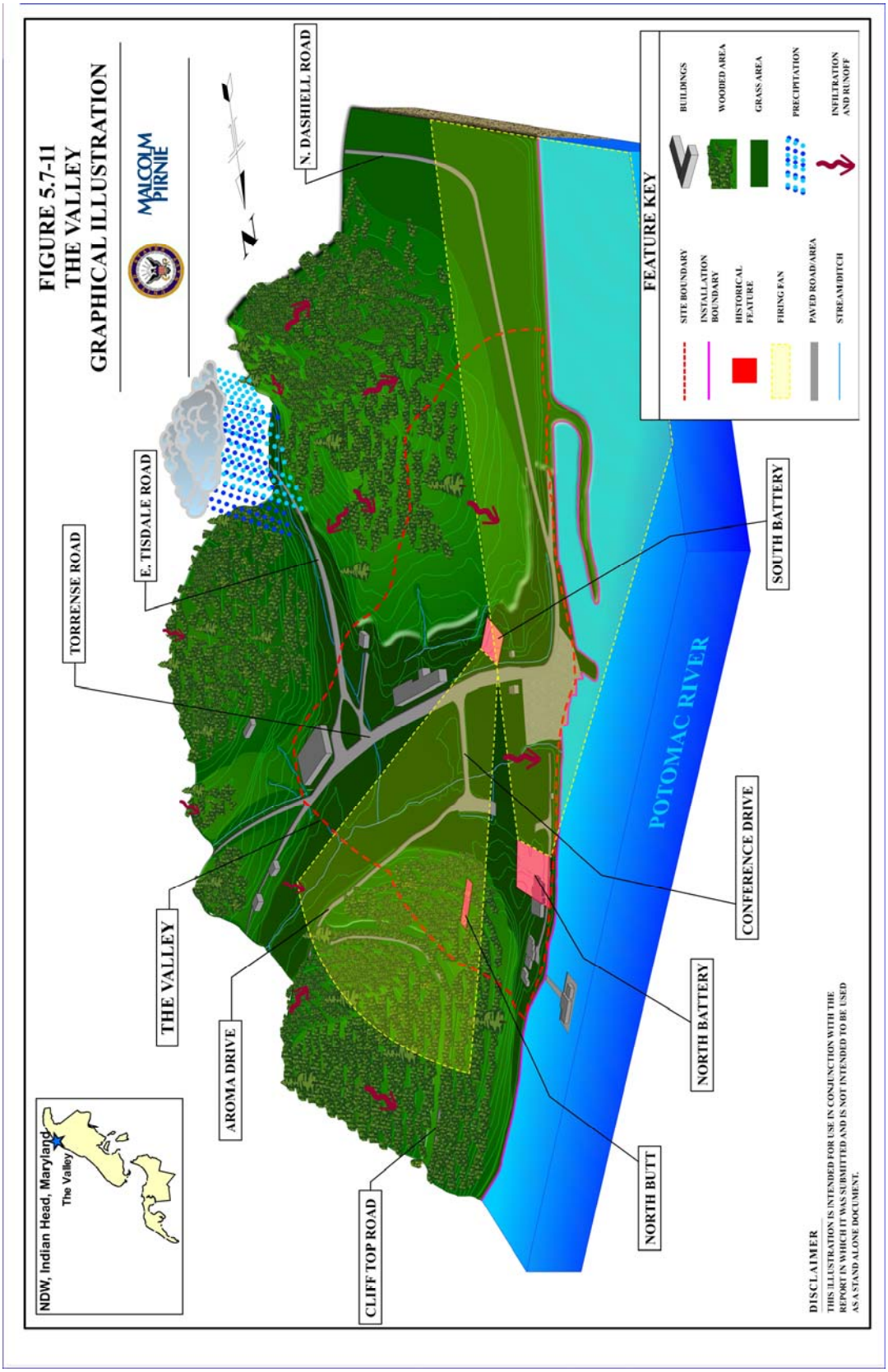


Figure 5.7-11: The Valley Graphical Illustration



5.7.12. Summary

The Valley was used from 1891 through 1921 for testing and experimental research and development of Navy ordnance, including gun proving and testing projectiles, armor plates, primers, fuzes, powder, and mines. The Valley was used from 1940 through 1944 for jet propulsion research. Short-range guns and projectiles were tested by firing into butts placed against the hillsides of The Valley. Long-range guns were tested by firing south toward primary impact areas at Stump Neck and the Potomac River. Powder testing was also conducted to determine explosive force, deterioration in storage, and other characteristics.

No evidence of MEC was observed on the surface at The Valley during the site visit; however, historical documentation described numerous munitions testing activities. According to installation personnel, MEC and associated debris have been found during various activities near the range and has been removed and disposed of by EOD. However, no documents were found to indicate that large scale MEC and/or MC removal actions were completed. Thus, MEC is suspected to be present at the range. Potential MC associated with the types of munitions known to have been used at the range includes metals and explosives. MC may be present at the range in surface and subsurface soils.

Preliminary Assessment
NDW, Indian Head, Maryland

MALCOLM PIRNIE

Map 5.7-1
Visual Survey
The Valley

Legend

- Installation Boundary
- The Valley
- Site Reconnaissance

0 40 80 120 160Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005

Preliminary Assessment
NDW, Indian Head, Maryland

MALCOLM PIRNIE

Map 5.7-2
Range / Site Details
The Valley

Legend

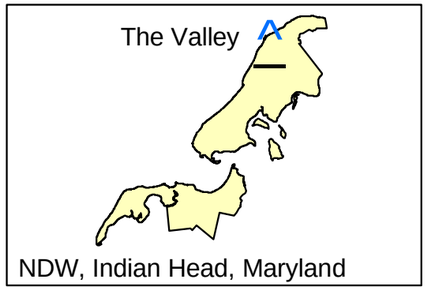
- Installation Boundary
- Roads
- Structures
- Contours
- Streams
- Wetlands
- The Valley From Inventory
- The Valley Identified During PA

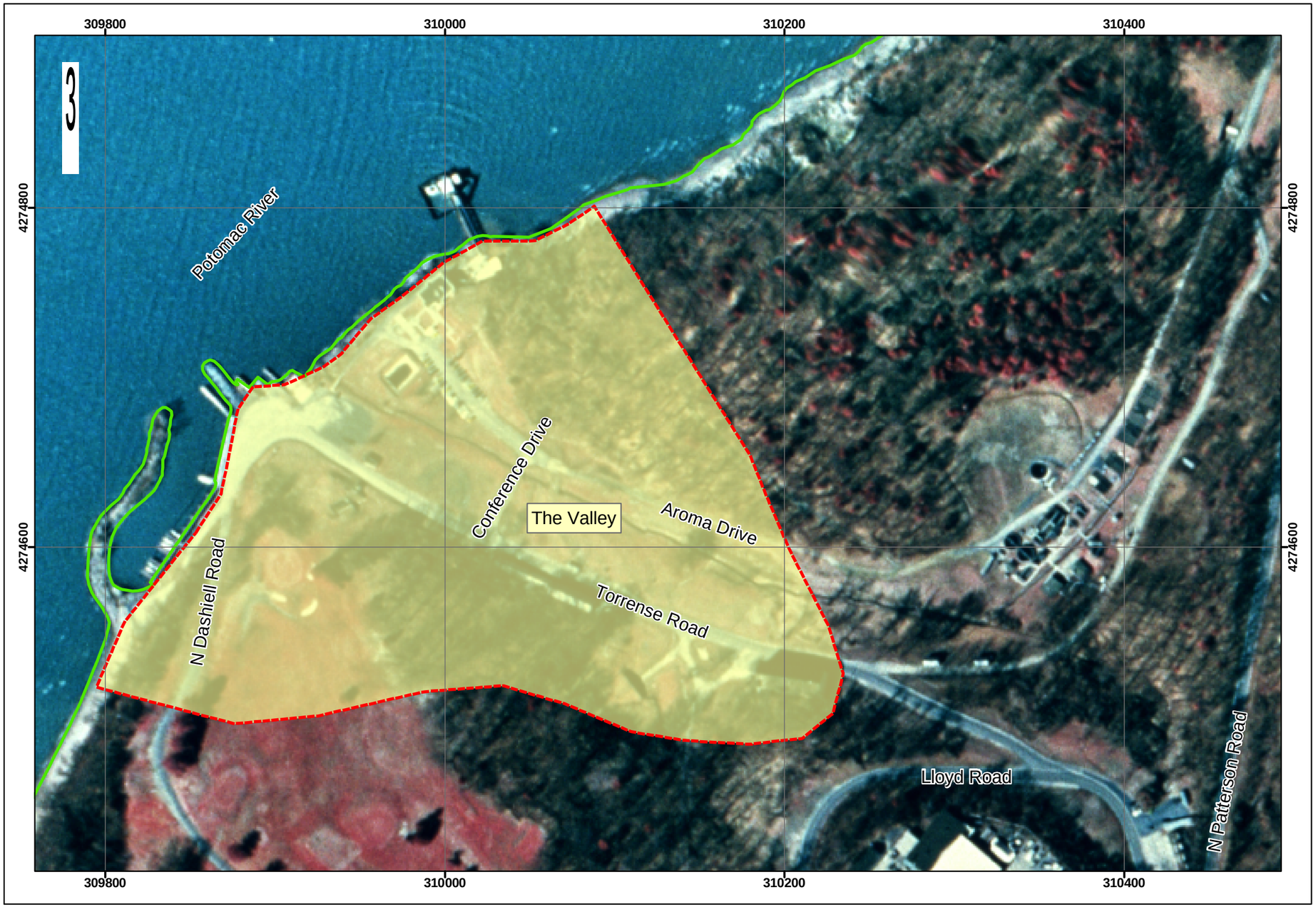
0 40 80 120 160Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005





Preliminary Assessment
NDW, Indian Head, Maryland

MALCOLM PIRNIE

Map 5.7-3
Munitions Characterization
The Valley

Legend

- Installation Boundary
- The Valley

MEC Presence *

- Known
- Suspect

* MEC Presence was determined through review of historical documentation, interviews and/or visual survey.

0 40 80 120 160Meters

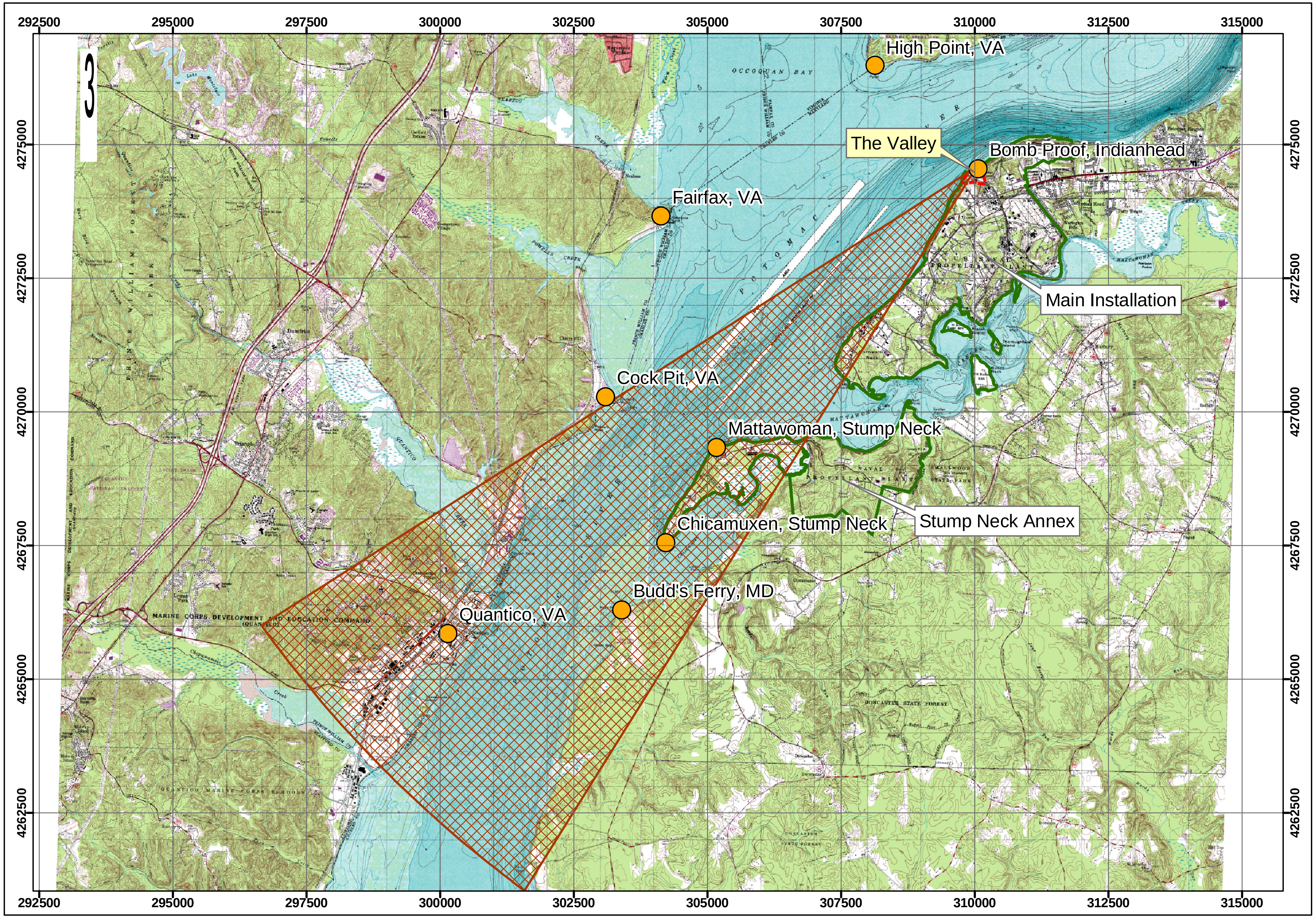
Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005

Preliminary Assessment
NDW, Indian Head, Maryland

Map 5.7-4
Firing Fan
The Valley



Legend

- Installation Boundary
- The Valley
- Firing Fan
- Observation Station

0 1,000 2,000 3,000 4,000Meters

Data Source: USGS. 7.5 Minute Series
Topographic Survey - Bathymetric Map
Indian Head, MD-VA, 1981
Quantico, VA-MD, 1981

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005

Preliminary Assessment
NDW, Indian Head, Maryland

Map 5.7-5
Firing Fan Over Main Installation
The Valley

Legend

- Installation Boundary
- The Valley
- Firing Fan
- Observation Station

0 500 1,000 1,500 2,000 Meters

Data Source: USGS. 7.5 Minute Series
Topographic Survey - Bathymetric Map
Indian Head, MD-VA, 1981
Quantico, VA-MD, 1981

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005

Preliminary Assessment
NDW, Indian Head, Maryland

MALCOLM PIRNIE

Map 5.7-6
The Valley - Fragmentation Zone
The Valley

Legend

- Installation Boundary
- The Valley
- Fragmentation Zone

0 250 500 750 1,000Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

Contract: N62472-02-D-1300
Edition: Final Preliminary Assessment
Date: September 2005

Preliminary Assessment
NDW, Indian Head, Maryland

MALCOLM PIRNIE

Map 5.7-7
Firing Fan - 1916 Detail Map
The Valley

Legend

- Installation Boundary
- The Valley
- Firing Fan

0 50 100 150 200 Meters

Data Source: USGS, DOQQ Indian Head, MD, 1998

Indian Head, Maryland
Naval Proving Ground & Smokeless Powder Factory
July 1st, 1916

Coordinate System: UTM Zone 18N
Datum: NAD 83
Units: Meters

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IHDIVNAVSURFWARCEN Notice, 2004.

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Plan Showing Naval Proving Ground, July 1 1913.

Plan Showing Naval Proving Ground, July 1 1914.

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Map of the Reservation Showing Improvements to June 1917,June 1917.

Map of the Reservation, Indian Head Maryland, 1936.

Map of the Reservation Completed as of May 30 1942, June 1942.

Map of the Reservation Conditions as of June 30 1947, June 1947.

Map of the Reservation Conditions as of "Unmarked", Suspected 1952.

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Aerial Photos

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Flyover of the Valley, 1-4.

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Interviews

Jeff Bossart, Indian Head – Natural resources, November 17 2003.

Walter Carr, Indian Head – NG Plant, November 19, 2003.

Bruce Dalton, Indian Head - Safety Department, November 25 2003.

Kathy Frey, Indian Head – Well Data, November 18 2003.

Frank James, Indian Head – Safety Department, November 21, 2003.

Larry Kijek, Stump Neck- Safety Department, November 20, 2003.

Wes Pero, Indian Head – Safety Department Head, November 17 2003.

Diana Rose – Indian Head Environmental Department, Water Team Leader. November 18 2003.

Lou Scalfari, Indian Head – Architect, November 21, 2003.

Dave Stuart, Installation/Office: Indian Head – PublicWorks/Utilities, November 17 2003.

Ivan Tominack, Indian Head – Engineer, November 19 2003.

Field Notes

Field Notes from the Valley, 2003.

Summery of Review of Historical Documents, March 7 2000.

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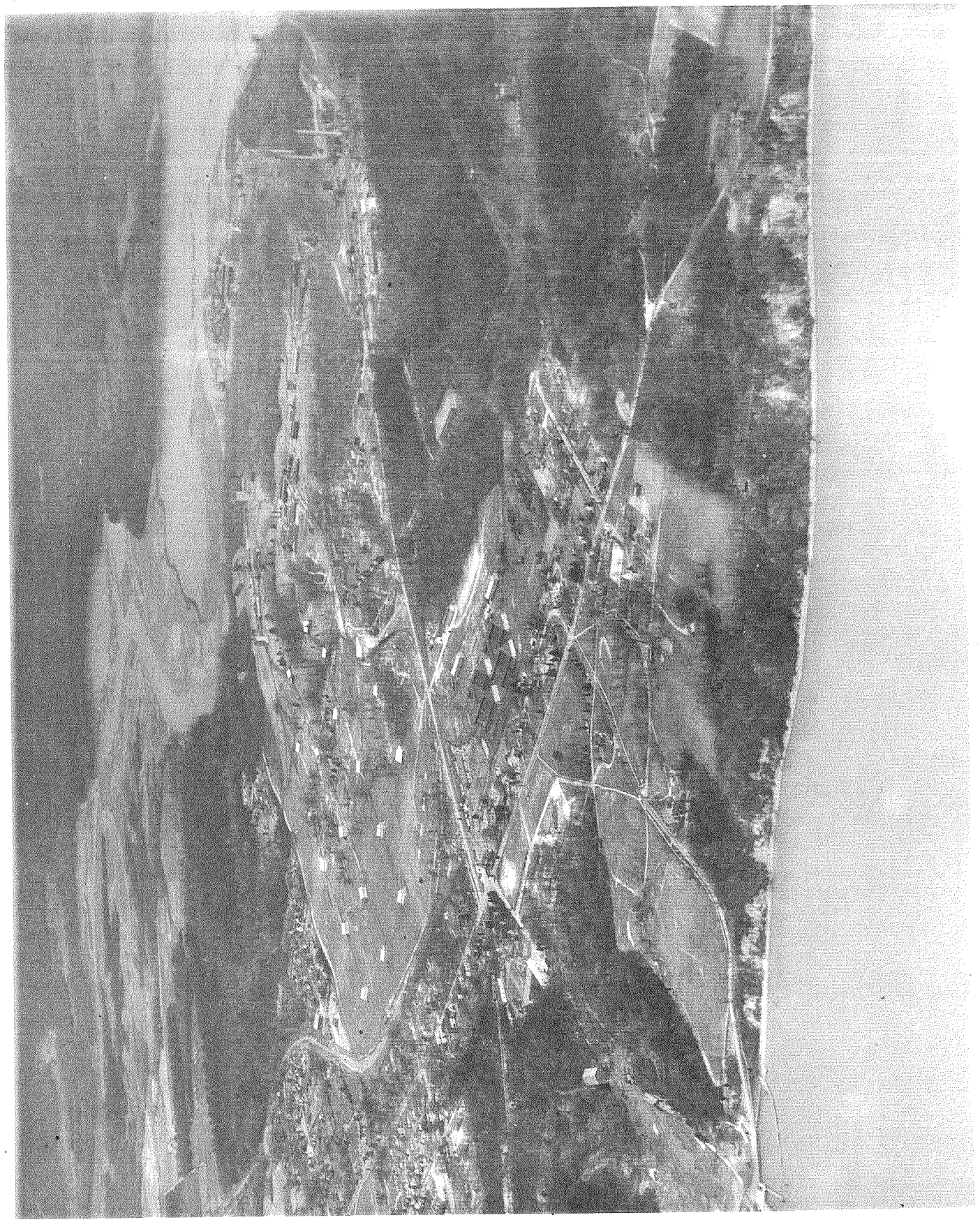

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Naval Powder Factory
Indian Head Md.

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20 Oct. 1943

TAKEN BY

NAS Anacostia

LOCATION

SUBJECT

Oblique of Powder Factory, Indian Head, Md. F.L. $8\frac{1}{4}$". View N. Alt. 2200'.

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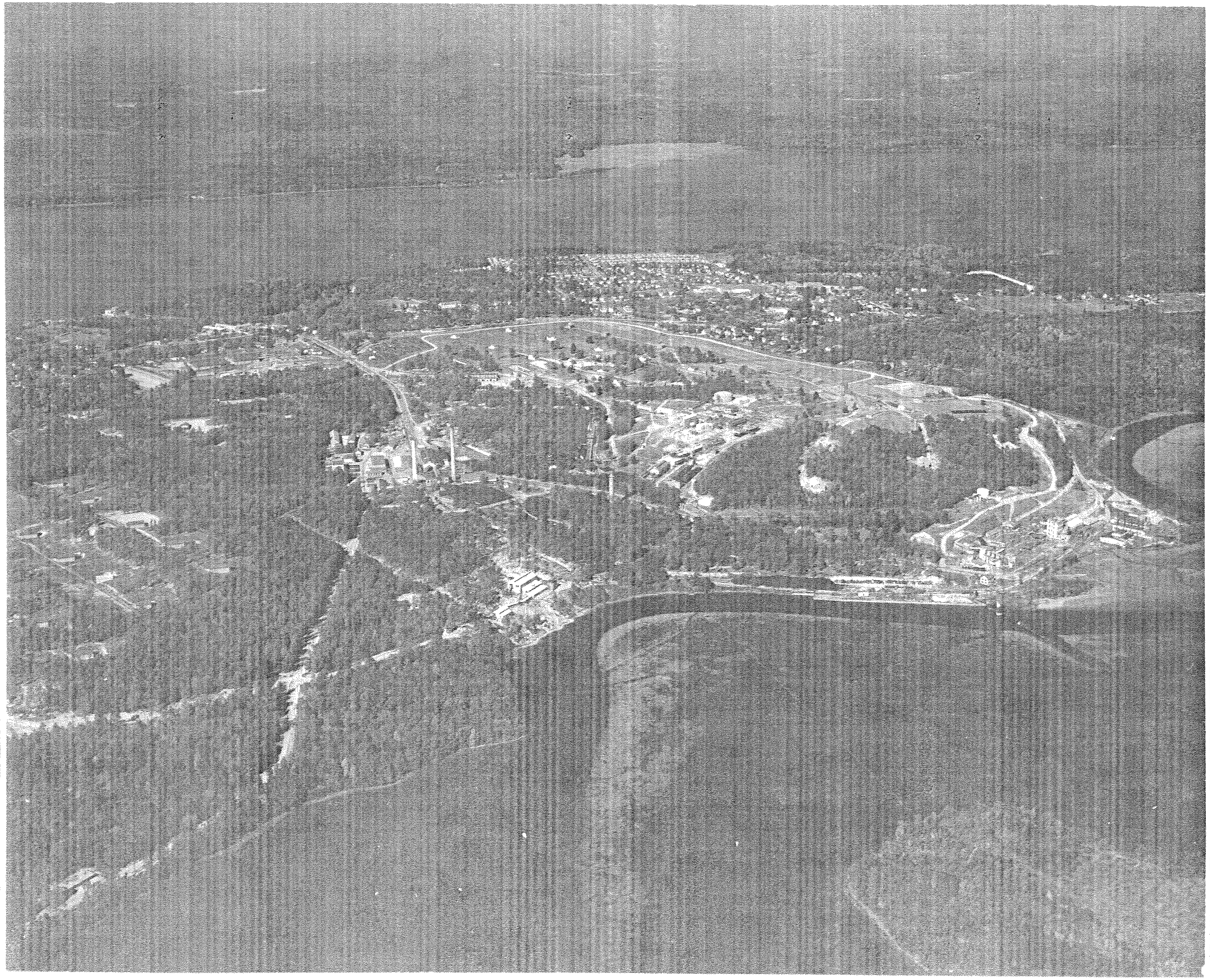

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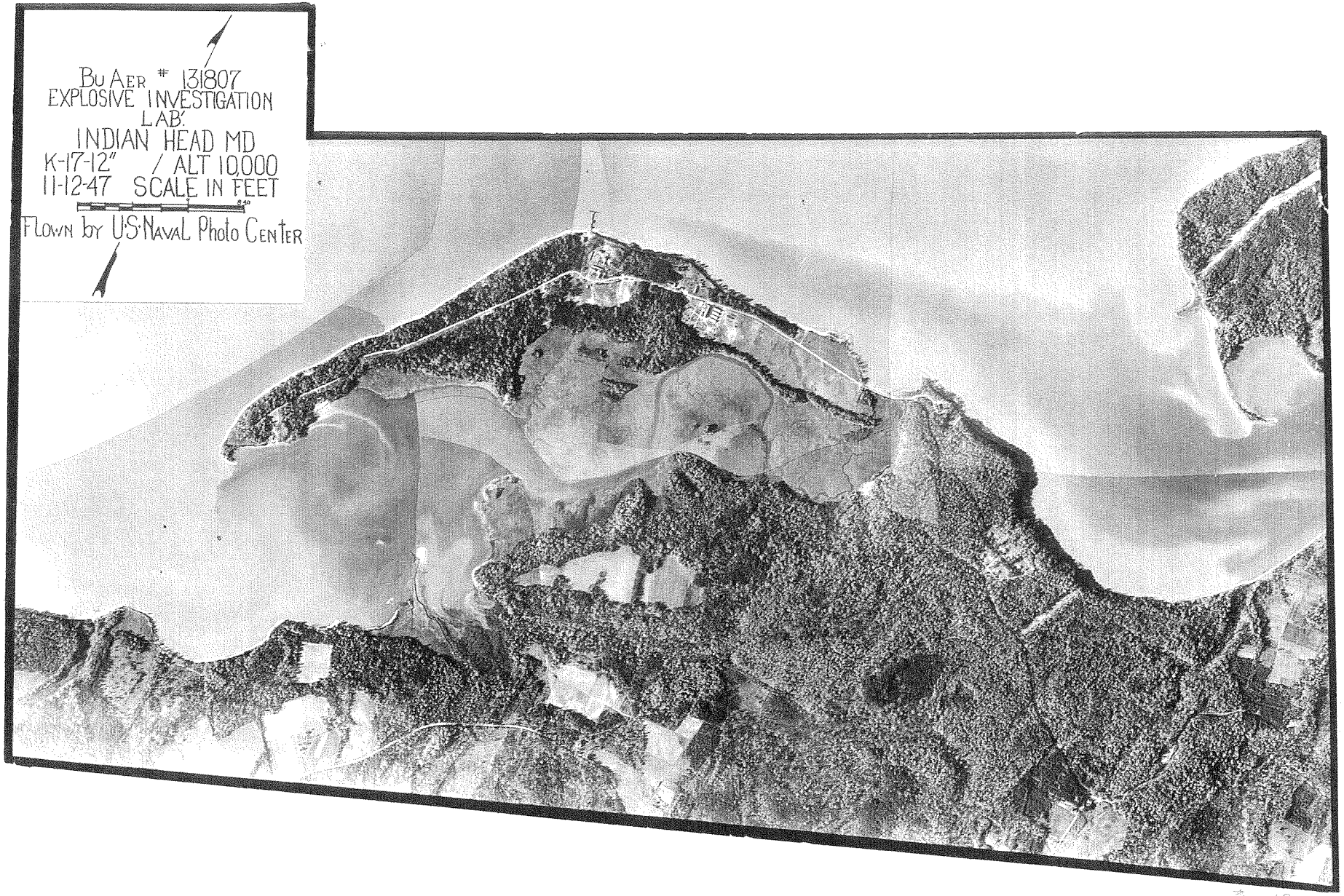

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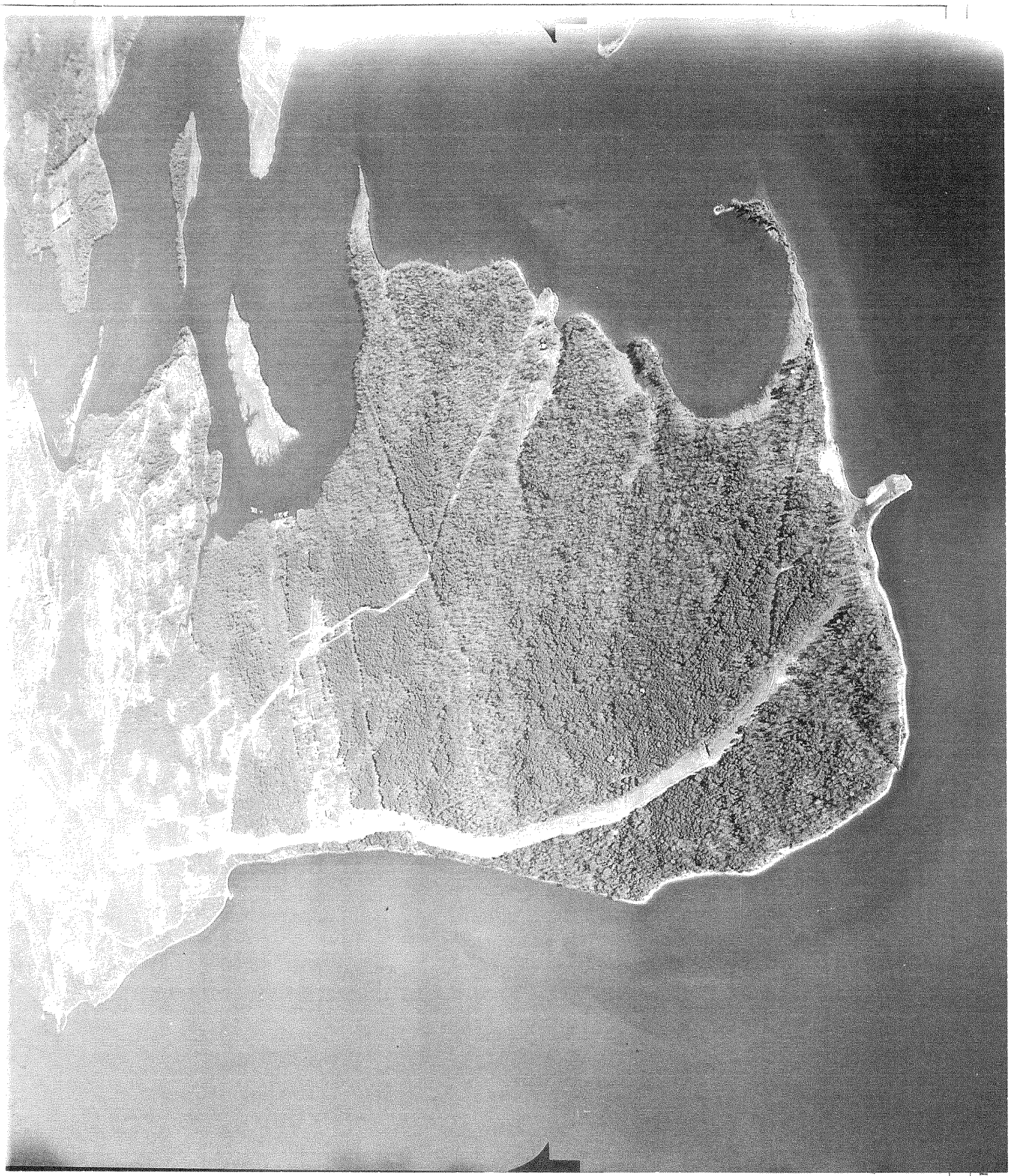

NOV 48

U. S. ARMY

6400

NUMBER DATE

406792 NEG 17 NOV 48

TAKEN BY:
NFC

LOCATION:
INDIAN HEAD, MD.

SUBJECT:

NAVAL POWDER FACTORY,
INDIAN HEAD, MD. F.L.
12"

LOOKING EAST. ALT 6400'

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RG 80 Dept Navy
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NUMBER DATE

406795 NEC 17 NOV 48

TAKEN BY:
NTC

LOCATION:
INDIAN HEAD, Md.

SUBJECT:

NAVAL POWDER FACTORY,
INDIAN HEAD, MD. F.L. 12"

ALT 6100' S.E. Area,
LOOKING SOUTH.

RELEASED FOR PUBLICATION:

DATE: NOV 746

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406813 6 Jan. 1949

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LOCATION:

SUBJECT:
NAVAL EXPLOSIVE INVES
TIGATION LAB. INDIAN-
HEAD, MD. ALT. 9000'
F.L. 12"

LOOKING WEST.

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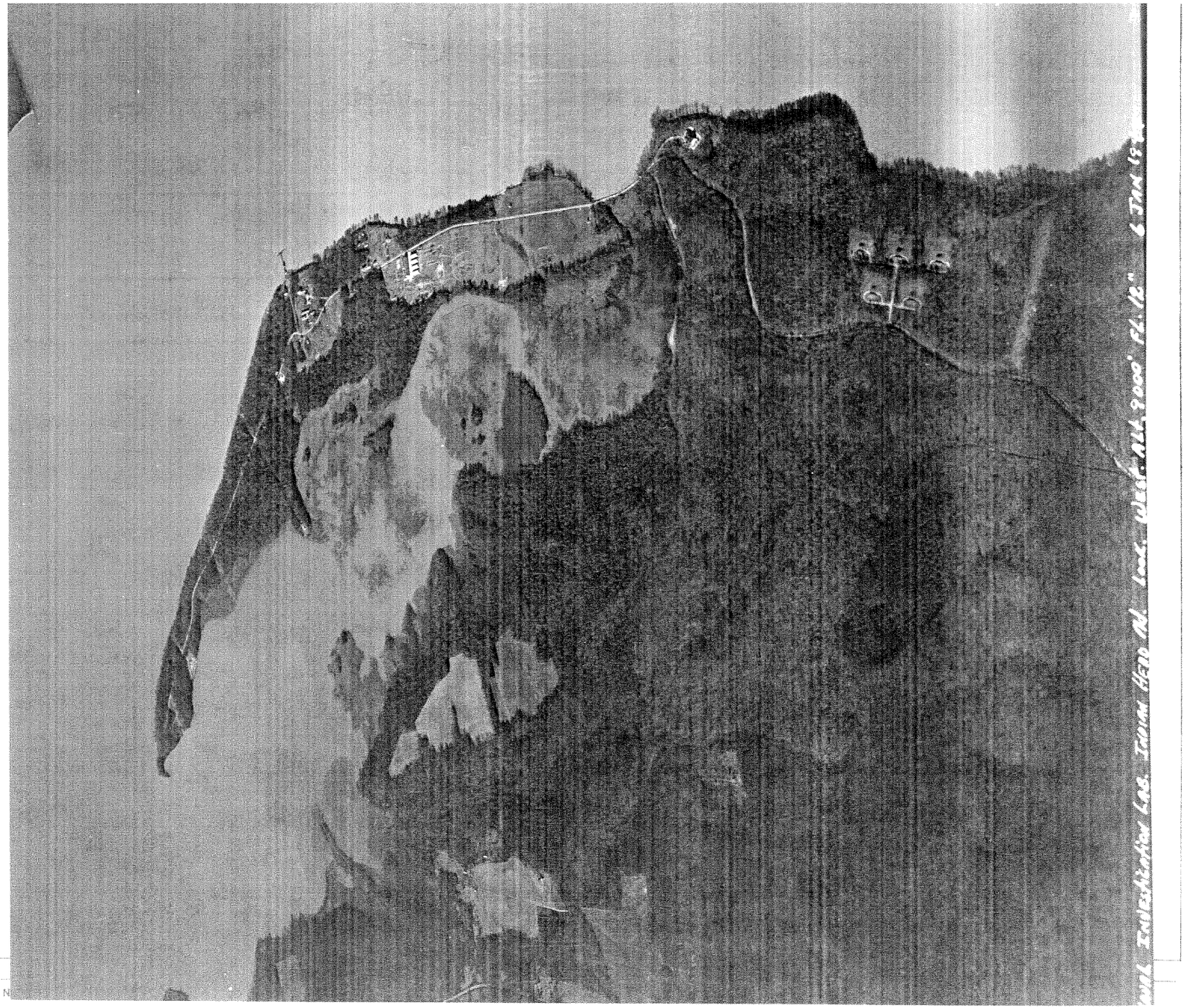

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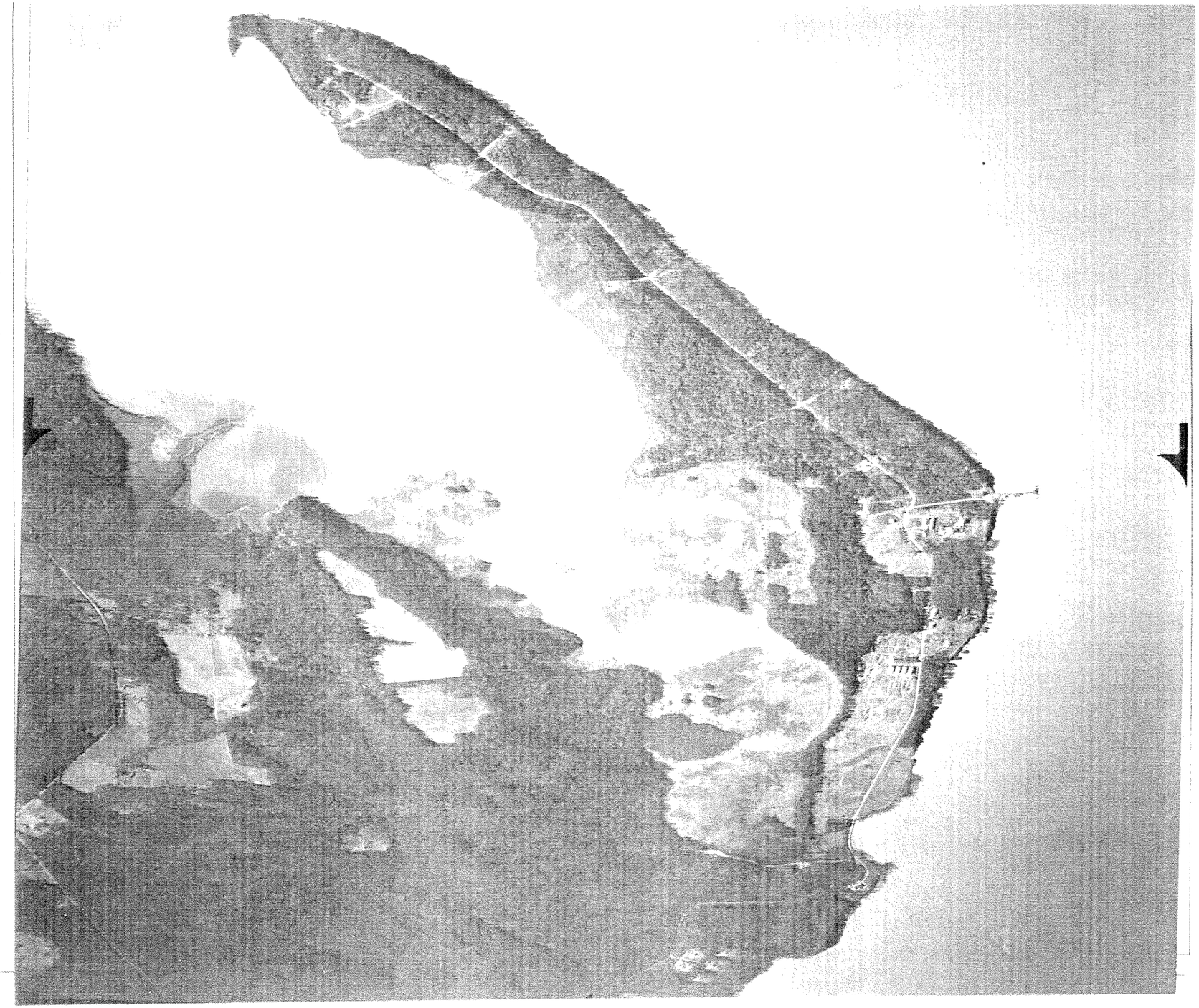

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LOCATION:

SUBJECT:

NAVAL EXPLOSIVE INVESTIGATION LAB. INDIANHEAD, MD. ALT. 9000' F.L. 12".

SECOND SECTION, LOOKING WEST.

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Aerial

DEPARTMENT OF DEFENSE
STILL MEDIA RECORDS CENTER
WASHINGTON, D.C. 20374-1681

SDAN: L29644
SAVRIN:
DATE: 3 Oct 1967
SERVICE ID: PAA4511-10-67
PHOTOGRAPHER: PH1 Heineman

Naval Propellant Plant, Indian Head, Md.....An aerial view of the plant.

OFFICIAL U.S. NAVY PHOTO (RELEASED)

Single Base

[illegible] of the Old Powder Line area, looking north, at the Naval Propellant Plant, Indian Head, Maryland.

Photo By: Bob Carlisle

OFFICIAL PHOTOGRAPH
U. S. NAVAL PROPELLANT PLANT
INDIAN HEAD, MD.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 19, 2003

Person Conducting the Interview/Title/Organization: Rhonda Stone

Person Being Interviewed/Title/Organization: Christina Adams – IHDIV-NSWC Public Affairs

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Interviewed to obtain general information.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Ms. Adams was not able to provide any additional information. She suggested we contact Tara Landis of the Public Affairs Office.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: October 29, 2003

Person Conducting the Interview/Title/Organization: Shelly Kolb, Malcolm Pirnie

Person Being Interviewed/Title/Organization: Dave Bode, Safety Office, NSWC Indian Head

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.):

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Mr. Bode was interviewed primarily for his knowledge of EOD calls at the Indian Head sites. He was also questioned regarding any additional anecdotal information on the Indian Head sites and any knowledge (EOD calls or anecdotal) he may have had on the Stump Neck sites.

FDR Skeet Range

Mr. Bode had no information regarding this site.

IED

According to Mr. Bode this site was used as a training range. The site contains a few areas where training was conducted using limited amounts of explosives. He suggested speaking to Larry Kijack EOD (sp?) to obtain additional information.

Single Base Propellant Grains Spill Area

Mr. Bode stated that the site was a production site for single based propellant grains and that grain could still be found on the ground surface near the tracks.

Safety Thermal Treatment Area

According to Mr. Bode, this site was a test area and is located approximately 2000 feet up the peninsula from an active disposal area. He stated that the site was active from 1963 to the early

1990s and he believed the site is currently a RCRA site. It was unclear if the site Mr. Bode was referring to was the "site".

Test Area 2

Mr. Bode had no information regarding this site.

Old Skeet ad Trap Range

Mr. Bode had no information regarding this site.

Marine Rifle Range

Mr. Bode had no information regarding this site.

Small Arms Range (pistol)

Other than the fact that this range was closed in the mid 1990s, Mr. Bode had no information regarding this site.

Rum Point Skeet Range

Mr. Bode stated that this range was used for recreation (skeet and trap) only and was established by a Captain Nicholson in approximately 1990 and was used until 2002. The range was used primarily by the Potomac River Gun Club and run by the installation's Moral Welfare and Recreation division. He was not aware of any EOD calls being made to the range. He did not have information regarding the prior use of the property.

Torpedo Burial Site

Mr. Bode had no information regarding this site.

Torpedo Casing Disposal Area

Mr. Bode had no information regarding this site.

Area 8

Mr. Bode had no information regarding this site.

Stump Neck Impact Area

Mr. Bode had no information regarding this site.

Old Demolition Area

Mr. Bode had no information regarding this site.

Air Blast Pond

Mr. Bode had no information regarding this site.

Igniter Area

Mr. Bode had no information regarding this site.

IOD Site

Mr. Bode had no information regarding this site.

The Valley

Mr. Bode had no information regarding this site.

Test Area 1

Mr. Bode had no information regarding this site.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 19, 2003

Person Conducting the Interview/Title/Organization: Hien Dinh and Grant Heslin

Person Being Interviewed/Title/Organization: Jeff Bossart – IHDIV-NSWC Natural Resources

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Interviewed to obtain information on hunting and natural resources at IHDIV – NSWC.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

• Has well locations, depth and water towers data (lines, valves – nothing on aquifer sizes, but which aquifer the wells pull from)

• Kathy Frey has all maps or map files, and more info

• Endangered species info/maps - will provide copies

• Hunting maps – will send via email; '91-'96 Wild Turkey repopulation project at IH and SN… birds transplanted from Dahlgren, VA; population is now high enough to hunt.

• Archeological Survey Reports can be obtained from John Stacy

• New Marina built (upgraded) in 1994. Started by extending the breakwater to protect boats. If ordnance was found, they would cease work, but none was ever found. They did find inert material further down between the dock and valley. It was labeled 'inert', presumably by EOD, and used as a sort of Rip Rap on the banks of the river to prevent erosion.

• This area between the dock and the Valley (See Hien's Map) saw some action during the War of 1812. Some canon balls suspected but unconfirmed. History says artillery battery there – British had 8lb'ers, Americans had 4 – 6lb'ers.

• Found inert mine casings while tilling 200' from end of field (See Hien's Map). The casings were circular shaped and had been crushed/flattened. Inert mine casings were found at SN just north of the water tower, in the old firebreak.

• Says John Stacy has history of old marina – which has been there since 1890.

• Valley used to be a freshwater wetland. A pump house was also built in the 1890s, about the time the original marina was built – piping brought water from river, which was used for fire protection.

• Jeff is the individual that identified the igniters found in the Igniter Area. He described them as an "electric primer" or "an electrically primed rifle cartridge about .50 caliber sized". The items were found in late '96 or early '97. Hien has the location on the map where they were found. Jeff says he grabbed a few and gave them to Bruce Dalton (IH Safety-Retired). His said he believes Bruce had the moved to scrap storage container for flashing at the Burn Point.

• Recreational information: Old area 8 pond stocked with Trout from '95 – '00; Tidal portion of Chicamuxen Creek never stocked, but it is heavily fished for large and small mouth bass, perch and trout.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 18, 2003

Person Conducting the Interview/Title/Organization: Rhonda Stone – Team Leader MPI

Person Being Interviewed/Title/Organization: Tom Cox, IHDIV-NSWC Director of Facilities.

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Worked for Public Works for 16 ½ years.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- The flat area just south of Archer Ave and just east of Roach Road is the leach field for the sanitary sewer effluent for the Stump Neck Annex. The use as a septic field was terminated in 2002. This is the area suspected as an EOD Demo area.
- The renovation of Bldg 62 occurred in approximately 1985
- Tom Cox is not aware of any UXO Sweeps done in the Valley during the Marina Redevelopment.
- ROINCC office would have specific records on the construction project during the Marina redevelopment, but they only keep the records 7 years.
- Building numbers for the Sanitary Sewer Treatment Plant at the Valley would provide more information on the use after the gun proving.

- EOD Incidents at the Valley that he is aware of:
    - Several live 50-cal torc wrench rounds were discovered (casings only). An EOD Safety guy was paid to dispose of them. The exact timeframe they were found isn't known, but it was during the redevelopment.
    - During the Marina Redevelopment, live and inert ordnance was uncovered from the new breakwater and renovation to the extension of the existing breakwater.
    - The entire area wasn't sweep for UXO because of the minimal amount found and "a bureaucratic reason".
- EOD left the main installation in 1998. EOD TECHDIV started at the main installation in the mid-1940's
- Reportedly, EOD did not use any live ordnance at the main installation.
- In approximately 1991 to 1995, Building 518 (storage facility for explosives) deflagrated. This building is not located in any of the MRP site areas.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 25, 2003 (via telephone)

Person Conducting the Interview/Title/Organization: Denise Tegtmeyer, Malcolm Pirnie, Inc.

Person Being Interviewed/Title/Organization: Bruce Dalton

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Retired from Indian Head; Heidi Morgan recommended interview

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Retired from Indian Head
- Worked in Safety Department for 15 years
- Worked at Indian Head for a total of 33 years
- Prior to Safety worked in facilities and CAD (cartridge activated devices) department
- Never worked in the EOD Department

Remembered several EOD responses
- Responses included mis-placed ordnance
- Old shells dug-up, cannons near the old Proving Ground (The Valley)
- Every time they dug at the marina they would find something
  - Old projectiles – none live
  - Happened throughout the 1990s – about 4-6 times
  - Projectiles were found on the riverbank –
- Upstream, between the marina and the EOD dock
- Items were inert
- Dahlgren was contacted
  - Mike Olup from Dahlgren would know more
- Security once called EOD at Andrews (instead of Dahlgren) because Safety Department was not involved
  - Andrews only responded once
  - Security Office would have the details

There were also finds at the old EOD training facility
Right of fence line after the golf course
50 caliber rounds
Now the CIBIRF parking lot, rounds were uncovered while grading for the parking lot
Happened about 4 years ago

Explosive Arcs
Dave Bode would have details he was the ESQD POC for the Safety Department
QD maps evolving continually
Changes of arcs not done as maps but as QD associated with building changes
Burning grounds should be included in the explosive arcs and on maps if they exist
Burning grounds are also on recent maps
Earlier burning grounds may be treated differently

Burning Grounds
Only remembers the Safety Thermal and Strauss Avenue burning points
"Old Safety Burn Point" (Safety Thermal) was used to test and dispose of special items
Highly dangerous, more sensitive or experimental items
CAD items – a tank served as a barricade for the CADS and the
CADs were heated in the tank until they exploded
Also disposed of contaminated lab solvents and black powder at the Safety Thermal Burning Point
Strauss Ave. Burn Point replaced the Safety Thermal prior to 1968
Only heard stories of a burn point at the intersection of Strauss Ave & Caffee Road
Activities were not conducted here during his time at Indian Head
But it wouldn't surprise him if this was a burning point
Old Burning Ground – at the corner of the Single Base area
Heard it was used as a disposal area
Remains are present
Not used during his time at Indian Head

Not involved with disposal until he worked with the CAD production unit (about 68-70) then involved with oversight, procedures and safety with the Safety Department

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 21, 2003

Person Conducting the Interview/Title/Organization: Rhonda Stone

Person Being Interviewed/Title/Organization: Jim Dolph – Navy Historian

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Interviewed to obtain general information.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

INDIAN HEAD – MAIN SIDE – RANGE NOTES

EOD School – Underwater Ordnance School

The Underwater Ordnance / Diving Division was located in Building 901 and had the responsibility of teaching all types of underwater ordnance, both foreign and domestic. It maintained two practical training areas, one on Stump Neck and one on the Main Side. The Practical Training Area on the Main Side included and was located in the vicinity of Diving Locker Building 1444. The Diving Locker was constructed in 1968 and was 18' by 60'. It provided an instructor's office, classroom, workshop and compressor room. An *"Inert Ordnance Underwater Minefield"*, was placed offshore. It provided a practical training area in underwater ordnance disposal techniques in the Potomac River under realistic conditions.

(References 2 & 4)

"Potential" New Range at EOD School

The Explosive Ordnance Disposal School Command Narrative for the year 1973 states that " Two firing bunkers were built in the Practical Area of SD-I to allow students to actually live fire the cal.50 Dearmer and the Rocket Wrench without being transported to Stump Neck, a distance of 13 miles from the school proper".

(Reference 1)

Safety Thermal Treatment Point

Reference 5 provides a list of items being disposed of at the Pyrotechnics Burning point in 1978.

(Reference 5)

Original Burning Grounds (Old Zinc Recovery Furnace Area)

Prior to the construction of the Zinc Recovery Furnace, Test Well #16 is shown on, or adjacent to the site in 1919. The Zinc Recovery Furnace was erected on the site prior to World War II. The "Burning Cage" is not shown on the site on a 1952 station map, but, first appears on a station map dated 1954.

(References 6 & 7)

Pistol Range

This range does not appear on maps prior to 1949 or after 1953. It was most likely eliminated when Buildings 718 and 739 were erected in 1953. An undated aerial photograph of this area, post 1955, indicates that the area had been extensively cleared and graded, possibly built-up.

(Reference 8)

List of References

1. Naval School, Explosive Ordnance Disposal, *"Command Narrative"*, Naval Ordnance Station, Indian Head, MD., year 1973

2. Naval School, Explosive Ordnance Disposal, *"Command Narrative"*, Naval Ordnance Station, Indian Head, MD., year 1971

3. Naval School, Explosive Ordnance Disposal, *"Command Narrative"*, Naval Ordnance Station, Indian Head, MD., year 1972

4. Naval School, Explosive Ordnance Disposal, *"Command Narrative"*, Naval Ordnance Station, Indian Head, MD., year 1970

5. Memo with enclosure from 281A to OESO. Subject: Propellant/hazardous waste disposal capability; inventory of. Ref: (a) Memo OESO: ILT: PC, OESO: 28:78 6240 of 13 April 1978. (3) Pyrotechnics Burning Point Disposing of enclosure. 29 September 1978.

6. Plan , "United States Naval Powder Factory, Indian Head., *Conditions as of October 31, 1952."*, Plan Number 15219

7. Plan, "Master Shore Station Development Plan", Y&D Dwg 670,633., August 31, 1954

8. Aerial Photograph, United States Naval Powder Factory, Indian Head, Maryland., (Undated) (Note: Post 1953 because it shows building that were constructed in 1953 or after.)

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: June 27, 2003

Person Conducting the Interview/Title/Organization: Denise Tegtmeyer, Malcolm Pirnie

Heidi Morgan (Indian Head), Ray McManus (ECC), and Mike Baker (ECC) also in attendance

Person Being Interviewed/Title/Organization: Frank Ehrenreiht, retired Marine Corp EOD

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Retired Marine Corp EOD that trained and worked at Stump Neck

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- His life with the Marine Corp
    - Joined the MC at 17 in August of 1941
    - Went to Quantico
    - Served guard duty on Constitution Ave. in DC
    - Served on a carrier
    - Went to Lejeune
    - Left MC at end of war (after 1.5 years)
    - Back to MC in 1947
    - Went to Quantico for demolitions
    - Went to China (Singtown)
    - Returned from China in 1951
    - At Stump Neck 1951
        - EOC school after China
        - Part of last class that took deep sea diving
        - One of first graduating classes at Indian Head

    - Retired in 1969 to work at Indian Head on gun systems
        - Gunfighter program (there's a picture in "Powder and Propellant")
        - Steve Mitchell worked with him
- Transported explosives/fuses in his car to Wallups Island
- Worked at Stump Neck after gun-fighter program
- Worked a few years at Rum Point
- Range 6 was the only active area
- Training area near 6SN
    - Behind building on left
    - Former concrete bunker
- Did work across from Range 3
    - X-ray training in building near Range 3
    - Practical Training Area
        - Left side of road
        - Used booby traps and stripped fuses
        - Old disassembly building *(no RDX contamination per Heidi)*
- Bombs up to 5 pounds at Range 6
- Roach Road
    - Didn't use practical area *(Area 8)*
    - Didn't train in area with pond because only the Navy used that area
    - EOD used Area 8 for booby traps before it moved *(Heidi)*
    - Also a booby trap area near Range 3
        - Used shape charges (C3)
        - C3 is an RDX based explosive
        - Vicinity of Range 3 is practical explosives area
            - One room wooden classroom
- Rum Point
    - Ramp near water near former house
    - Using a backhoe – 500 pound bombs found near house
- George Mason
    - 1812 War
    - Owned Rum Point
    - Ammo dump at end of point *(Heidi)*
- Gill Bivens (in his 70s)
    - Worked for Frank
    - found wooden rudder off Rum Point
    - Civil war book shows rudder of this boat
    - 16 inch steel plates – one went through
- only known pond was at Area 8
- worked on water, but never fired into river
    - only frag from demo area went into water

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 18, 2003

Person Conducting the Interview/Title/Organization: Hien Dinh and Grant Heslin

Person Being Interviewed/Title/Organization: Kathy Frey – IHDIV-NSWC Environmental Department

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Interviewed to obtain well data.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- All wells tap into the Patapsco ground water aquifer for drinking water, EXCEPT well #16a which taps into the Patuxent for steam to B Plant – it is also potable, but with a taste. Piping is too small so can't be put in distribution system, otherwise, is another DW source.

- Low silica wells, like those near Goddard Power Plant (#15, 17 and 18) – water doesn't need to be treated, also used for drinking water.

Available wells:

- Indian Head: #2, 2A, 7, 12, 15, 16A, 17, 18

- Stump Neck: #43 SN → 1945; old, minimal output, iron problems; considering rehab or new well; #2012 SN → 1953 – newer well, but not optimal.

Stump Neck Well OPTIONS:

1) rehab both wells → use #2012 as Main, 43 as back-up

2) Construct a New well → use #2012 as back-up, take 43 out of service
3) Use #2012 as main → construct a new smaller well as back-up

- IH: River water used for fire protection

- Private well at Bullets Neck; tested quarterly; monthly if in use.

- SN: Well water used for fire protection

- Private wells near Rum Point – Considered private due to population definitions (not enough people/not enough use per year). The wells are tested quarterly; monthly if in use.

Well system at IH – Upgrades to SCADA will be paid for by IH
Well system at SN – New SCADA system paid for by MILCON P160 –> Groundwater Rule requires 7 sensors; updates Drinking Water systems and larger Reverse Osmosis system for river water treatment.

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: October 16, 2003

Person Conducting the Interview/Title/Organization: Hien Dinh, Malcolm Pirnie

Person Being Interviewed/Title/Organization: Jim Hersey, UXO Program Director, NAVEODTECHDIV

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): employee at Stump Neck since 1974

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- Torpedo Casing Disposal Area
    - The location on map is incorrect. It is NOT under the water tower but farther down Archer Avenue at the firebreak.
    - About 300 feet from Archer Avenue on the right hand side of the firebreak area (currently known as a Wildlife Area) heading toward the water.
    - In the mid to late 70s, used as magnetic training (mag. range) before Test Area 2 was established in the late 1970s
    - All items were inert, including empty cases of 60mm mortar, 81mm mortar, 105mm projectile, 155mm projectile, MK81 (250 lbs bomb), and MK82 (500 lbs Bomb). During the initial set-up of the non-magnetic range, anomalies signatures indicated large items around the area where the torpedo casing were supposes to be located. Without intrusive investigation, we cannot confirm this.
    - In the early 1981 or 1982, Natural Resources converted the firebreak into a wildlife sanctuary. The area was disked (a method that turns and loosens the

soil with a series of discs) and planted with grass. In the process, most, if not all, inert ordnance items were uncovered and thrown to the side.

- Foreign ordnance may have been buried here also.

- Test Area 2
  - Until 1978, this area was a pristine wooded area. The Base needed a new and larger non-magnetic testing area.
  - No explosive testing was ever done; no shooting and no impacts have occurred at this site to the best of the interviewee's recollection. Only inert ordnance was used at this site.
  - Nickname "Magnetic Range".
  - Two line shafts were constructed in the late 70s or early 80s. Basically, inert ordnance items were lowered into the shaft and their magnetic signature would be measured by placing sensors at various distances from the center of the shaft.

- Test Area 1
  - From the early 50s to late 60s, this was the site for the first shore-to-ship communication by bouncing the signals of the surface of the moon.
  - In the late 60 to early 70, AA&D (Advanced, Access and Disablement) trainings (such as booby traps, trip wires, etc.) were conducted at the site.
  - Shotgun primers might have been used to initiate the charge on blasting caps.
  - For the last decade, the site was use primarily as training area for various robotics testing.

- Old Skeet and Trap Range
  - Range was established in the 50's and closed in the mid 80's.
  - Site open to military and civilian employee for recreation.
  - Potomac River Gun Club used this site until the mid 80's then moved to the Rum Point Skeet Range.
  - Explosive Ordnance Disposal (EOD) personnel trained at this site.

- Currently, the site is an open grass field that is mainly used as recreation and for robotics testing.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 21, 2003

Person Conducting the Interview/Title/Organization: Grant Heslin and Hien Dinh

Person Being Interviewed/Title/Organization: Frank James – IHDIV-NSWC Safety Department/EOD

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): to obtain general information.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Entered MC in '65
EOD school in '74
EOD school in '81 – instructor
Contractor with VSE for 2 years
IH Safety from '90- present

- Dug up 50 pounders in vicinity of the Marina 2 years ago; near the boat dock at the end of the pier, left hand side. Does not know the disposition, but suspects the items were classified as inert and then disposed of.

- Captain Sieband (Retired) found empty projectile casing (12") just off the road near #6 tee box on golf course.

- 4" projectile near Bldg. #705 digging for new water line – Frank saw this – suspected inert – rotating band was missing, no tracer element

- Vicinity bldg. 3069 and 3090 – suspected dumping site for “empty” rocket motors

- Bldg. #571: they used to hose down the bays at the extrusion plant; the shavings were hosed down on ground, single base propellant (NG)

- Area 8 – “render safe” training conducted there; used to detonate squibs

- EOD school – fired squibs and Mark 2 Impulse cartridges – stopped in ‘85

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: November 17, 2003

Person Conducting the Interview/Title/Organization: Denise Tegtmeyer, Malcolm Pirnie, Inc.

Person Being Interviewed/Title/Organization: Shawn Jorgensen – Indian Head Environmental Department

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Environmental information regarding Indian Head, specifically RCRA corrective permit

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Old Demo Area at Stump Neck
- RCRA Corrective Action permit
- Permit effective January 1990 – agreed to study 6 of the 24 sites identified
- Information should be available in the administrative Record
- VI Report indicated that sampling would be required
- Permit required investigation
  - Work Plan was created and then the VI investigation was conducted
- Reports was written in the late 1990s
- The FFA (Federal Facility Agreement) recently put the sites into CERCLA

Small Arms Range (Pistol) at Stump Neck
- Building 731 –X-ray facility release spent fixer containing silver to ground
- Site 5 – look for in the Administrative Record (93-94 timeframe)
  - Removal action conducted to remove silver contaminated soil from X-ray facility; soil was buried at old borrow pit to right of pistol range
  - Filled pit with contaminated soil
  - Topped with a 18 inch clay layer, “do not disturb” tape, and 6 inch top soil

Identified in GIS as “silver contaminated soil area”
All documented in a Removal Action report for Site 5 – July 1995

A 1983 study identified 10 Stump Neck sites, RCRA Facility Assessment identified 24 sites.

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: November 19, 2003

Person Conducting the Interview/Title/Organization: Shelly Kolb, Malcolm Pirnie

Person Being Interviewed/Title/Organization:

Cee Cee Krawling – Base Security Division

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Cee Cee was interviewed to obtain information regarding EOD calls.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Cee Cee stated that the EOD response records are kept for 2 years. The records are kept in logbooks, which are arranged by date. We would have to know the date of the response to get the information. She was going to request the Chief's permission for us to review the records. Once she had permission she was going to have Theresa pull the records for us to review. The records were not reviewed. Ms. Krawling was contacted as a follow up to determine if it would be possible to still review the records, but Malcolm Pirnie was not able to speak with her.

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: November 20, 2003

Person Conducting the Interview/Title/Organization: Hien Dinh and Grant Heslin, Malcolm Pirnie

Person Being Interviewed/Title/Organization:
Larry Kijek – Environmental/Safety

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Larry serves as the Division Head for Facilities, Environmental, Occupational Safety, and Explosive Safety; Attended EOD school in '84Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Also present: Dawn Cave '98 – '03

- The environmental offices built in '94
- Ordnance response occurred on Friday 11/14– An underwater mine, a torpedo, and a bomb were discovered 50-75' off shore during low tide. The 1st responders are 99% sure the items are inert. Fire department responded – more suspected along the shore from one end of SN to the other. Most likely placed there for sonar training in the '70s and '80s
- Mines or torpedoes found when breaking ground at building 2195 (Ask Disassembly for disposition of items)
- Torpedoes (inert) used for land fill all along causeway

- 1000's of fuzes and a few bombs were found in Chicamuxen Creek, reported by a kayaker, and easily observable during low tide. Larry went to the sight and confirmed the siting.

- Torpedo burial – "stream" is just seasonal standing water, and may even be the burial pit.

- Beryllium burial ground near 2019 (Tool burial site) and Larry says he hears another is out on western portion of peninsula.

- According to Dawn, there is an arsenic burial site at end of Range 6, across the street from a magazine near monitoring well.

- Sampling data → monitoring well near the old steam-out facility has higher levels of Arsenic.

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: October 16, 2003

Person Conducting the Interview/Title/Organization: Hien Dinh, Malcolm Pirnie

Person Being Interviewed/Title/Organization: Chris Lopez, Equipment Specialist, Technical Support Branch, Research And Development Department, NAVEODTECHDIV

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Retired Air Force EOD, employee at Stump Neck since 2001 and avid hunter at Stump Neck and IHDIV.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- Stump Neck Impact Area
    - The area needs to extend well into the peninsula up to the Marine Rifle Range and expand outward to cover the entire Chicamuxan Wildlife Management Area. Due to the increase in size, this area could overlap Air Blast Pond, Old Skeet and Trap Range, and Torpedo Burial Site.
    - Noticed many craters along the Chicamuxan Creek bank.
    - An aerial photo from the 50's showed divots in the area that could be from impacts caused by gun testing from the Valley at Indian Head Division, NSWC.
- Old Demo Range
    - In wooded areas, northwest of the hypervelocity building.

- Part of this area is within the blast exclusion zone radius of Range 2 (hypervelocity area). This range is currently active and has a capability to detonate up to 5 lbs of NEW (net explosive weight).

- There is a large water tank located at this site. This tank could be used for underwater testing. The time period of use was not known.

- There is an active range farther west from the site- Range 3. Range 3 has a capability to detonate up to 20 lbs NEW on surface and op to 60 lbs NEW for subsurface. The fragment exclusion zone for Range 3 will extend into this site.

- IOD and IED areas

  - See Earl Scroggins interview summary.

- Hunting at Stump Neck and Indian Head Division

  - No hunting along the Valley at Indian Head. However, beyond Aroma Drive to Cliff Top Road, hunting is allowed in the area, but only for 1 or 2 Saturdays a year. Only accomplished hunters (civilian and Navy personnel) that have proven to be reliable are allowed to hunt in this area. Special permission is required to hunt in this area. The hunt is usually to control the deer population.

  - Special hunting areas also include: Areas behind the sewer treatment plan, behind the hospital, along the golf course, and behind the training area.

  - Archery is allowed from mid-September to the end of the year.

  - Shotguns and muzzleloaders are allowed on Saturdays during respective seasons (see Andy Pedersen Interview summary.) The hunting area for these types is designated by "F##" on the hunting maps. These markers can be found on stakes or stamped to designate the areas.

  - A number followed by a letter (ex. 15A) on the hunting maps indicates hunting zones. Prior to hunting, the hunter must get a permit to hunt on base and the permit is only for one designated hunting zone. If the hunter wants to hunt in another zone, he/she must exit the zone and report to the base and get a permit for the other zone. This is a safety precaution to protect the hunter and for the base to determine where the hunter is located.

  - "WB##" is designated as waterfowl hunting areas.

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: November 18, 2003

Person Conducting the Interview/Title/Organization: Shelly Kolb, Malcolm Pirnie

Person Being Interviewed/Title/Organization:

Elaine Magdinec – Environmental Engineer

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Elaine is the person who completed the Navy Range Inventory.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Elaine was interviewed to gain a better understanding of why Test Area #2 was entered into the inventory. The miscellaneous portion of the inventory sheets for Test Area #2 indicated that a site survey revealed that this area might have been used for ordnance testing and/or training in the past. The inventory sheets indicated that this site was identified through a historical search. Very little is known about this possible site. This site may have been used for ordnance testing and/or training.

Elaine stated that the majority of the information she used, for the inventory, was from the IR program. She suggested speaking to Shawn Jorgensen regarding the historical search. She also suggested speaking to Jack Meyers, who worked at Tech Div and added sites to the survey at the last minute.

Additionally, Ms. Magdinec was interviewed to obtain general information on all of the sites included in the Navy Range Inventory. She provided us with the folder she had that contained all of the information used to complete the Navy Range Inventory. All relevant documents from this folder were copied. In general, the data used to complete the Navy range Inventory was obtained from the IR Program.

Ms. Magdinec stated that the Torpedo Casing Disposal area was identified by Jack Meyers. Jack reportedly told Ms. Magdinec that the Torpedo Casing Disposal Site was a place used for discarding old parts and that no live torpedoes were discarded in this area (to the best of his knowledge)

FDR Skeet Range

- The Commanding Officer of the installation identified this range during the Inventory process. The commanding officer was reportedly informed that a range was missed by Mr. Kenny Grimes. Upon interview with Kenny Grimes, he stated that Joe Cooper was the person who informed him of a range near the picnic area.

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: September 25, 2003

Person Conducting the Interview/Title/Organization: Jen Buckels, Malcolm Pirnie

Person Being Interviewed/Title/Organization: Jack Meyers, Retired Employee, IHDIV NSWC

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Previous employee at Indian Head

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- Torpedo Casing Disposal Area
    - Located approximately 100 feet north of Archer Avenue
    - Overlaps the cleared, Wildlife Refuge area
    - Torpedo Casings buried off to the left of the cleared area close to the woods
    - Best estimate is that Torpedo Casings were buried during the 1950s; length of time casings were buried here is unknown
    - Torpedo Casings would all be inert; nothing else buried with the casings
    - Casings approximately 18-30 inches in length
    - Depth of burial or density of casings in the area is unknown
    - Did not see any activities there himself but heard about the site from someone else; does not recall that person's name

- Recommended speaking with Jeff Bossart from Natural Resources Indian Head Environment to find out when the Wildlife Refuge area was established

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: June 26, 2003

Person Conducting the Interview/Title/Organization: Denise Tegtmeyer, Malcolm Pirnie

Heidi Morgan (Indian Head), Ray McManus (ECC), and Mike Baker (ECC) also in attendance

Person Being Interviewed/Title/Organization: Gordon Miller, retired Marine Corp EOD

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Retired Marine Corp EOD that trained and worked at Stump Neck

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- Landmarks and roads at Stump Neck have changed over the years, so he may not be familiar with locations on our map
- He is the oldest living EOD Marine (since deceased)
- From American University – 1943
- Had to qualify at school as a hard-hat-diver
- No firing at Indian Head because of explosives present
    - Burn area on Mattawoman Creek – about 10 acres
    - Burned small amounts of propellants
- Marines on horseback were security forces at base
- Boondocks swamp area
- School at Stump Neck
    - Classrooms at demo point – current Range 6
        - Fired from hill
        - Culvert was safety area
        - Had bullet proof glass
- Pond *(sounds like Air Blast Pond or current Area 8)*

    - Navy trained for sea ordnance
        - Mine and torpedo simulator work
    - About 6 feet deep and one-acre
    - There was a sandy/clay pit
        - Possible the pit we saw in the woods on site walk
        - Dan Hains also saw the pit in the woods
    - Torpedoes used as training aids
- Point was used for demo *(probably current Range 6)*
    - Once destroyed pyrotechnics
    - Used as a look-out to the Potomac for ships
    - Frags would fall into the river and the swamp area around point
    - Never exploded 'big bombs' in this area
    - 1 to 1.5 pound blocks of TNT, propellant, and pyrotechnics were used
- Other areas worked with inert items
    - Some with shape charges
    - M80 and booby traps used
- Explosives work at ponds *(current Area 8)*
    - Included wooded areas
    - Had to ID ordnance and render-safe
    - Two to three problems/procedures per day
        - Examples/testing
    - Classroom right next to pond (in woods)
        - Pond by building 60SN (building still has heater for when used as classroom)
    - Would drag torpedoes into pond
    - Line mine area near pond
        - Inert landmines setup for render-safe procedures
        - Mines were along road
        - Navy ordnance and Navy EOD mine and torpedo divisions
- Gordy's years at Indian Head
    - Went to Paris Island in 1942
    - Went to school in 1943
    - From school to Lejeune, NC to Hawaii, then to the war
    - Out of marines in 1946 but joined reserves
    - 1950 called back for Korea
        - Took refresher course at Indian Head
        - Took additional refreshers in 54, 55, and 56
    - Spent 6 years as an instructor (68, 58, 52, 60)
    - All items used at Indian Head (Stump Neck) were inert
    - At return in 1950, installation was unchanged except new fence at Stump Neck and no horse patrols
    - Stump Neck had a barracks area and chow hall
    - Retired in 1970
- Civil War ordnance
    - Trench positions
    - Cannon positions along river

    - Frequently found stashes of cannons at point
- 3 and 7 inch guns fired from golf course to Stump Neck
    - From point behind golf course
    - Firing down river
- Never found projectiles at Stump Neck
- Accident at demo point
    - Hang fire
    - 6 dead and many wounded
- No stories of burial or improper disposal
- In the mid1960s the nitro plant blew
    - Two fatalities at NG plant
- 1959 magazine explosion
- Small wooden buildings throughout stump Neck were used as classrooms
- Marine Rifle Range
    - Also used pistols
    - Pistols fired into river
    - Range paralleled river
    - Embankment behind targets *probably hump at tree line)*
- Commander and public (by invitation) used skeet range
    - Fired over water
    - Shot skeet here after he retired
    - 'Modern' skeet and trap set-up
- Entire area along road to point (at Stump Neck) was wooded, only a few fields
- First place to use radioactive slugs
    - X-ray ordnance for type
- Diving done from dock at Stump Neck

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 17, 2003

Person Conducting the Interview/Title/Organization: Shelly Kolb, Denise Tegtmeyer & Rhonda Stone; Malcolm Pirnie

Person Being Interviewed/Title/Organization: Heidi Morgan, Environmental Office, NSWC Indian Head

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): POC at Indian Head

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- Torpedo Casing Disposal Area
    - A former employee of SN (Jack Meyers) told Ms. Morgan that metal debris was supposedly buried in the left side of the wildlife field. Also, Jeff Bossart said he saw stuff at the end of the wildlife field.
    - The map in the Draft IAS identifies the location of this site.
- Test Area 2
    - No explosive testing was ever done; no shooting and no impacts have occurred at this site to the best of the interviewee's recollection. Only inert ordnance was used at this site.
- Test Area 1
    - In the late 60 to early 70, AA&D (Advanced, Access and Disablement) trainings (such as booby traps, trip wires, etc.) were conducted at the site.
    - SN currently using the facilities for testing

- Old Skeet and Trap Range
    - See Range Survey for specifics
- Battle Range Firing
    - See Range Survey for specifics
- IOD Site
    - The range area has been graded and renovated.
    - Something occurred in the field between the IOD site and Bldg 69SN
    - Red flags were posted along the northern and western boundaries of the Advanced IED Area that stated "active explosive operations in progress".
    - Reportedly, during nearby groundwater sampling in 1997-1998, Ms. Morgan heard "fire in the hole" followed by loud explosions. This further confirms the use of this area by the EOD School for training activities.
- Area 8
    - Check with Shawn Jorgensen
    - The RFI/VI map should show where water and air shots were performed.
- Water Impact Areas
    - Jim Dolph should have additional information.
    - Memo to the US Coast Guard to shut down traffic on the Potomac for 3 days for under water firing/testing. Memo does not indicate where in the Potomac but it was apparently a one-time event. Traffic was shut down from the Chapman's Point to the mouth of Mattawoman Creek.
    - Also, may contain ordnance fly-out for the Large Motor Test Facility. Check Elaine's notes for spill report.
- FDR Skeet Range
    - EPIC study may be helpful. It may show when the surrounding area by the magazines was cleared.
    - The Technical Library may have pictures of FDR picnicking. The stone icehouse that is still at the site may be in the pictures.
- Igniter Area

- Jeff Bossart is the key resource for this site. While canoeing on the Mattawomen Creek during the late 1980's, he observed what he perceived as igniters during low low tide.

- The Valley
  - They fired into butts at The Valley. Pictures should be available at the Technical Library. An Anniversary brochure should contain the pictures.
  - Jeff Bossart should know the marina history.
  - Bruce Dalton & Dave Bode may know about UXO responses at the Valley. Reportedly there was one at the marina and two near the housing area on the hill. Dahlgren EOD was responsible.
  - Dave Stewart (Public Works/waterline & sewer repair) may know if ordnance was encountered during the waterline repair/construction activities in the Valley.
  - 2 EOD Incidents have occurred in this area. Check with Dahlgren EOD.
  - Building 48 was constructed in 1900.

- Burning Grounds
  - Walter Carr and Art Mayer may have info. They may be able to compare the production time vs. the proposed burning times.
  - Ivan Tominack mentioned an old burning ground near the Pilot Plant. This area may have eroded into the river by now.
  - Dave Bode should have old maps with the explosives arcs. This could help determine where burning could have taken place safely.
  - Single Base Propellant Grains Spill Area is adjacent to the Original Burning Ground. The IAS Report indicated that cans of single base were burned here. In IR Program as Site 28. This site closed in the 1940s.
  - Thought Safety Thermal Treatment Point opened in the 1960s.
  - The gap between the 1940 and 1960s may be the time the NG Slums area was used or the site by the Pilot Plant.
  - The Strauss Avenue Thermal Treatment Point is now active.
  - Jim Dolph may have information on additional burning points.

- Old Demo Range
  - Site is identified on the Draft IAS map.

- The location of the site needs to be refined during the PA process.
- Jim Dolph should have additional information.

- Stump Neck Impact Area
  - Jon Stacy has a map of the Valley firing. Shows that from causeway west was in the firing fan.
  - Check with Jack Myers regarding UXO findings.
  - Aerial photos are useful in determining the potential impact area.

- There is a potential demo area on Archer Ave and Roach Road. The area was disturbed to install the new sewer lines.

- Specific questions asked during the interview with answers
  - RCRA permits information - Pertaining the RCRA Part B permit for the Old Demolition Site, - it did have one back in 1991, however the Navy filed a RFI/VI Work Plan with EPA and the state to get the regulatory status of the site changed to CERCLA. This supposedly began to happen in 1998. We need to confirm that this transition occurred.
  - Updates to development since 1990 Master Plan. Data indicates that development has taken place since 1990, for example, MILCON Code 45 Building, has any other development taken place since 1990?
  - Database information on buildings 2156, 1SN, and 2SN. These were not included on the original list because the range has expanded.
  - Confirm the following regarding the IOD Site: Information in the administrative record indicated that the bunker has/had two manhole like openings in the roof. These openings, along with the bunker interior, were supposedly filled with concrete. Photos collected during the site walk do not support this report. Need to confirm that the bunker was filled in.
  - Need to confirm dates of use for the Old Demolition Range? Current data from FFI/VI says it was used from 1962 until Range 3.

Please provide additional photos of the Small Arms Range **Photos were provided.**

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 17, 2003

Person Conducting the Interview/Title/Organization: Denise Tegtmeyer, Rhonda Stone, and Shelly Kolb; Malcolm Pirnie, Inc.

Person Being Interviewed/Title/Organization: Jeff Morris - RPM

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Institutional Knowledge of Indian Head

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Suggests referencing "History by Bart" in PAs
Will provide a link to a history website about Stump Neck (link we have is inactive)
Site list
- 22 sites are on list
- Additional sites
  - Amend trip report (include comments on previous version)
  - Possible demo site at Stump Neck
  - Possible rifle range at Stump Neck
  - Possible pistol range at Indian Head
  - Possible burning ground at Indian Head
  - Need to submit an additional set of CSMs with the new and missing sites
  - Need to return with GPS if sites are added

Areas of the sites should be refined on the maps
- Discuss the change in the PA
- Areas on maps we were given are estimates – they are counting on us to refine

Goal of the PA is to combine all old reports into one document, including sampling data.

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: November 18, 2003

Person Conducting the Interview/Title/Organization: Denise Tegtmeyer & Doug Sawyers, Malcolm Pirnie, Inc.

Person Being Interviewed/Title/Organization: William Penn

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Retired from Indian Head, formerly of IED

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Retired in 1977 then worked for the State Department
Ran the Improvised Explosives Devices (IED) Department from about 1973 to 1975
- Required to teach how MEC could be improvised
- Mostly training, testing was typically done at Tech Center
- Training was done outside (non-frag producing)

Improvised showed the law enforcement community how to disarm
- Expanded course with knowledge from overseas
  - Foreign explosives
  - Based on activities overseas – terrorism, etc.

Training
- New ordnance was sent to Tech Center then sent to be tested if it was to be used by the Navy
- Training was confined to space and range limitations
  - 4 pound of TNT or equivalent, including fragment producing
  - Letters, parcels, pipe bombs, etc. with chlorate and thorates
  - Training was to practice render safe procedures and if it was done incorrectly a small charge would go off
- The stripping bunker (defusing) was not used by his group
- Practical exercise sites

Used to model bombs, etc. in a car, building, etc.
Car carcasses and structures used to model real life situations
TNT, etc. would explode if EOD Tech. failed the exercise

Chemicals used
- Metallic sodium
- Potassium chlorate – used this the most because both explosive and incendiary (and because the opposition used it too)
- ANFO-ammonia nitrol fuel oil – also used this frequently because both explosive and incendiary (and because the opposition used it too)
- Sulfuric acid
- Nitric acid
- Permanganate
- Sodium peroxide
- Magnesium powder
- Aluminum powder
- Iron oxide
- HTH – potassium hyperchlorate
- Red phosphorus – used very little because too dangerous

Industrial / Household products used
- Brake fluid
- Kitchen cleaners

Explosives used
- Electric and non-electric blasting caps
- DETA sheet – rubber like explosive
- Military (no NG) and civilian (has NG) dynamite (no NG by itself)
- C4, C3, TNT, black and smokeless powder
    - Made some black powder using sulfur, charcoal, salt pectin
- Astro-pac – binary liquid explosive
- Tie fuse
- Cord and caps
- No white phosphorus because not used by opposition
- Also used military thermite and thermate

No burying, burning, or disposal on-site

Gravel area was used for demonstration

Also worked at the Indian Head Tech center
- Staff sergeant from 78-79
- Published render safe procedures

Taught at Indian Head classroom in 72/73
- Taught grenades

Took EOD basic course in 1960 and also took the refreshers at Indian Head with Marines

If large quantities were to be disposed, they would be taken to the point (range 6) for disposal
- This never occurred during his time at the site
- All explosives were consumed on-site

Doesn’t recall any UXO findings at Stump Neck

Pits were used around the building
- About 15-20 feet from the building
- About one meter deep
- Half dozen or so pits used

Area 8
- Underwater munitions
- May have tested other munitions, but mostly underwater munitions
- Unknown if any disposal occurred here
- Used by Navy, not Marines

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: September 25, 2003

Person Conducting the Interview/Title/Organization: Hien Dinh, Malcolm Pirnie

Person Being Interviewed/Title/Organization: Andy Pedersen, Senior Engineer, NAVEODTECHDIV

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): employee at Stump Neck and avid hunter at Stump Neck and Indian Head Main Side.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- Deer and waterfowl season is September 15 to January 31
- Turkey season is mid-April to mid-May
- Hunting is allowed most days of the week
    - Not during work hours
    - Weekends are most popular
    - See attached schedule
- Torpedo Casing Disposal Area
    - At the end of the Wildlife Area, at the water inert buried ordnance
    - Buried in the mid to late 70s
    - Area near water also used as magnetic training (mag. range) before Test Area 2 was established in the late 1970s

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 19, 2003

Person Conducting the Interview/Title/Organization: Rhonda Stone, Team Leader-MPI

Person Being Interviewed/Title/Organization: Allison Poe – IHDIV-NSWC GIS Specialist

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Interviewed to obtain GIS files for the installation

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

The following GIS files were obtained from Ms. Poe:

- Updated IRP Map
- Utility layers for both Stump Neck and the Main Installation
- Endangered species information
- Potable wells located on Stump Neck and the Main Installation

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: October 1, 2003

Person Conducting the Interview/Title/Organization: Denise Tegtmeyer, Malcolm Pirnie

Person Being Interviewed/Title/Organization: Ben Redman, CH2Mhill, Vice President for OE, Oakridge, TN 865-483-9032 x535

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Retired Marine Captain, history about Test Area 1 Division Head of IED and IND (improvised nuclear device) and refresher division and chemical division training

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Test Area 1

- Impact area in early 1900s
  - From Mainside
  - Encompassed most of Stump Neck
  - Impacts/craters near Area 8
- Training
  - As part of IED
  - IND is now AAD – Advanced Access and Disablement
  - Started in 1982 through 85 or after
  - Filled with water for diving
    - Explosives testing
    - Effects of water charges
  - Set-up for IED training
    - IED wired to explosives 50 feet away

        - ¼ pound charge of TNT (likely suspended)
        - set-off monitoring charge
        - similar to IND program
        - no radionuclides or contamination
- Buildings on site were used to operate antennas and cranes
    - Moved to focus point in dish with cranes
    - Like in the James Bond movie
- Satellite system
    - Three antenna sites on Potomac River in 1950s – including one at Stump Neck
- William Penn (who lives in Waldorf) may have more information

Stump Neck

- IED once used almost all of Stump Neck
- Indian Head had the right of domain, condemnation by emanate domain because of UXO hazards

OK, to follow-up with additional questions

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 18, 2003 (via telephone)

Person Conducting the Interview/Title/Organization: Denise Tegtmeyer & Doug Sawyers, Malcolm Pirnie, Inc.

Person Being Interviewed/Title/Organization: Diana Rose – Indian Head Environmental Department, Water Team Leader at base since 1988

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Identified as person to answer water discharge permit

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Heard of small ponds at Stump Neck that were filled with water for testing by EOD techs

About 5 years ago, but ponds were always there
General area of Stump Neck Impact Area
Ponds may still be there
Carey Yates (now in R&D) would have more information

The Valley

Sewer discharge runs underground along the Valley and discharges to the Potomac River
Sewage Treatment Plant is nearby

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 21, 2003

Person Conducting the Interview/Title/Organization: Grant Heslin

Person Being Interviewed/Title/Organization: Lou Scalafari – IHDIV-NSWC
Retired Architect

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Interviewed to obtain general information.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- Initially project engineer; '85 Demolitions Coordinator; '89 – Architect: Master Planning – Co-wrote IH individual master plan.
- Were Pre-development UXO sweeps done routinely? Yes, but cursory
  UXO responses? None that he knows of.
- Future development plans? Knows of no changes or updates to last published Master Plan.
  Individual Installation MPs no longer done… only on a regional basis now.
  Speak to Bill Fini for more information on Planning
- Archeological Study along railroad?
  In general archeological study done annually
- Single Base Repellant Grain Spill? Doesn't know much about the incident but is sure that there are still grains in bldg. 453 on and around the loading dock. Most of the old propellant manufacturing buildings still have chemical debris scattered about.

- While he was in service, all buildings identified for demolition were cleaned-up per Indian Head SOP.

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: October 16, 2003

Person Conducting the Interview/Title/Organization: Hien Dinh, Malcolm Pirnie

Person Being Interviewed/Title/Organization: Earl Scroggins, Technical Support Branch Head, Research And Development Department, NAVEODTECHDIV

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Former Air Force EOD, employee at Stump Neck since 1981

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- Torpedo Casing Disposal Area
    - See Mr. Jim Hersey Interview sheet.

- Air Blast Pond
    - Used in the 60's and early 70's
    - Ordnance type unknown
    - Drop tests in pond – ordnance was suspended by steel wire between 2 metal towers and dropped from different heights.
    - Currently, the site is closed and the base has no future plan for the site.

- IOD and IED areas

- Never heard of inert ordnance devices (IOD), when you take an ordnance items and modify it become an Improvised Explosive Devices (IED).
- The two areas should really be one site because the EOD school has used the entire area for ID training throughout the wooded areas.
- In the IOD area, Bldg 7NS, Old Ordnance building, was a booby trap IED training building.
- Also called Air Practical Area – the school used raw TNT (1/4 lb to ½ lb) and detonator cord was also used. This area was used between 1967 and 1970.
- This area also used as Old De-armer Range and Rocket Area just of Parker Road.
- Site also called Place Munitions and Testing Area. The instructor from the EOD School would wire a ¼ lbs of TNT to a test item some distance away. If the student did not follow the proper procedures to disarm the test item, the TNT would go off and this alerted everyone that the student made a life threatening mistake.
- Currently, the area is not being used. The area has not been used since the EOD School moved to Eglin Air Force Base (AFB) in 1995.

- Old Skeet and Trap Range
  - Use to go there and shoot in the early 80's.
  - Used mostly small arms and shotgun.
  - There used to be targets along the shoreline and in the river.

- Area 8
  - Need to be bigger in size than what is illustrated on the map.
  - The area used from the 1960's to 1995 when the EOD School moved to Eglin AFB.
  - This site is strictly used for underwater ordnance training, such as torpedoes and underwater mines
  - Used ¼ to ½ lbs of raw TNT for testing
  - Detonator cord and electric blasting caps were also used.

- Only EOD were allowed
- There is a pond at this site. The pond was used for diving training.

- Test Area 1
  - IND (Improvised Nuclear Device) Training from 1985 to 1987.
  - All training items were inert. No energetic materials (uranium or plutonium).
  - No idea of any ordnance training after the moon relay station closed.

- Small Arms Range (Pistol)
  - Shut down due to lead contamination
  - Silver contamination was dumped here and piled into little berms.
  - Smallwood State Park is located behind the slope where the targets were located. There was a potential that people and wildlife could be threatened in the line of fire.
  - The site needs to be bigger than what the map depicted.

- Rum Point Skeet Range
  - Current scale from the map needs to be scaled back.
  - The range should only extended to the border of Rum Point Road.

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: November 20, 2003

Person Conducting the Interview/Title/Organization: Rhonda Stone & Denise Tegtmeyer, Malcolm Pirnie, Inc.

Person Being Interviewed/Title/Organization: Jonathan Stacey, Cultural Resources, Indian Head

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Cultural Resources POC

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- All of Stump Neck was searched for cultural resources. The August 1996 report "Phase I Cultural Resources Survey of Stump Neck Annex and Supplemental Architectural Investigations, Indian Head NSWC, Charles County, Maryland" presents the results. The maps show where the shovel tests were done and the items that were found.
- Development at the marina
    - More information may be available from the pipe-laying project.
    - The drawings in the 'Vault' can be checked to verify construction of the buildings within The Valley. The text on the drawings may also be useful.
    - Fill was used in the marina area.
    - Should be able to assume there was nothing at The Valley prior to its construction other than fishing shacks on a pier.
    - The railroad may just be buried instead of formally removed.

- No remnants of past structures were found during the redevelopment.

- IED area is included in an in-progress base wide ecological assessment. Generally regarding the consolidation of buildings.

- It was proposed that the IOD area would go to the Marines for IED work, however it is in the bald eagle habitat.

- The Rum Point Skeet Range is also in the bald eagle habitat.

- The Rum Point Skeet Range may be used by EOD in the future.

- The original PAs that OESO has would identify who first put the sites on the map.

- FDR Skeet Range is on a 1942 map. It shows three buildings including the outhouse, high & low buildings. The outhouse is still present at the site. It also shows the stone building, piers, and dock. The stone building remaining in the area of the FDR Skeet Range was most likely associated with the docks and recreation area.

- The 1952 map shows the FDR Skeet Range Buildings too. It also show the magazines constructed near the proposed location of the NG Slums.

- The 1963 map shows the same information as the 1952 map.

- A 1966 map shows explosive arcs. No arcs are shown in the area of the NG Slums. Older maps may be available in the 'vault.'

- Refer to copies of historic maps for complete details. Sites included in the maps include NG Slums, FDR Skeet Range, Safety Thermal Treatment Point, Single Base Propellant Grains Spill Area, and The Valley.

<u>Site Specific Questions asked:</u>

- Since the Master Plan for IH is dated 1990 what are the current future use plans for:
  - IED Site – Being consolidated and size decreased. TECHDIV is the tenant, so they would know.
  - IOD Site – Was going to be given to the Marines for training, but it wasn't because of the Eagle Habitat.
  - The installation is currently in the process of doing a basewide EA to review all processing and develop the future plans for all of the sites.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 18, 2003

Person Conducting the Interview/Title/Organization: Hien Dinh and Grant Heslin

Person Being Interviewed/Title/Organization: Dave Stewart – IHDIV-NSWC Public Works/Utilities

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Interviewed to obtain general information.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- Knew of EOD response, projectile discovered near south west corner of Bldg #54 – General Storehouse; he estimates sometime in 1999. (Wes Pero says 10/02)
- Knew of other EOD response at bldg #705 – a projectile was discovered that was later accidentally detonated, and a man lost his leg.
- He remembers hearing that in vicinity of bldg #900, as his crew was preparing to build a new parking lot; some ordnance was dug up. This was never confirmed by another source, but Dave says he's pretty sure that something was found. In any case, he suspects they were just training aides or duds. He called a coworker, Michael Swann, who stopped by and after looking, he also identified the parking lot at bldg #900 as a location where he thought some "duds" were found.
- Dave suggested talking to Frank James and Jim Humphries (sp?)
- Told us that Allison Poe could provide the GIS layers with all the utilities information.

- He knew of a single base propellant spill that occurred near the RR tracks when a train car flipped and dumped its load.

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: June 26, 2003

Person Conducting the Interview/Title/Organization: Denise Tegtmeyer, Malcolm Pirnie

Person Being Interviewed/Title/Organization:

Robert Wiley – Quality Control Manager, ECC

Dan Hains – UXO Safety, Malcolm Pirnie

Ray McManus – UXO Technician & UXO Safety, ECC

Michael Baker – UXO Safety, ECC

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Retired EOD Technicians who worked and/or trained at Stump Neck

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- Bob Wiley
  - EOD School in 1971
  - Retired EOD Technician
  - 20 years in the Army
  - 7 years with ECC
- Dan Hains
  - School in 76-77
  - Three years at Stump Neck as CWO3 (1990-1993)
  - Retired Navy (CWO4) after 19 years
- Ray McManus
  - School in 62, plus yearly refreshers

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 19, 2003

Person Conducting the Interview/Title/Organization: Rhonda Stone

Person Being Interviewed/Title/Organization: Christina Adams – IHDIV-NSWC Public Affairs

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Interviewed to obtain general information.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Ms. Adams was not able to provide any additional information. She suggested we contact Tara Landis of the Public Affairs Office.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: October 29, 2003

Person Conducting the Interview/Title/Organization: Shelly Kolb, Malcolm Pirnie

Person Being Interviewed/Title/Organization: Dave Bode, Safety Office, NSWC Indian Head

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.):

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Mr. Bode was interviewed primarily for his knowledge of EOD calls at the Indian Head sites. He was also questioned regarding any additional anecdotal information on the Indian Head sites and any knowledge (EOD calls or anecdotal) he may have had on the Stump Neck sites.

FDR Skeet Range

Mr. Bode had no information regarding this site.

IED

According to Mr. Bode this site was used as a training range. The site contains a few areas where training was conducted using limited amounts of explosives. He suggested speaking to Larry Kijack EOD (sp?) to obtain additional information.

Single Base Propellant Grains Spill Area

Mr. Bode stated that the site was a production site for single based propellant grains and that grain could still be found on the ground surface near the tracks.

Safety Thermal Treatment Area

According to Mr. Bode, this site was a test area and is located approximately 2000 feet up the peninsula from an active disposal area. He stated that the site was active from 1963 to the early

1990s and he believed the site is currently a RCRA site. It was unclear if the site Mr. Bode was referring to was the "site".

Test Area 2

Mr. Bode had no information regarding this site.

Old Skeet ad Trap Range

Mr. Bode had no information regarding this site.

Marine Rifle Range

Mr. Bode had no information regarding this site.

Small Arms Range (pistol)

Other than the fact that this range was closed in the mid 1990s, Mr. Bode had no information regarding this site.

Rum Point Skeet Range

Mr. Bode stated that this range was used for recreation (skeet and trap) only and was established by a Captain Nicholson in approximately 1990 and was used until 2002. The range was used primarily by the Potomac River Gun Club and run by the installation's Moral Welfare and Recreation division. He was not aware of any EOD calls being made to the range. He did not have information regarding the prior use of the property.

Torpedo Burial Site

Mr. Bode had no information regarding this site.

Torpedo Casing Disposal Area

Mr. Bode had no information regarding this site.

Area 8

Mr. Bode had no information regarding this site.

Stump Neck Impact Area

Mr. Bode had no information regarding this site.

Old Demolition Area

Mr. Bode had no information regarding this site.

Air Blast Pond

Mr. Bode had no information regarding this site.

Igniter Area

Mr. Bode had no information regarding this site.

IOD Site

Mr. Bode had no information regarding this site.

The Valley

Mr. Bode had no information regarding this site.

Test Area 1

Mr. Bode had no information regarding this site.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 19, 2003

Person Conducting the Interview/Title/Organization: Hien Dinh and Grant Heslin

Person Being Interviewed/Title/Organization: Jeff Bossart – IHDIV-NSWC Natural Resources

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Interviewed to obtain information on hunting and natural resources at IHDIV – NSWC.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

• Has well locations, depth and water towers data (lines, valves – nothing on aquifer sizes, but which aquifer the wells pull from)

• Kathy Frey has all maps or map files, and more info

• Endangered species info/maps - will provide copies

• Hunting maps – will send via email; '91-'96 Wild Turkey repopulation project at IH and SN… birds transplanted from Dahlgren, VA; population is now high enough to hunt.

• Archeological Survey Reports can be obtained from John Stacy

• New Marina built (upgraded) in 1994. Started by extending the breakwater to protect boats. If ordnance was found, they would cease work, but none was ever found. They did find inert material further down between the dock and valley. It was labeled 'inert', presumably by EOD, and used as a sort of Rip Rap on the banks of the river to prevent erosion.

• This area between the dock and the Valley (See Hien's Map) saw some action during the War of 1812. Some canon balls suspected but unconfirmed. History says artillery battery there – British had 8lb'ers, Americans had 4 – 6lb'ers.

• Found inert mine casings while tilling 200' from end of field (See Hien's Map). The casings were circular shaped and had been crushed/flattened. Inert mine casings were found at SN just north of the water tower, in the old firebreak.

• Says John Stacy has history of old marina – which has been there since 1890.

• Valley used to be a freshwater wetland. A pump house was also built in the 1890s, about the time the original marina was built – piping brought water from river, which was used for fire protection.

• Jeff is the individual that identified the igniters found in the Igniter Area. He described them as an "electric primer" or "an electrically primed rifle cartridge about .50 caliber sized". The items were found in late '96 or early '97. Hien has the location on the map where they were found. Jeff says he grabbed a few and gave them to Bruce Dalton (IH Safety-Retired). His said he believes Bruce had the moved to scrap storage container for flashing at the Burn Point.

• Recreational information: Old area 8 pond stocked with Trout from '95 – '00; Tidal portion of Chicamuxen Creek never stocked, but it is heavily fished for large and small mouth bass, perch and trout.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 19, 2003

Person Conducting the Interview/Title/Organization: Rhonda Stone and Grant Heslin

Person Being Interviewed/Title/Organization: Walter Carr – IHDIV-NSWC NG Plant

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Interviewed to obtain information on NG Slums.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- Met Joe Cooper prior to conducting the interview. He was asked about FDR Skeet Range, and he remembered it being at the location depicted on the site map. Couldn't remember when the high and low houses disappeared.

- Walter said FDR Skeet Range was absolutely there- YES – He personally saw clay pigeons on the ground; He suspect the explosion at the NG plant most likely knocked the structures down (the old FDR Skeet Range was located just a few hundred feet behind the NG plant. (see diagram)

- Look in the book Powder and Propellants, by Rodney Carlisle; printed '90, published '02; ISBN# 1-57441-149-7. Book is great source of historical info about IH and NG Plant.

- Started making NG in Pilot Plant in late '40s (about '48); showed us blueprints of the plant. The drawings were approved in 1948.

- Knew about NG Burning Grounds on Strauss Road

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 17, 2003 (am)

Person Conducting the Interview/Title/Organization: Rhonda Stone, Team Leader-MPI

Person Being Interviewed/Title/Organization: Joe Cooper – Retired former employee at the NG Plant

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Employee at the NG Plant since 1961.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- The FDR Skeet Range was not in use when he started at the NG Plant in 1961, but the buildings and range were still visible at that point.
- In 1961, the buildings were still standing, but the area was covered in vegetation and no berms, targets, or firing lines were visible.
- The buildings at the range were knocked down in 1967 when the NG Plant exploded.
- The area was used as a picnic area before the NG Plant was built.
- Mr. Cooper had no personal knowledge that FDR ever used the FDR Skeet Range.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 18, 2003

Person Conducting the Interview/Title/Organization: Rhonda Stone – Team Leader MPI

Person Being Interviewed/Title/Organization: Tom Cox, IHDIV-NSWC Director of Facilities.

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Worked for Public Works for 16 ½ years.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- The flat area just south of Archer Ave and just east of Roach Road is the leach field for the sanitary sewer effluent for the Stump Neck Annex. The use as a septic field was terminated in 2002. This is the area suspected as an EOD Demo area.
- The renovation of Bldg 62 occurred in approximately 1985
- Tom Cox is not aware of any UXO Sweeps done in the Valley during the Marina Redevelopment.
- ROINCC office would have specific records on the construction project during the Marina redevelopment, but they only keep the records 7 years.
- Building numbers for the Sanitary Sewer Treatment Plant at the Valley would provide more information on the use after the gun proving.

- EOD Incidents at the Valley that he is aware of:
    - Several live 50-cal torc wrench rounds were discovered (casings only). An EOD Safety guy was paid to dispose of them. The exact timeframe they were found isn't known, but it was during the redevelopment.
    - During the Marina Redevelopment, live and inert ordnance was uncovered from the new breakwater and renovation to the extension of the existing breakwater.
    - The entire area wasn't sweep for UXO because of the minimal amount found and "a bureaucratic reason".
- EOD left the main installation in 1998. EOD TECHDIV started at the main installation in the mid-1940's
- Reportedly, EOD did not use any live ordnance at the main installation.
- In approximately 1991 to 1995, Building 518 (storage facility for explosives) deflagrated. This building is not located in any of the MRP site areas.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 25, 2003 (via telephone)

Person Conducting the Interview/Title/Organization: Denise Tegtmeyer, Malcolm Pirnie, Inc.

Person Being Interviewed/Title/Organization: Bruce Dalton

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Retired from Indian Head; Heidi Morgan recommended interview

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Retired from Indian Head
- Worked in Safety Department for 15 years
- Worked at Indian Head for a total of 33 years
- Prior to Safety worked in facilities and CAD (cartridge activated devices) department
- Never worked in the EOD Department

Remembered several EOD responses
- Responses included mis-placed ordnance
- Old shells dug-up, cannons near the old Proving Ground (The Valley)
- Every time they dug at the marina they would find something
  - Old projectiles – none live
  - Happened throughout the 1990s – about 4-6 times
  - Projectiles were found on the riverbank –
- Upstream, between the marina and the EOD dock
- Items were inert
- Dahlgren was contacted

Mike Olup from Dahlgren would know more

Security once called EOD at Andrews (instead of Dahlgren) because Safety Department was not involved

Andrews only responded once

Security Office would have the details

There were also finds at the old EOD training facility

Right of fence line after the golf course

50 caliber rounds

Now the CIBIRF parking lot, rounds were uncovered while grading for the parking lot

Happened about 4 years ago

Explosive Arcs

Dave Bode would have details he was the ESQD POC for the Safety Department

QD maps evolving continually

Changes of arcs not done as maps but as QD associated with building changes

Burning grounds should be included in the explosive arcs and on maps if they exist

Burning grounds are also on recent maps

Earlier burning grounds may be treated differently

Burning Grounds

Only remembers the Safety Thermal and Strauss Avenue burning points

"Old Safety Burn Point" (Safety Thermal) was used to test and dispose of special items

Highly dangerous, more sensitive or experimental items

CAD items – a tank served as a barricade for the CADS and the CADs were heated in the tank until they exploded

Also disposed of contaminated lab solvents and black powder at the Safety Thermal Burning Point

Strauss Ave. Burn Point replaced the Safety Thermal prior to 1968

Only heard stories of a burn point at the intersection of Strauss Ave & Caffee Road

Activities were not conducted here during his time at Indian Head

But it wouldn't surprise him if this was a burning point

Old Burning Ground – at the corner of the Single Base area

Heard it was used as a disposal area

Remains are present

Not used during his time at Indian Head

Not involved with disposal until he worked with the CAD production unit (about 68-70) then involved with oversight, procedures and safety with the Safety Department

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 21, 2003

Person Conducting the Interview/Title/Organization: Rhonda Stone

Person Being Interviewed/Title/Organization: Jim Dolph – Navy Historian

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Interviewed to obtain general information.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

INDIAN HEAD – MAIN SIDE – RANGE NOTES

EOD School – Underwater Ordnance School

The Underwater Ordnance / Diving Division was located in Building 901 and had the responsibility of teaching all types of underwater ordnance, both foreign and domestic. It maintained two practical training areas, one on Stump Neck and one on the Main Side. The Practical Training Area on the Main Side included and was located in the vicinity of Diving Locker Building 1444. The Diving Locker was constructed in 1968 and was 18' by 60'. It provided an instructor's office, classroom, workshop and compressor room. An *"Inert Ordnance Underwater Minefield"*, was placed offshore. It provided a practical training area in underwater ordnance disposal techniques in the Potomac River under realistic conditions.

(References 2 & 4)

"Potential" New Range at EOD School

The Explosive Ordnance Disposal School Command Narrative for the year 1973 states that " Two firing bunkers were built in the Practical Area of SD-I to allow students to actually live fire the cal.50 Dearmer and the Rocket Wrench without being transported to Stump Neck, a distance of 13 miles from the school proper".

(Reference 1)

Safety Thermal Treatment Point

Reference 5 provides a list of items being disposed of at the Pyrotechnics Burning point in 1978.

(Reference 5)

Original Burning Grounds (Old Zinc Recovery Furnace Area)

Prior to the construction of the Zinc Recovery Furnace, Test Well #16 is shown on, or adjacent to the site in 1919. The Zinc Recovery Furnace was erected on the site prior to World War II. The "Burning Cage" is not shown on the site on a 1952 station map, but, first appears on a station map dated 1954.

(References 6 & 7)

Pistol Range

This range does not appear on maps prior to 1949 or after 1953. It was most likely eliminated when Buildings 718 and 739 were erected in 1953. An undated aerial photograph of this area, post 1955, indicates that the area had been extensively cleared and graded, possibly built-up.

(Reference 8)

List of References

1. Naval School, Explosive Ordnance Disposal, *"Command Narrative"*, Naval Ordnance Station, Indian Head, MD., year 1973

2. Naval School, Explosive Ordnance Disposal, *"Command Narrative"*, Naval Ordnance Station, Indian Head, MD., year 1971

3. Naval School, Explosive Ordnance Disposal, *"Command Narrative"*, Naval Ordnance Station, Indian Head, MD., year 1972

4. Naval School, Explosive Ordnance Disposal, *"Command Narrative"*, Naval Ordnance Station, Indian Head, MD., year 1970

5. Memo with enclosure from 281A to OESO. Subject: Propellant/hazardous waste disposal capability; inventory of. Ref: (a) Memo OESO: ILT: PC, OESO: 28:78 6240 of 13 April 1978. (3) Pyrotechnics Burning Point Disposing of enclosure. 29 September 1978.

6. Plan , "United States Naval Powder Factory, Indian Head., *Conditions as of October 31, 1952."*, Plan Number 15219

7. Plan, "Master Shore Station Development Plan", Y&D Dwg 670,633., August 31, 1954

8. Aerial Photograph, United States Naval Powder Factory, Indian Head, Maryland., (Undated) (Note: Post 1953 because it shows building that were constructed in 1953 or after.)

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 18, 2003

Person Conducting the Interview/Title/Organization: Hien Dinh and Grant Heslin

Person Being Interviewed/Title/Organization: Kathy Frey – IHDIV-NSWC Environmental Department

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Interviewed to obtain well data.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- All wells tap into the Patapsco ground water aquifer for drinking water, EXCEPT well #16a which taps into the Patuxent aquifer and was originally intended to supply water for the Steam B Plant. This water is potable, but with a slight metallic taste. Piping is too small so can't be put in distribution system, otherwise, is another DW source.

- Low silica wells, like those near Goddard Power Plant (#15, 17 and 18) – water doesn't need to be treated, also used for drinking water.

Available wells:

- Indian Head: #2, 2A, 7, 12, 15, 16A, 17, 18

- Stump Neck: #43 SN → 1945; old, minimal output, iron problems; considering rehab or new well; #2012 SN → 1953 – newer well, but not optimal.

Stump Neck Well OPTIONS:

1) rehab both wells → use #2012 as Main, 43 as back-up
2) Construct a New well → use #2012 as back-up, take 43 out of service
3) Use #2012 as main → construct a new smaller well as back-up

- IH: River water used for fire protection

- Private well at Bullets Neck; tested quarterly; monthly during the summer use.

- SN: Well water used for fire protection

- 2 private wells near Rum Point – Considered private due to population definitions (not enough people/not enough use per year). The wells are tested quarterly; Skeet Range tested for bacteria monthly if in use.

Well system at IH – Upgrades planned in MILCON P-160; new tanks, improved SCADA, new well, demolish old bldgs

Well system at SN – Upgrades planned in MILCON P-160; new tanks, new well, upgrade SCADA system (Groundwater Rule may require continuous residual monitoring sensors); updates Drinking Water systems and larger Reverse Osmosis system for river water treatment.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 17, 2003 (am)

Person Conducting the Interview/Title/Organization: Rhonda Stone, Team Leader-MPI

Person Being Interviewed/Title/Organization: Kenny Grimes – Employee at the NG Plant

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Employee at the NG Plant since 1961

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Mr. Grimes was interviewed because according to Elaine Magdenic (who completed the Navy Range Inventory); the FDR Skeet Range was added because of Mr. Grimes personal knowledge of this area. According to Ms. Magdenic, the IHDIV-NSWC Commander added the FDR Skeet Range to the Range Inventory because of information he received from Mr. Grimes.

During the interview with Mr. Grimes, he stated that the information on the "Skeet Range" was actually provided to him by Mr. Joe Cooper. He provided contact information for Joe Cooper and Mr. Cooper was interviewed.

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: November 17, 2003

Person Conducting the Interview/Title/Organization: Denise Tegtmeyer, Malcolm Pirnie, Inc.

Person Being Interviewed/Title/Organization: Shawn Jorgensen – Indian Head Environmental Department

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Environmental information regarding Indian Head, specifically RCRA corrective permit

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Old Demo Area at Stump Neck
- RCRA Corrective Action permit
- Permit effective January 1990 – agreed to study 6 of the 24 sites identified
- Information should be available in the administrative Record
- VI Report indicated that sampling would be required
- Permit required investigation
  - Work Plan was created and then the VI investigation was conducted
- Reports was written in the late 1990s
- The FFA (Federal Facility Agreement) recently put the sites into CERCLA

Small Arms Range (Pistol) at Stump Neck
- Building 731 –X-ray facility release spent fixer containing silver to ground
- Site 5 – look for in the Administrative Record (93-94 timeframe)
  - Removal action conducted to remove silver contaminated soil from X-ray facility; soil was buried at old borrow pit to right of pistol range
  - Filled pit with contaminated soil
  - Topped with a 18 inch clay layer, “do not disturb” tape, and 6 inch top soil

Identified in GIS as “silver contaminated soil area”

All documented in a Removal Action report for Site 5 – July 1995

A 1983 study identified 10 Stump Neck sites, RCRA Facility Assessment identified 24 sites.

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: November 19, 2003

Person Conducting the Interview/Title/Organization: Shelly Kolb, Malcolm Pirnie

Person Being Interviewed/Title/Organization:

Cee Cee Krawling – Base Security Division

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Cee Cee was interviewed to obtain information regarding EOD calls.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Cee Cee stated that the EOD response records are kept for 2 years. The records are kept in logbooks, which are arranged by date. We would have to know the date of the response to get the information. She was going to request the Chief's permission for us to review the records. Once she had permission she was going to have Theresa pull the records for us to review. The records were not reviewed. Ms. Krawling was contacted as a follow up to determine if it would be possible to still review the records, but Malcolm Pirnie was not able to speak with her.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 19, 2003

Person Conducting the Interview/Title/Organization: Rhonda Stone, Team Leader-MPI

Person Being Interviewed/Title/Organization: Tara Landis – IHDIV-NSWC Public Affairs Office

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Interviewed to obtain press release documents that may contain information that FDR visited the installation.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Ms. Landis was not able to be interviewed until after December 4, 2003 due to an event that she was coordinating. She stated that Public Affairs only has current documents and that anything from the timeframe when FDR was Assistant Secretary to the Navy would be stored at the Technical Library.

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: November 18, 2003

Person Conducting the Interview/Title/Organization: Shelly Kolb, Malcolm Pirnie

Person Being Interviewed/Title/Organization:

Elaine Magdinec – Environmental Engineer

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Elaine is the person who completed the Navy Range Inventory.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Elaine was interviewed to gain a better understanding of why Test Area #2 was entered into the inventory. The miscellaneous portion of the inventory sheets for Test Area #2 indicated that a site survey revealed that this area might have been used for ordnance testing and/or training in the past. The inventory sheets indicated that this site was identified through a historical search. Very little is known about this possible site. This site may have been used for ordnance testing and/or training.

Elaine stated that the majority of the information she used, for the inventory, was from the IR program. She suggested speaking to Shawn Jorgensen regarding the historical search. She also suggested speaking to Jack Meyers, who worked at Tech Div and added sites to the survey at the last minute.

Additionally, Ms. Magdinec was interviewed to obtain general information on all of the sites included in the Navy Range Inventory. She provided us with the folder she had that contained all of the information used to complete the Navy Range Inventory. All relevant documents from this folder were copied. In general, the data used to complete the Navy range Inventory was obtained from the IR Program.

Ms. Magdinec stated that the Torpedo Casing Disposal area was identified by Jack Meyers. Jack reportedly told Ms. Magdinec that the Torpedo Casing Disposal Site was a place used for discarding old parts and that no live torpedoes were discarded in this area (to the best of his knowledge)

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: December 5, 2003

Person Conducting the Interview/Title/Organization: Denise Tegtmeyer, Malcolm Pirnie

Person Being Interviewed/Title/Organization: John McDevitt, retired Chemical Engineer from Indian Head

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Retired from Indian Head Pilot Plant, currently employed by AOT (Advance Ordnance Technology)

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- Worked at Indian Head Pilot Plant as a Chemical Engineer from 1959 to 1991
  - Laboratory test data was scaled up to test quantities
  - Propellants and explosives
- Burning Grounds
  - Entire time he was employed the main burning ground was the Strauss Ave. Thermal Treatment Point
    - Propellants and explosives were burned here
  - Safety Thermal Treatment Point was also active while he was at Indian Head
  - Caffee Road Thermal Treatment Point was also used
  - No burning ground was present at the intersection of Strauss Avenue and Caffee Road, to his knowledge
- Only heard of the FDR Skeet Range through the pictures of FDR that circulated
- NG Slums
  - Never heard of this area
  - All NG burning was done at the Strauss Ave Burn Point
  - Never been to that area, so he wouldn't have additional information
  - Believes the NG plant was built in the 50s, and prior to that there was a small NG plant at the Pilot Plant

- Single Base Line
    - The single base line was not operating when he came to Indian Head
    - It reopened during the Vietnam era
    - Site is now mostly torn down
- Commented as a member of the community on the sites listed for the EPA & Superfund
    - 2 or 3 sites were investigated for contamination, and no findings
    - Doesn't recall the name of the sites, but one was potential TCE at Building 292
- Valley
    - One of the magazines used but his group was located in the Valley area
    - No records of UXO findings anywhere on post, including the Valley area
- Only worked at Indian Head, so he has no information about the sites at Stump Neck

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 17, 2003

Person Conducting the Interview/Title/Organization: Shelly Kolb, Denise Tegtmeyer & Rhonda Stone; Malcolm Pirnie

Person Being Interviewed/Title/Organization: Heidi Morgan, Environmental Office, NSWC Indian Head

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): POC at Indian Head

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- Torpedo Casing Disposal Area
    - A former employee of SN (Jack Meyers) told Ms. Morgan that metal debris was supposedly buried in the left side of the wildlife field. Also, Jeff Bossart said he saw stuff at the end of the wildlife field.
    - The map in the Draft IAS identifies the location of this site.
- Test Area 2
    - No explosive testing was ever done; no shooting and no impacts have occurred at this site to the best of the interviewee's recollection. Only inert ordnance was used at this site.
- Test Area 1
    - In the late 60 to early 70, AA&D (Advanced, Access and Disablement) trainings (such as booby traps, trip wires, etc.) were conducted at the site.

- SN currently using the facilities for testing

- Old Skeet and Trap Range
  - See Range Survey for specifics

- Battle Range Firing
  - See Range Survey for specifics

- IOD Site
  - The range area has been graded and renovated.
  - Something occurred in the field between the IOD site and Bldg 69SN
  - Red flags were posted along the northern and western boundaries of the Advanced IED Area that stated "active explosive operations in progress".
  - Reportedly, during nearby groundwater sampling in 1997-1998, Ms. Morgan heard "fire in the hole" followed by loud explosions. This further confirms the use of this area by the EOD School for training activities.

- Area 8
  - Check with Shawn Jorgensen
  - The RFI/VI map should show where water and air shots were performed.

- Water Impact Areas
  - Jim Dolph should have additional information.
  - Memo to the US Coast Guard to shut down traffic on the Potomac for 3 days for under water firing/testing. Memo does not indicate where in the Potomac but it was apparently a one-time event. Traffic was shut down from the Chapman's Point to the mouth of Mattawoman Creek.
  - Also, may contain ordnance fly-out for the Large Motor Test Facility. Check Elaine's notes for spill report.

- FDR Skeet Range
  - EPIC study may be helpful. It may show when the surrounding area by the magazines was cleared.
  - The Technical Library may have pictures of FDR picnicking. The stone icehouse that is still at the site may be in the pictures.

- Igniter Area

- Jeff Bossart is the key resource for this site. While canoeing on the Mattawomen Creek during the late 1980's, he observed what he perceived as igniters during low low tide.

- The Valley
  - They fired into butts at The Valley. Pictures should be available at the Technical Library. An Anniversary brochure should contain the pictures.
  - Jeff Bossart should know the marina history.
  - Bruce Dalton & Dave Bode may know about UXO responses at the Valley. Reportedly there was one at the marina and two near the housing area on the hill. Dahlgren EOD was responsible.
  - Dave Stewart (Public Works/waterline & sewer repair) may know if ordnance was encountered during the waterline repair/construction activities in the Valley.
  - 2 EOD Incidents have occurred in this area. Check with Dahlgren EOD.
  - Building 48 was constructed in 1900.

- Burning Grounds
  - Walter Carr and Art Mayer may have info. They may be able to compare the production time vs. the proposed burning times.
  - Ivan Tominack mentioned an old burning ground near the Pilot Plant. This area may have eroded into the river by now.
  - Dave Bode should have old maps with the explosives arcs. This could help determine where burning could have taken place safely.
  - Single Base Propellant Grains Spill Area is adjacent to the Original Burning Ground. The IAS Report indicated that cans of single base were burned here. In IR Program as Site 28. This site closed in the 1940s.
  - Thought Safety Thermal Treatment Point opened in the 1960s.
  - The gap between the 1940 and 1960s may be the time the NG Slums area was used or the site by the Pilot Plant.
  - The Strauss Avenue Thermal Treatment Point is now active.
  - Jim Dolph may have information on additional burning points.

- Old Demo Range
  - Site is identified on the Draft IAS map.

- The location of the site needs to be refined during the PA process.
- Jim Dolph should have additional information.

- Stump Neck Impact Area
  - Jon Stacy has a map of the Valley firing. Shows that from causeway west was in the firing fan.
  - Check with Jack Myers regarding UXO findings.
  - Aerial photos are useful in determining the potential impact area.

- There is a potential demo area on Archer Ave and Roach Road. The area was disturbed to install the new sewer lines.

- Specific questions asked during the interview with answers
  - RCRA permits information - Pertaining the RCRA Part B permit for the Old Demolition Site, - it did have one back in 1991, however the Navy filed a RFI/VI Work Plan with EPA and the state to get the regulatory status of the site changed to CERCLA. This supposedly began to happen in 1998. We need to confirm that this transition occurred.
  - Updates to development since 1990 Master Plan. Data indicates that development has taken place since 1990, for example, MILCON Code 45 Building, has any other development taken place since 1990?
  - Database information on buildings 2156, 1SN, and 2SN. These were not included on the original list because the range has expanded.
  - Confirm the following regarding the IOD Site: Information in the administrative record indicated that the bunker has/had two manhole like openings in the roof. These openings, along with the bunker interior, were supposedly filled with concrete. Photos collected during the site walk do not support this report. Need to confirm that the bunker was filled in.
  - Need to confirm dates of use for the Old Demolition Range? Current data from FFI/VI says it was used from 1962 until Range 3.

Please provide additional photos of the Small Arms Range **Photos were provided.**

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 17, 2003

Person Conducting the Interview/Title/Organization: Denise Tegtmeyer, Rhonda Stone, and Shelly Kolb; Malcolm Pirnie, Inc.

Person Being Interviewed/Title/Organization: Jeff Morris - RPM

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Institutional Knowledge of Indian Head

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Suggests referencing "History by Bart" in PAs
Will provide a link to a history website about Stump Neck (link we have is inactive)
Site list
- 22 sites are on list
- Additional sites
  - Amend trip report (include comments on previous version)
  - Possible demo site at Stump Neck
  - Possible rifle range at Stump Neck
  - Possible pistol range at Indian Head
  - Possible burning ground at Indian Head
  - Need to submit an additional set of CSMs with the new and missing sites
  - Need to return with GPS if sites are added

Areas of the sites should be refined on the maps
- Discuss the change in the PA
- Areas on maps we were given are estimates – they are counting on us to refine

Goal of the PA is to combine all old reports into one document, including sampling data.

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: November 18, 2003

Person Conducting the Interview/Title/Organization: Denise Tegtmeyer & Doug Sawyers, Malcolm Pirnie, Inc.

Person Being Interviewed/Title/Organization: William Penn

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Retired from Indian Head, formerly of IED

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Retired in 1977 then worked for the State Department
Ran the Improvised Explosives Devices (IED) Department from about 1973 to 1975
- Required to teach how MEC could be improvised
- Mostly training, testing was typically done at Tech Center
- Training was done outside (non-frag producing)

Improvised showed the law enforcement community how to disarm
- Expanded course with knowledge from overseas
  - Foreign explosives
  - Based on activities overseas – terrorism, etc.

Training
- New ordnance was sent to Tech Center then sent to be tested if it was to be used by the Navy
- Training was confined to space and range limitations
  - 4 pound of TNT or equivalent, including fragment producing
  - Letters, parcels, pipe bombs, etc. with chlorate and thorates
  - Training was to practice render safe procedures and if it was done incorrectly a small charge would go off
- The stripping bunker (defusing) was not used by his group
- Practical exercise sites

Used to model bombs, etc. in a car, building, etc.
Car carcasses and structures used to model real life situations
TNT, etc. would explode if EOD Tech. failed the exercise

Chemicals used
- Metallic sodium
- Potassium chlorate – used this the most because both explosive and incendiary (and because the opposition used it too)
- ANFO-ammonia nitrol fuel oil – also used this frequently because both explosive and incendiary (and because the opposition used it too)
- Sulfuric acid
- Nitric acid
- Permanganate
- Sodium peroxide
- Magnesium powder
- Aluminum powder
- Iron oxide
- HTH – potassium hyperchlorate
- Red phosphorus – used very little because too dangerous

Industrial / Household products used
- Brake fluid
- Kitchen cleaners

Explosives used
- Electric and non-electric blasting caps
- DETA sheet – rubber like explosive
- Military (no NG) and civilian (has NG) dynamite (no NG by itself)
- C4, C3, TNT, black and smokeless powder
  - Made some black powder using sulfur, charcoal, salt pectin
- Astro-pac – binary liquid explosive
- Tie fuse
- Cord and caps
- No white phosphorus because not used by opposition
- Also used military thermite and thermate

No burying, burning, or disposal on-site

Gravel area was used for demonstration

Also worked at the Indian Head Tech center
- Staff sergeant from 78-79
- Published render safe procedures

Taught at Indian Head classroom in 72/73
- Taught grenades

Took EOD basic course in 1960 and also took the refreshers at Indian Head with Marines

If large quantities were to be disposed, they would be taken to the point (range 6) for disposal
- This never occurred during his time at the site
- All explosives were consumed on-site

Doesn’t recall any UXO findings at Stump Neck

Pits were used around the building
- About 15-20 feet from the building
- About one meter deep
- Half dozen or so pits used

Area 8
- Underwater munitions
- May have tested other munitions, but mostly underwater munitions
- Unknown if any disposal occurred here
- Used by Navy, not Marines

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: October 30, 2003

Person Conducting the Interview/Title/Organization: Denise Tegtmeyer, Malcolm Pirnie

Person Being Interviewed/Title/Organization: AJ Perk

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): retired Production Engineer and former head of production from Indian Head

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- AJ was the head of production in charge of manufacturing at Indian Head for 11 or 13 years
- He started as a Production Engineer in 1962 and retired in 1997
- He only has knowledge of Indian Head, not Stump Neck
- Safety Thermal Treatment Plant
    - Used since he started at Indian Head in 1962
    - Used almost daily from 1962 – 1997 except when productions was down then only used about 3 days a week
    - Before the environmental laws, all material was burned directly on the ground
        - Scrap propellants were put in pits and ignited, this continued for years
        - All types of propellants manufactured or dissembled at Indian Head was burned there

        - New soil was brought in as needed
        - Once a storm (or hurricane) brought the water/tide up and covered the point. The point was set-up for a burn and all the material got washed away
        - Burn pans were added around 1980
    - Quite a few incidences where material actually blew – spew into water and over land. Happened on several occasions.
        - Some caused by nitroglycerin solvents, pool of matter, that would blow
        - Some blows caused by plastic bonded explosives in bulk form
        - Use of pans didn't stops blows. But by then they knew more of what caused the blows and how to spread the materials. The pans were eventually inspected to stop the blows
        - People may have been burned with pre-mature ignition
            - One man had to run into the water
            - Few people hurt
            - Once the blue metal dumpsters that brought in the scrap propellants caused a premature blow because the dumpster either hit the pan or the lid of the dumpster hit the dumpster and ignited the material which caught on fire. The truck driver was uninjured, but the two men on the ground were burned.

- No known dumping in creek. Never heard of the Igniter Area, but wouldn't know why igniters would be disposed in the creek.
- Single Base Propellant Spills Area
    - Probably happened when moving – spillage of process propellants
    - Scraps would be taken to the Safety Thermal Treatment Point
    - Recovered solvents (ether and alcohol) that possible could spill
    - No major spills recalled, but granules may still be present at the site
- Other sites for disposal/burning could include a liquid fuel processing and storage operation which was done for the Air Force
- Other people who may be able to help include Ivan Tominack and Paul Mosher

- Paul should have lots of knowledge of the plants and Indian Head. He currently lives in Missouri (816-701-0620). He was an engineer in the pilot plant and production areas and his wife was a research chemist.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 11, 2003

Person Conducting the Interview/Title/Organization: Hien Dinh and Grant Heslin

Person Being Interviewed/Title/Organization: Wes Pero – IHDIV-NSWC Safety Department Head

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Interviewed to obtain general information.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

EOD Responses in the valley: 2 projectiles found

- 10/02 in vicinity of bldg. 54, an 8 inch projectile was discovered, was rendered safe and is now on display at the Safety Office (perfectly intact, painted blue)
- Second incident – old 12 inch gun projectile, was found partially buried near bldg. 705. The projectile was moved to the scrap yard for destruction.
- Other EOD responses: None come to mind
- Explosive Safety Arcs associated with NG – He has no information on this but will check into it and call either Hien or Grant.

- **Shocking the Point**: Safety Thermal Point and Strauss Thermal Treatment Area. Procedure was needed when NG slum burning was done on the ground.
    > In practice from start of NG production until about the mid-80's
    > Procedure involved putting 5 and 10-pound charges in the ground near the NG slum burning sites, and then detonate the charges. The shock wave would set off any NG pockets that formed in the ground. If left alone, the NG pockets could easily detonate with enough pressure and cause serious injury or death.
    > Since the mid 80's NG is burned in slum pans – not in ground, thus no need for "Shocking".

- Single Base Propellant spill at the Acid Plant. Material moved from Dry House and Blending houses (torn down) and transferred into trucks – spilling occurred during transfer.

- Early on in IH history, the Single Base Propellant operation and the necessary facilities took up the majority of the installation.
    > Sulphuric acid, Nitric acid, Powder plant, Powder live

- Wes Pero had no information on the Igniters found by Jeff Bossart
- Large motor testing… Hien has more information on his map.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 17, 2003

Person Conducting the Interview/Title/Organization: Heather Polinsky – MPI PM

Person Being Interviewed/Title/Organization: Peter Perry – retired IHDIV-NSWC

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Worked at Indian Head 30 years (1960's to 1990's)

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- The Cast Plant was also known as the Igniter Building.
- Igniters seen by Jeff Bossart in the Igniter Area may have been from the Cast Plant.
- He is not surprised that Igniters were found at the end of Greenslade Road.
- NG Slums was used to burn excess propellants, defective leftovers, old units from the fleet, and used old propellant. These items would burn instantaneously.
- The Single Base Productions was operating during his employment. He is aware of multiple spills in this area.
- FDR visited Indian Head in the 1920's while he was Secretary of the Navy. Public Affairs Office would have record of this.
- Additional contacts provided:
    - Jerry Volman – La Plata 301-934-2474
    - AJ Perk – White Plains
    - Robert Wilson – lives in Indian Head

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 19, 2003

Person Conducting the Interview/Title/Organization: Rhonda Stone, Team Leader-MPI

Person Being Interviewed/Title/Organization: Allison Poe – IHDIV-NSWC GIS Specialist

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Interviewed to obtain GIS files for the installation

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

The following GIS files were obtained from Ms. Poe:

- Updated IRP Map
- Utility layers for both Stump Neck and the Main Installation
- Endangered species information
- Potable wells located on Stump Neck and the Main Installation

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 18, 2003 (via telephone)

Person Conducting the Interview/Title/Organization: Denise Tegtmeyer & Doug Sawyers, Malcolm Pirnie, Inc.

Person Being Interviewed/Title/Organization: Diana Rose – Indian Head Environmental Department, currently Water Team Leader; worked in Environmental Department at base since 1988

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Identified as person to answer water discharge permit

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Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Contact John Tominack, NOSA, (301)744-4534/4450 to see what permits were here prior to 1985, I was not here until 1988.

Heard of small ponds at Stump Neck that were filled with water for testing by EOD techs

About 5 years ago, but ponds were always there
General area of Stump Neck Impact Area
Ponds may still be there
Carey Yates (now in R&D) would have more information

The Valley

Sewer discharge runs underground along the Valley and discharges to the Potomac River
Sewage Treatment Plant is nearby

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 21, 2003

Person Conducting the Interview/Title/Organization: Grant Heslin

Person Being Interviewed/Title/Organization: Lou Scalafari – IHDIV-NSWC
Retired Architect

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Interviewed to obtain general information.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- Initially project engineer; '85 Demolitions Coordinator; '89 – Architect: Master Planning – Co-wrote IH individual master plan.
- Were Pre-development UXO sweeps done routinely? Yes, but cursory
  UXO responses? None that he knows of.
- Future development plans? Knows of no changes or updates to last published Master Plan.
  Individual Installation MPs no longer done… only on a regional basis now.
  Speak to Bill Fini for more information on Planning
- Archeological Study along railroad?
  In general archeological study done annually
- Single Base Repellant Grain Spill? Doesn't know much about the incident but is sure that there are still grains in bldg. 453 on and around the loading dock. Most of the old propellant manufacturing buildings still have chemical debris scattered about.

- While he was in service, all buildings identified for demolition were cleaned-up per Indian Head SOP.

Interview Record

Installation/Range or Site: Indian Head, Maryland

Date/Time: November 20, 2003

Person Conducting the Interview/Title/Organization: Rhonda Stone & Denise Tegtmeyer, Malcolm Pirnie, Inc.

Person Being Interviewed/Title/Organization: Jonathan Stacey, Cultural Resources, Indian Head

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Cultural Resources POC

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- All of Stump Neck was searched for cultural resources. The August 1996 report "Phase I Cultural Resources Survey of Stump Neck Annex and Supplemental Architectural Investigations, Indian Head NSWC, Charles County, Maryland" presents the results. The maps show where the shovel tests were done and the items that were found.
- Development at the marina
    - More information may be available from the pipe-laying project.
    - The drawings in the 'Vault' can be checked to verify construction of the buildings within The Valley. The text on the drawings may also be useful.
    - Fill was used in the marina area.
    - Should be able to assume there was nothing at The Valley prior to its construction other than fishing shacks on a pier.
    - The railroad may just be buried instead of formally removed.

- No remnants of past structures were found during the redevelopment.

- IED area is included in an in-progress base wide ecological assessment. Generally regarding the consolidation of buildings.

- It was proposed that the IOD area would go to the Marines for IED work, however it is in the bald eagle habitat.

- The Rum Point Skeet Range is also in the bald eagle habitat.

- The Rum Point Skeet Range may be used by EOD in the future.

- The original PAs that OESO has would identify who first put the sites on the map.

- FDR Skeet Range is on a 1942 map. It shows three buildings including the outhouse, high & low buildings. The outhouse is still present at the site. It also shows the stone building, piers, and dock. The stone building remaining in the area of the FDR Skeet Range was most likely associated with the docks and recreation area.

- The 1952 map shows the FDR Skeet Range Buildings too. It also show the magazines constructed near the proposed location of the NG Slums.

- The 1963 map shows the same information as the 1952 map.

- A 1966 map shows explosive arcs. No arcs are shown in the area of the NG Slums. Older maps may be available in the 'vault.'

- Refer to copies of historic maps for complete details. Sites included in the maps include NG Slums, FDR Skeet Range, Safety Thermal Treatment Point, Single Base Propellant Grains Spill Area, and The Valley.

<u>Site Specific Questions asked:</u>

- Since the Master Plan for IH is dated 1990 what are the current future use plans for:
  - IED Site – Being consolidated and size decreased. TECHDIV is the tenant, so they would know.
  - IOD Site – Was going to be given to the Marines for training, but it wasn't because of the Eagle Habitat.
  - The installation is currently in the process of doing a basewide EA to review all processing and develop the future plans for all of the sites.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 18, 2003

Person Conducting the Interview/Title/Organization: Hien Dinh and Grant Heslin

Person Being Interviewed/Title/Organization: Dave Stewart – IHDIV-NSWC Public Works/Utilities

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Interviewed to obtain general information.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

- Knew of EOD response, projectile discovered near south west corner of Bldg #54 – General Storehouse; he estimates sometime in 1999. (Wes Pero says 10/02)
- Knew of other EOD response at bldg #705 – a projectile was discovered that was later accidentally detonated, and a man lost his leg.
- He remembers hearing that in vicinity of bldg #900, as his crew was preparing to build a new parking lot; some ordnance was dug up. This was never confirmed by another source, but Dave says he's pretty sure that something was found. In any case, he suspects they were just training aides or duds. He called a coworker, Michael Swann, who stopped by and after looking, he also identified the parking lot at bldg #900 as a location where he thought some "duds" were found.
- Dave suggested talking to Frank James and Jim Humphries (sp?)
- Told us that Allison Poe could provide the GIS layers with all the utilities information.

- He knew of a single base propellant spill that occurred near the RR tracks when a train car flipped and dumped its load. Check Hien's notes for more detail.

Interview Record

Installation/Range or Site: IHDIV-NSWC

Date/Time: November 19, 2003

Person Conducting the Interview/Title/Organization: Shelly Kolb, Malcolm Pirnie

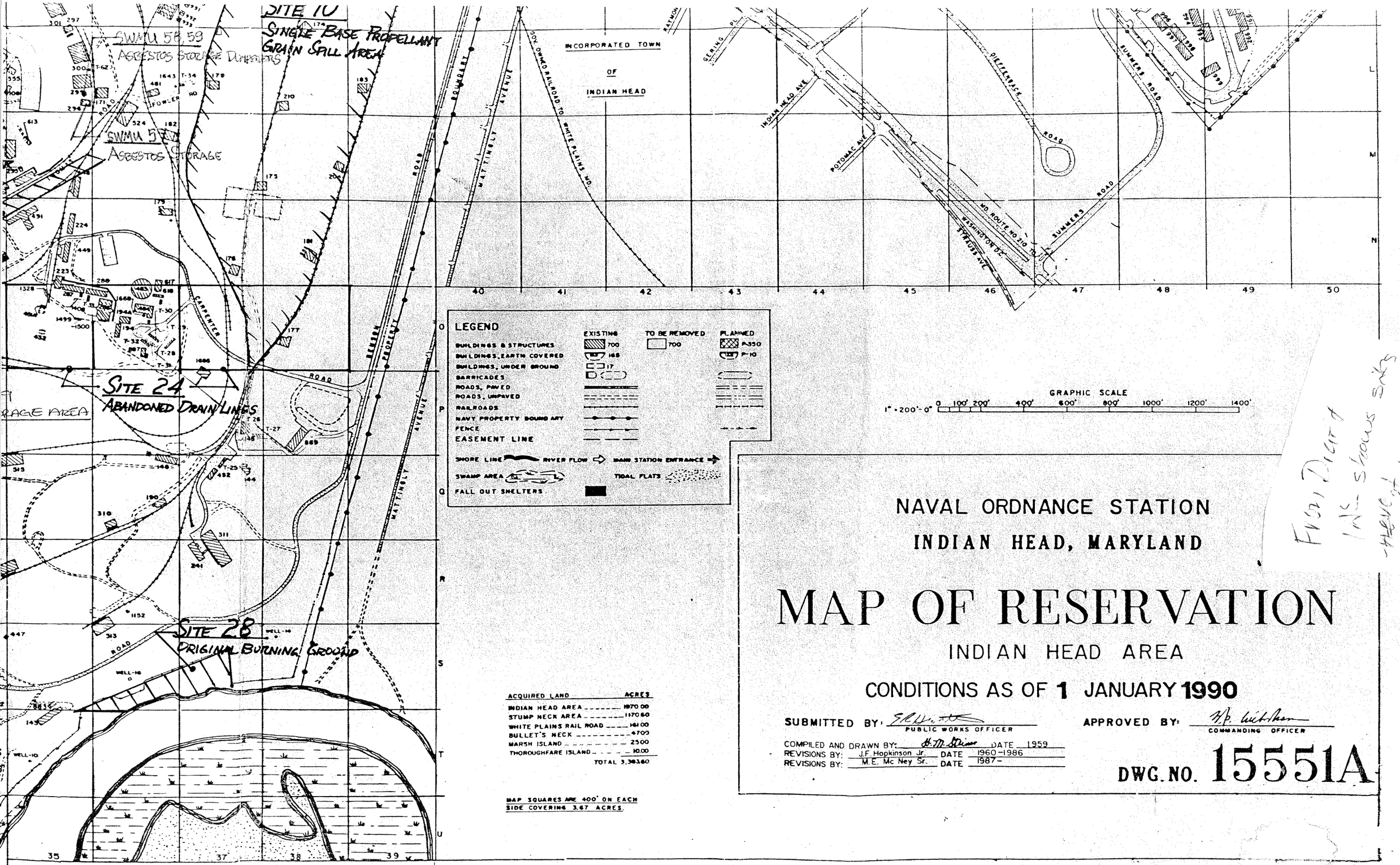
Person Being Interviewed/Title/Organization: Ivan Tominack, Retired from NSWC, Indian Head in June 1988

Reason for Selecting Person to Interview (i.e., Years at Installation, Position, Previous History, etc.): Ivan was once in charge of the burning points. He was interviewed to gain information regarding a potential new burning point location. He worked for EOD in 1951 and in the Cast Plant for 14 months in 1964-1965.

Interview Notes (i.e., Range History, Ordnance Types, Land Use, Historical Records/Maps Available):

Mr. Tominack transferred to the extrusion plant in 1955 from the Cordite Plant. He was there from approximately 1956-1961. During that time he was in charge of the burning points only during the C.P. tenure.

    - Retired USMC EOD after 26 years
- Michael Baker
    - School in 1958 plus refreshers and instructor in 1966-67
    - Retired USMC EOD after 30 years
- Range 6 – two weeks of basic training at Range 6 at the end of the point
- CONEX boxes shipped in from Vietnam with Ordnance
    - Russian and Japanese ordnance
    - See 'History by Bart'
    - May have been used at Stump Neck
- Old EOD School is now SEABIRTH – Marines at Lejeune
- IED Building – only 50 caliber used
- Air Blast Pond
    - Not used in 1976
    - Overgrown by 1990
- Area 8
    - Training area for school
    - ½ lb blocks of TNT suspended in air to monitor training
- IED
    - Show students what you could do with explosives
    - Used GP radar
- Pre-history for impact area
- Old Skeet and Trap Area – always an open field
- Rum Point – still active, pneumatic cannons
- Pistol Range
    - 38 and 45 caliber and 9 mm
    - closed by 1990 for lead contamination
- Test Area
    - School would do 'rigging & digging'
    - Training, no explosives



LEGEND

	EXISTING	TO BE REMOVED	PLANNED
BUILDINGS & STRUCTURES	700	700	P-350
BUILDINGS, EARTH COVERED	165		P-10
BUILDINGS, UNDER GROUND	17		
BARRICADES			
ROADS, PAVED			
ROADS, UNPAVED			
RAILROADS			
NAVY PROPERTY BOUND ARY			
FENCE			
EASEMENT LINE			
SHORE LINE	RIVER FLOW	MAIN STATION ENTRANCE	
SWAMP AREA	TIDAL FLATS		
FALL OUT SHELTERS			

GRAPHIC SCALE
1" = 200'-0" 0 100' 200' 400' 600' 800' 1000' 1200' 1400'

ACQUIRED LAND	ACRES
INDIAN HEAD AREA	1970.00
STUMP NECK AREA	1170.60
WHITE PLAINS RAIL ROAD	161.00
BULLET'S NECK	47.00
MARSH ISLAND	25.00
THOROUGHFARE ISLAND	10.00
TOTAL	3,383.60

MAP SQUARES ARE 400' ON EACH SIDE COVERING 3.67 ACRES.

NAVAL ORDNANCE STATION
INDIAN HEAD, MARYLAND

MAP OF RESERVATION

INDIAN HEAD AREA

CONDITIONS AS OF 1 JANUARY 1990

SUBMITTED BY: _____ PUBLIC WORKS OFFICER

APPROVED BY: _____ COMMANDING OFFICER

COMPILED AND DRAWN BY: _____ DATE 1959
REVISIONS BY: J.F. Hopkinson Jr. DATE 1960-1986
REVISIONS BY: M.E. Mc Ney Sr. DATE 1987-

DWG. NO. 15551A

SITE INSPECTION RECOMMENDED

VISITED – NO FURTHER ACTION RECOMMENDED

NEXT NEESA VISIT

NOS CURRENT OPERATIONS RECOMMENDATIONS
CHESDIV IR RECOMMENDATIONS

IAS SITES

ABC 123 SWMU SITES

DRAFT 1.
LARGE MOTOR
TEST AREA

DRAFT 2.
DRAINAGE DITCH AT
MOTOR PREP BLDG

AOC B.
IAS # 3
FORMER WITR

SWMU G
SAND BLASTING
SAND STORAGE AREA

SWMU #20
SAFETY BURN PT

RCRA closure

TRENCH (BLDG 890)
STRAND BURNING
FACILITY

DRAFT 20
SLUM PITS
BURN AREA

SWMU 56
SPENT FIXER STORAGE

SITE 6
RADIOGRAPHIC FACILITY
OPEN DRAIN

SITE 5
X-RAY BLDG.
OPEN DRAIN

SWMU 55
SPENT FIXER STORAGE

SWMU 3
PCB STORAGE UNIT

STRAUSS AVENUE

GALLERY ROAD

LEARY ROAD

SCHUYLER ROAD

GLENNON ROAD

VOGELI ROAD

HELLWEG ROAD

OLSON ROAD

MERCER ROAD

MAIN BURN POINT

SWMU 37 & 38
CAFFEE Rd LANDFILL
& WASTE OIL STORAGE

SWMU 21
CAFFEE Rd. BURN PIT

SITE 11
CAFFEE Rd. LANDFILL

SITE 17
METAL PARTS DISPOSAL

SWMU 36
RADIATOR (PAINT INCINERATOR)

CAFFEE

RUM POINT
GOV. PROPERTY

STUMP NECK
GOV. PROPERTY

MARINA

SWEDEN POINT

WATTA NOKA

L M N O P Q R S T U

-5 -4 -3 -2 -1 2 3 4 5 6 7 8 9 10 11

AOC B
IAS #3
FORMER NITRATION BLDG 673

SITE 3
NG EXPLOSION

SWMU 40-46
WASTEWATER COLLECTION/TREATMENT
(MOSER PLANT)

SWMU 47-51
SPENT ACID STORAGE/TREATMENT
(MOSER PLANT)

SWMU 22
SLURRY MIX WASTEWATER

SITE 30
TEST FIRING AREA

SITE 7
HMX SPILL

SITE 8
Hg WASTEWATER

SWMU 8
DRUM ACCUMULATION
SWMU 9 & 10
SPENT ACID STORAGE TANKS

SWMU #7
IAS #8
DRAIN SYSTEMS
SEDIMENTATION TRAP

SWMU 11
TOWN GUT LANDFILL

BLDG 334 LEAD CONTAM. IN DITCH FROM SCREEN CLEAN

HISTORICAL SITES

SITE 12
TOWN GUT
DISPOSAL SITE

SWMU 52
NG SLURRY STORAGE

HMX
OVEN
BUILDING

P O T O M A C

R I V E R

STRAUSS AVENUE

ROAD

MERCER ROAD

GREENBRIER ROAD

TRAVERSE ROAD

CAFFEE ROAD

BLOSH ROAD

ROMANY COURT

DRAFT 21
NITROGLYCERIN EXPLOSION
& OTTO FUEL II SPILL

IAS #18
HOG ISLAND
MERCURY
SLUDGE
HISTORICAL SITES

SITE 18
SEWAGE SLUDGE

IAS #21
BRONSON RD
LANDFILL AND
DITCHES NEAR
BLDG 479

AOC J.
SMALL MOTOR
TEST AREA

SITE 21
BRONSON RD. LANDFILL
(SWMU 16)

SITE 22
NG SLUDGE BURNING AREA
(SWMU 77)

SITE 23
HYD. OIL DISCHARGES
(SWMU 17, 16)

SWMU 52
NG SLUDGE DISPOSAL

TOWN GUT
DISPOSAL SITE

MARSH ISLAND
GOV. PROPERTY

BULLET'S NECK
GOV. PROPERTY
HISTORICAL SITE

THROUGHFARE ISLAND
GOV. PROPERTY

BLANDY ROAD

ROAD

NOBLE

BRONSON

C R E E K

N

1201 1512 1385 1508 1132 1675 735 733 1223 788 (Well #17) 823 734 P-833 736 1217 1214 1215 737 739 1216 1451 1737 804 809 806 801 807 803 1306 702 708 706 705 1745 298 1795 1213 1294 1216 1298 1720 335 1387 332 710 709 711 1303 878 336 337 (Well #18) 475 476 M 1384 478 477 1685 1209 1736 1148 1204 1230 1722 1723 1234 1725 1727 1235 1233 1487 1297 1287 946 1043 1374 1340 1393 1479 1717 1700 1352 1382 1383 1379 1378 1381 1380 1377 1376 1375 1373 1372 1371 1370 1369 1368 1367 1366 1365 1364 1363 1362 1361 1360 1359 1358 1357 1356 1355 1354 1353 1352 1351 1350 1349 1348 1347 1346 1345 1344 1343 1342 1341 1340 1339 1338 1337 1336 1335 1334 1333 1332 1331 1330 1329 1328 1327 1326 1325 1324 1323 1322 1321 1320 1319 1318 1317 1316 1315 1314 1313 1312 1311 1310 1309 1308 1307 1306 1305 1304 1303 1302 1301 1300 1299 1298 1297 1296 1295 1294 1293 1292 1291 1290 1289 1288 1287 1286 1285 1284 1283 1282 1281 1280 1279 1278 1277 1276 1275 1274 1273 1272 1271 1270 1269 1268 1267 1266 1265 1264 1263 1262 1261 1260 1259 1258 1257 1256 1255 1254 1253 1252 1251 1250 1249 1248 1247 1246 1245 1244 1243 1242 1241 1240 1239 1238 1237 1236 1235 1234 1233 1232 1231 1230 1229 1228 1227 1226 1225 1224 1223 1222 1221 1220 1219 1218 1217 1216 1215 1214 1213 1212 1211 1210 1209 1208 1207 1206 1205 1204 1203 1202 1201 1200 1199 1198 1197 1196 1195 1194 1193 1192 1191 1190 1189 1188 1187 1186 1185 1184 1183 1182 1181 1180 1179 1178 1177 1176 1175 1174 1173 1172 1171 1170 1169 1168 1167 1166 1165 1164 1163 1162 1161 1160 1159 1158 1157 1156 1155 1154 1153 1152 1151 1150 1149 1148 1147 1146 1145 1144 1143 1142 1141 1140 1139 1138 1137 1136 1135 1134 1133 1132 1131 1130 1129 1128 1127 1126 1125 1124 1123 1122 1121 1120 1119 1118 1117 1116 1115 1114 1113 1112 1111 1110 1109 1108 1107 1106 1105 1104 1103 1102 1101 1100 1099 1098 1097 1096 1095 1094 1093 1092 1091 1090 1089 1088 1087 1086 1085 1084 1083 1082 1081 1080 1079 1078 1077 1076 1075 1074 1073 1072 1071 1070 1069 1068 1067 1066 1065 1064 1063 1062 1061 1060 1059 1058 1057 1056 1055 1054 1053 1052 1051 1050 1049 1048 1047 1046 1045 1044 1043 1042 1041 1040 1039 1038 1037 1036 1035 1034 1033 1032 1031 1030 1029 1028 1027 1026 1025 1024 1023 1022 1021 1020 1019 1018 1017 1016 1015 1014 1013 1012 1011 1010 1009 1008 1007 1006 1005 1004 1003 1002 1001 1000 999 998 997 996 995 994 993 992 991 990 989 988 987 986 985 984 983 982 981 980 979 978 977 976 975 974 973 972 971 970 969 968 967 966 965 964 963 962 961 960 959 958 957 956 955 954 953 952 951 950 949 948 947 946 945 944 943 942 941 940 939 938 937 936 935 934 933 932 931 930 929 928 927 926 925 924 923 922 921 920 919 918 917 916 915 914 913 912 911 910 909 908 907 906 905 904 903 902 901 900 899 898 897 896 895 894 893 892 891 890 889 888 887 886 885 884 883 882 881 880 879 878 877 876 875 874 873 872 871 870 869 868 867 866 865 864 863 862 861 860 859 858 857 856 855 854 853 852 851 850 849 848 847 846 845 844 843 842 841 840 839 838 837 836 835 834 833 832 831 830 829 828 827 826 825 824 823 822 821 820 819 818 817 816 815 814 813 812 811 810 809 808 807 806 805 804 803 802 801 800 799 798 797 796 795 794 793 792 791 790 789 788 787 786 785 784 783 782 781 780 779 778 777 776 775 774 773 772 771 770 769 768 767 766 765 764 763 762 761 760 759 758 757 756 755 754 753 752 751 750 749 748 747 746 745 744 743 742 741 740 739 738 737 736 735 734 733 732 731 730 729 728 727 726 725 724 723 722 721 720 719 718 717 716 715 714 713 712 711 710 709 708 707 706 705 704 703 702 701 700 699 698 697 696 695 694 693 692 691 690 689 688 687 686 685 684 683 682 681 680 679 678 677 676 675 674 673 672 671 670 669 668 667 666 665 664 663 662 661 660 659 658 657 656 655 654 653 652 651 650 649 648 647 646 645 644 643 642 641 640 639 638 637 636 635 634 633 632 631 630 629 628 627 626 625 624 623 622 621 620 619 618 617 616 615 614 613 612 611 610 609 608 607 606 605 604 603 602 601 600 599 598 597 596 595 594 593 592 591 590 589 588 587 586 585 584 583 582 581 580 579 578 577 576 575 574 573 572 571 570 569 568 567 566 565 564 563 562 561 560 559 558 557 556 555 554 553 552 551 550 549 548 547 546 545 544 543 542 541 540 539 538 537 536 535 534 533 532 531 530 529 528 527 526 525 524 523 522 521 520 519 518 517 516 515 514 513 512 511 510 509 508 507 506 505 504 503 502 501 500 499 498 497 496 495 494 493 492 491 490 489 488 487 486 485 484 483 482 481 480 479 478 477 476 475 474 473 472 471 470 469 468 467 466 465 464 463 462 461 460 459 458 457 456 455 454 453 452 451 450 449 448 447 446 445 444 443 442 441 440 439 438 437 436 435 434 433 432 431 430 429 428 427 426 425 424 423 422 421 420 419 418 417 416 415 414 413 412 411 410 409 408 407 406 405 404 403 402 401 400 399 398 397 396 395 394 393 392 391 390 389 388 387 386 385 384 383 382 381 380 379 378 377 376 375 374 373 372 371 370 369 368 367 366 365 364 363 362 361 360 359 358 357 356 355 354 353 352 351 350 349 348 347 346 345 344 343 342 341 340 339 338 337 336 335 334 333 332 331 330 329 328 327 326 325 324 323 322 321 320 319 318 317 316 315 314 313 312 311 310 309 308 307 306 305 304 303 302 301 300 299 298 297 296 295 294 293 292 291 290 289 288 287 286 285 284 283 282 281 280 279 278 277 276 275 274 273 272 271 270 269 268 267 266 265 264 263 262 261 260 259 258 257 256 255 254 253 252 251 250 249 248 247 246 245 244 243 242 241 240 239 238 237 236 235 234 233 232 231 230 229 228 227 226 225 224 223 222 221 220 219 218 217 216 215 214 213 212 211 210 209 208 207 206 205 204 203 202 201 200 199 198 197 196 195 194 193 192 191 190 189 188 187 186 185 184 183 182 181 180 179 178 177 176 175 174 173 172 171 170 169 168 167 166 165 164 163 162 161 160 159 158 157 156 155 154 153 152 151 150 149 148 147 146 145 144 143 142 141 140 139 138 137 136 135 134 133 132 131 130 129 128 127 126 125 124 123 122 121 120 119 118 117 116 115 114 113 112 111 110 109 108 107 106 105 104 103 102 101 100 99 98 97 96 95 94 93 92 91 90 89 88 87 86 85 84 83 82 81 80 79 78 77 76 75 74 73 72 71 70 69 68 67 66 65 64 63 62 61 60 59 58 57 56 55 54 53 52 51 50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

SITE 1
THORIUM SPILL

SITE 29
'THE VALLEY'
TEST FIRING AREA
(A37-041)

SWMU #2
IAS #2
TORRENCE ROAD

SITE 2
WASTE OIL
(SWMU 75)

SWMU 23
SEWAGE TREATMENT PLANT

SWMU 4
USTs

SWMU 5
USTs

SWMU #6
USED BATTERY
ACCUM. AREA

SITE 4
OIL SPILLS
(SWMU 76)

SITE 9
OIL SPILL

1007 & 1009
PROPELLANT
CONTAMINATED
DITCHES

INGRED WEIGH
EXHAUST &
DRAINAGE

SWMU 53 & 54
SPENT FIXER
STORAGE TANKS

MERCURY CONTAM.
OF BLDGS 101, 102, 103 CRAWL SPACE,
356, AND SEWER LINES FOR
ENTIRE AREA

SITE 16
CHEM. LAB DISPOSAL
(SWMU 60)

SWMU 13
DRUM ACCUMULATION

SWMU #14
IAS #14
WASTE ACID PIT

SITE 14
WASTE ACID DISPOSAL PIT
SWMU 38

SWMU 2
ACTIVE CONTAINER
STORAGE UNIT

SITE 13

SWMU #27
WASTE OIL STORAGE
DRAFT 37
GODDARD POWER PLANT (BLOW DOWN WATER)

SITE 10
SINGLE BASE PROPELLANT GRAIN SPILL AREA

SWMU 58,59
ASBESTOS STORAGE DUMPSTERS

SITE 19
CATCH BASINS AT CHAIR COLLECTION HOLES

SWMU 25,26,28
GODDARD FLY ASH SYSTEM & O/W SEPARATOR

SITE 15
B, H, F WASTEWATER (SWMU 15)

SWMU 57
ASBESTOS STORAGE

DRAFT 33
ETHYL LACTATE & BUTYL ACETATE SPILLS

SITE 20
SINGLE BASE POWDER FACILITIES

SWMU 29
ACID NEUTRALIZATION TANK

SWMU 30-32
COLLECTION SUMP AND NEUTRALIZATION

SWMU 78
TEMPORARY SOLVENT STORAGE

SWMU 33-35
WASTEWATER SUMP AND SETTLING TANKS

SWMU 64,65,66
WASTEWATER STORAGE TANKS

SWMU #39
DRUM STORAGE AREA

SITE 24
ABANDONED DRAIN LINES

SITE 25
HYD DISCHARGES FROM X-RAY BLDG

SITE 23
HYD. OIL DISCHARGES (SWMU 17,18)

SITE 26
THERMAL DESTRUCTOR 2 (SWMU 63)

DRAFT 45
SILVER NITRATE SPILL

DRAFT 45
SILVER NITRATE SPILL

FENCELINE TRANSFORMER STORAGE

SITE 27
THERMAL DESTRUCTOR 1 (SWMU 62)

SITE 28
ORIGINAL BURNING GROUND

UDMH HYDROGENATION BUILDING

SCRAP YARD TRANSFORMERS

TRANSFORMER FIELD

SWMU 1
INACTIVE CONTAINER STORAGE

24 25 26 27 28 29 30 31 35 37 38 39

SITE 1
THORIUM SPILL

SITE 29
'THE VALLEY'
TEST FIRING AREA
(A37-D41)

SWMU #2
IAS #2
TORRENCE ROAD

SITE 2
WASTE OIL
(SWMU 75)

SWMU 25
SEWAGE TREATMENT PLANT

SWMU 4
USTs

SWMU 5
SITE

SWMU #6
USED BATTERY
ACCUM. AREA

SITE 4
OIL SPILLS
(SWMU 76)

SITE 9
OIL SPILL

1007 & 1009
PROPELLANT
CONTAMINATED
DITCHES

INGRED WEIGH
EXHAUST &
DRAINAGE

SWMU 53 & 54
SPENT FIXER
STORAGE TANKS

MERCURY CONTAM.
OF BLDGS 101, 102, 103 CRAWL SPACE,
556, AND SEWER LINES FOR
ENTIRE AREA

SITE 16
CHEM. LAB DISPOSAL
(SWMU 60)

SWMU 13
DRUM ACCUMULATION

SWMU #14
IAS #14
WASTE ACID PIT

SITE 14
WASTE ACID DISPOSAL PIT
SWMU 39

SITE 13

SWMU 2
ACTIVE CONTAINER
STORAGE UNIT

DISPOSAL (SWMU 12)

CHEMICAL DISPOSAL PIT

SWMU #21
WASTE OIL STORAGE

DRAFT 37
GODDARD POWER PLANT (BLOW DOWN WATER)

SITE 19
CATCH BASINS AT CHIP COLLECTION HOLES

SWMU 25, 26, 28
GODDARD FLY ASH SYSTEM & O/W SEPARATOR

DRAFT 33
ETHYL LACTATE & BUTYL ACETATE SPILLS

SWMU 29
ACID NEUTRALIZATION

SWMU 30-32
COLLECTION SUMP AND NEUTRALIZATION

SWMU 78
TEMPORARY SOLVENT STORAGE

SWMU 33-35
WASTEWATER SUMP AND SETTLING TANKS

SWMU 64, 66
WASTEWATER STORAGE TANKS

SITE 15
B, H, F WASTEWATER (SWMU 15)

SITE 20
SINGLE BASE POWDER FACILITIES

SWMU #39
DRUM STORAGE AREA

SWMU 58, 59
ASBESTOS STORAGE DUMPSTERS

SWMU 5
ASBESTOS STORAGE

SITE 10
SINGLE BASE PROPELLANT GRAIN SAND AREA

SITE 24
ABANDONED DRAIN LINES

SITE 25
HYPO DISCHARGES
(SWMU 17, 18)

DRAFT 43
SILVER NITRATE SPILL

DRAFT 45
SILVER NITRATE SPILL

SITE 26
THERMAL DESTRUCTOR 2 (SWMU 63)

SITE 27
THERMAL DESTRUCTOR 1 (SWMU 62)

FENCELINE TRANSFORMER STORAGE

UDMH HYDROGENATION BUILDING

SCRAP YARD TRANSFORMERS

TRANSFORMER FIELD

SWMU 1
INACTIVE CONTAINER STORAGE

SITE 28
ORIGINAL BURNING GROUND

LEGEND

SITE 29
'THE VALLEY'
TEST FIRING AREA
(A37-041)

SWMU #2
IAS #2
TORRENCE ROAD

SITE 2
WASTE OIL
(SWMU 75)

SWMU 23
SEWAGE TREATMENT PLANT

SWMU 4
USTs

SWMU 5
USTs

SWMU #6
USED BATTERY
ACCUM. AREA

SITE 4
OIL SPILLS
(SWMU 76)

SITE 9
OIL SPILL

SWMU 2
ACTIVE CONTAINER
STORAGE UNIT

SITE 10

OHIO RIVER

PREVAILING WINDS
% ANNUAL DISTRIBUTION
WINTER
SUMMER

LEGEND

- Installation Boundary
- Ranges
- Electric Lines
- Wells (Monitoring/Potable)
- Sanitary Sewer
- Potable Water
- Water Lines (rw_utwatpip)
- Species Protection Areas

The Valley

Single Base Propellant Grains Spill Area

FDR Skeet Range

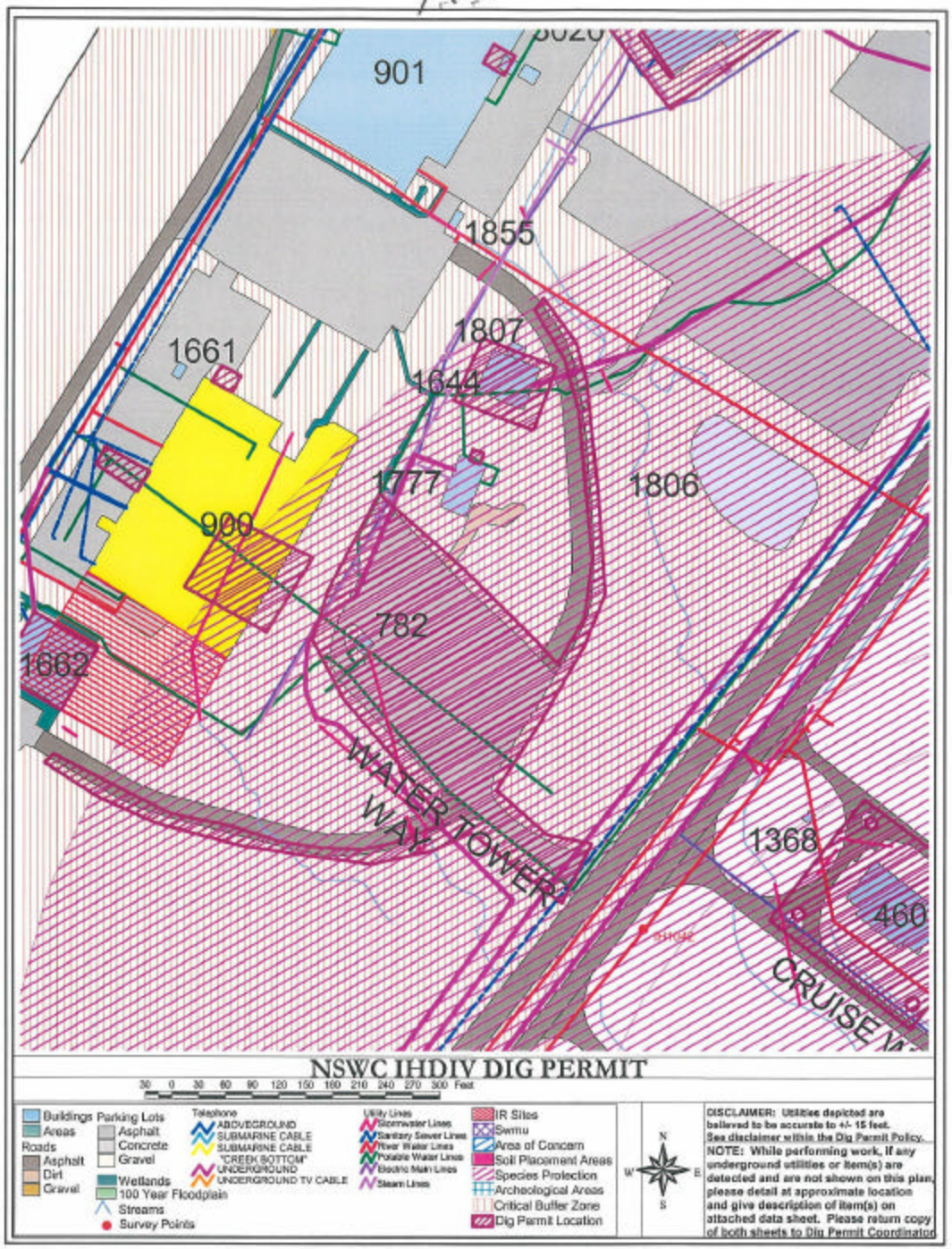
NG Slums Burning Ground

Igniter Area

Safety Thermal Treatment Point

N

Indian Head Utilities Data


901
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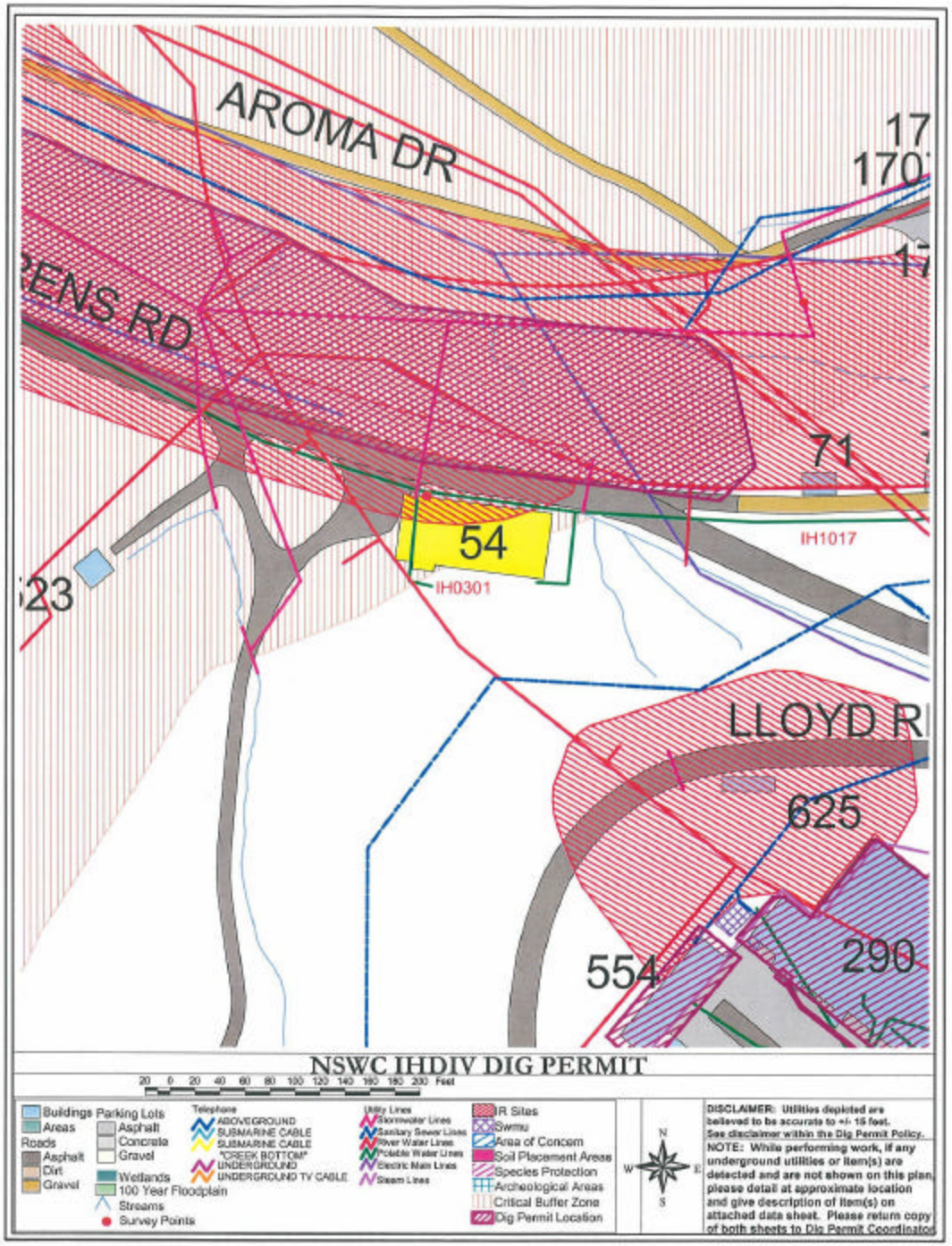
1662
WATER TOWER
1368
460
CRUISE
NSWC IHDIV DIG PERMIT
30 0 30 60 90 120 150 180 210 240 270 300 Feet
Buildings
Areas
Roads
Asphalt
Dirt
Gravel
Parking Lots
Asphalt
Concrete
Gravel
Wetlands
100 Year Floodplain
Streams
Survey Points
Telephone
ABOVEGROUND
SUBMARINE CABLE
SUBMARINE CABLE
"CREEK BOTTOM"
UNDERGROUND
UNDERGROUND TV CABLE
Utility Lines
Stormwater Lines
Sanitary Sewer Lines
Fiber Water Lines
Potable Water Lines
Electric Main Lines
Steam Lines
IR Sites
Swmu
Area of Concern
Soil Placement Areas
Species Protection
Archeological Areas
Critical Buffer Zone
Dig Permit Location
N
W
E
S
DISCLAIMER: Utilities depicted are believed to be accurate to +/- 15 feet. See disclaimer within the Dig Permit Policy.
NOTE: While performing work, if any underground utilities or item(s) are detected and are not shown on this plan, please detail at approximate location and give description of item(s) on attached data sheet. Please return copy of both sheets to Dig Permit Coordinator


AROMA DR
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54
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NSWC IHDIV DIG PERMIT
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Buildings
Areas
Roads
Asphalt
Dirt
Gravel
Parking Lots
Asphalt
Concrete
Gravel
Wetlands
100 Year Floodplain
Streams
Survey Points
Telephone
ABOVEGROUND
SUBMARINE CABLE
SUBMARINE CABLE
"CREEK BOTTOM"
UNDERGROUND
UNDERGROUND TV CABLE
Utility Lines
Stormwater Lines
Sanitary Sewer Lines
River Water Lines
Potable Water Lines
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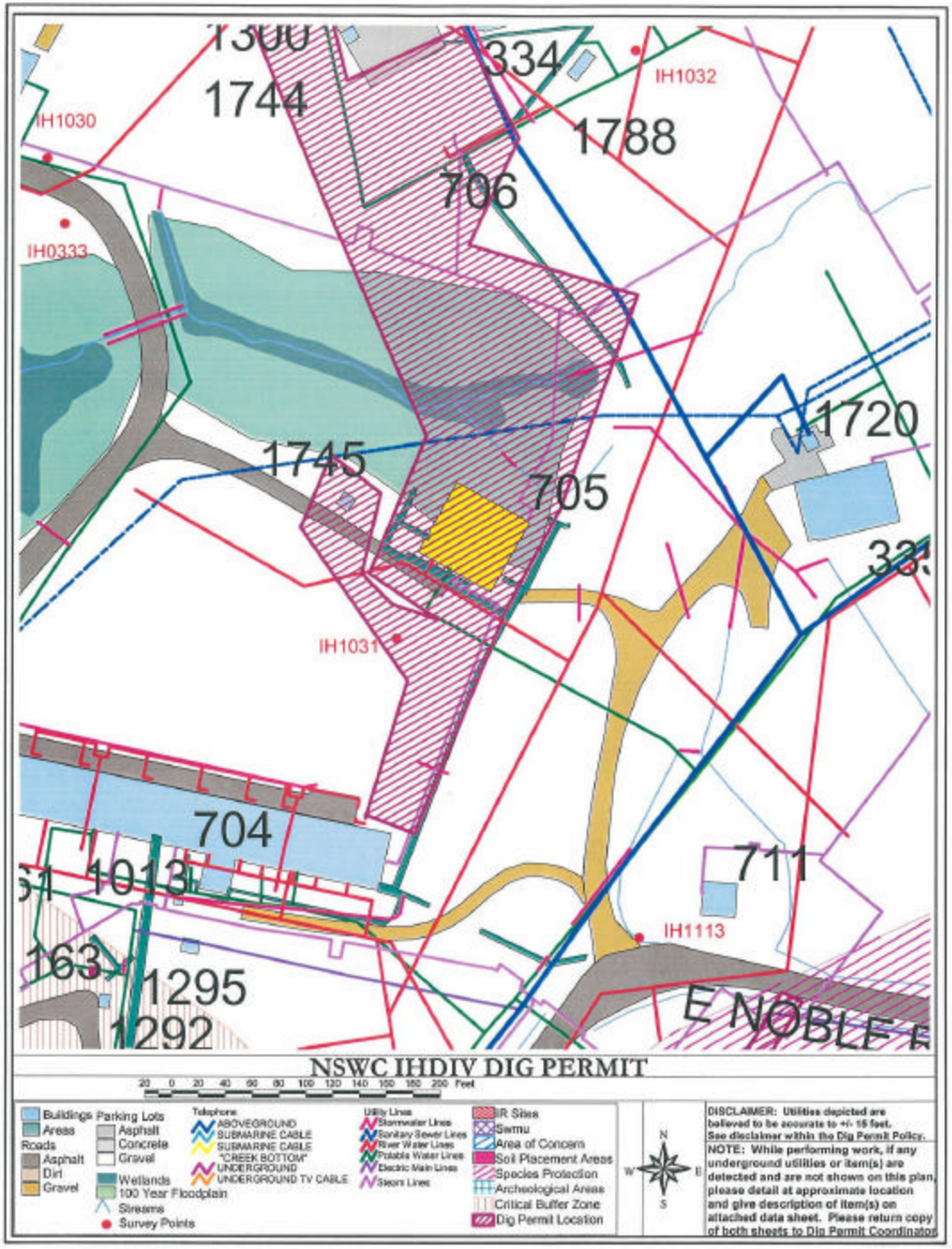
1300
1744
334
IH1032
IH1030
1788
706
IH0333
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705
IH1031
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IH1113
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1295
1292
E NOBLE
NSWC IHDIV DIG PERMIT
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Buildings
Areas
Roads
Asphalt
Dirt
Gravel
Parking Lots
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Gravel
Wetlands
100 Year Floodplain
Streams
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ABOVEGROUND
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River Water Lines
Potable Water Lines
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Soil Placement Areas
Species Protection
Archeological Areas
Critical Buffer Zone
Dig Permit Location
N
W
E
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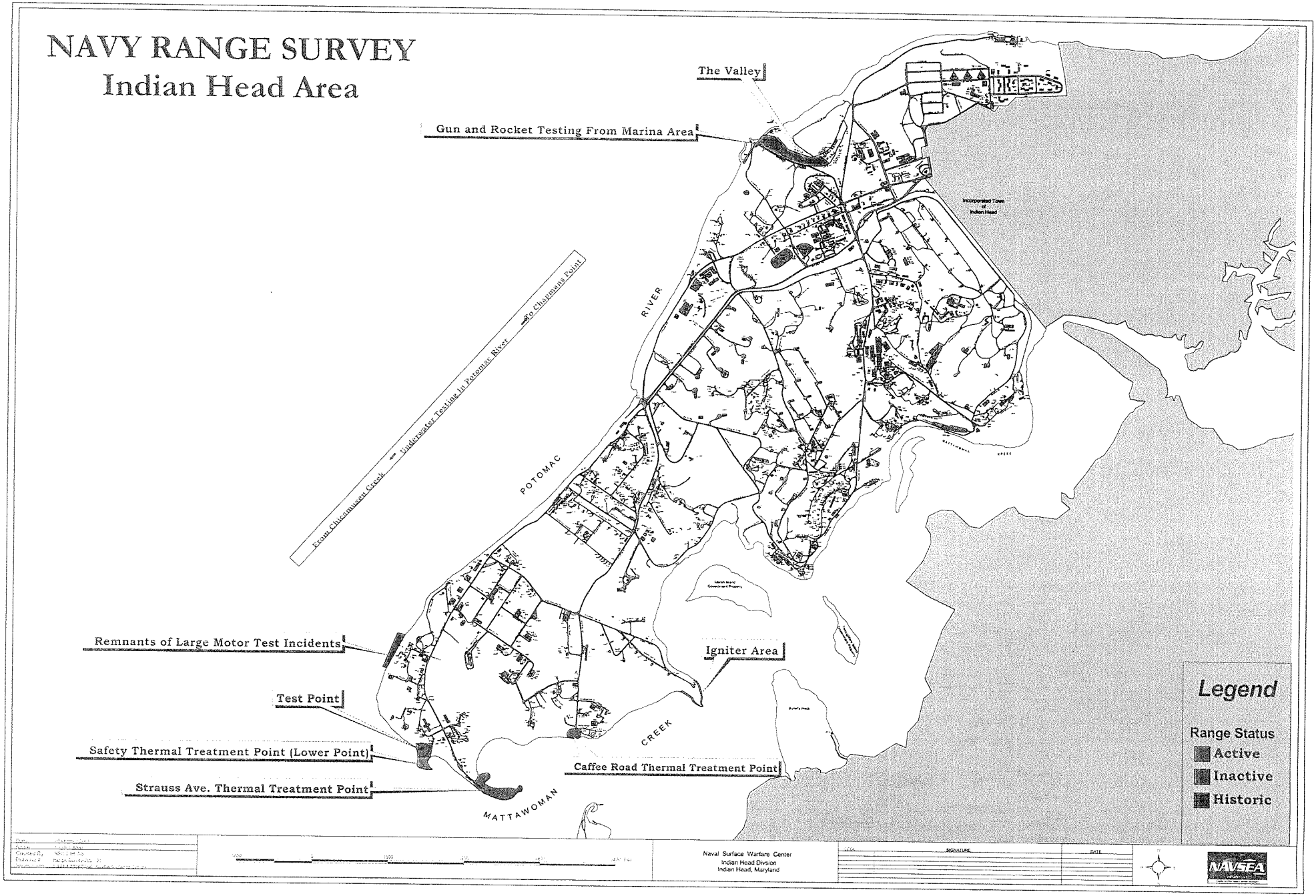
NOTE: While performing work, if any underground utilities or item(s) are detected and are not shown on this plan, please detail at approximate location and give description of item(s) on attached data sheet. Please return copy of both sheets to Dig Permit Coordinator

NAVY RANGE SURVEY
Indian Head Area

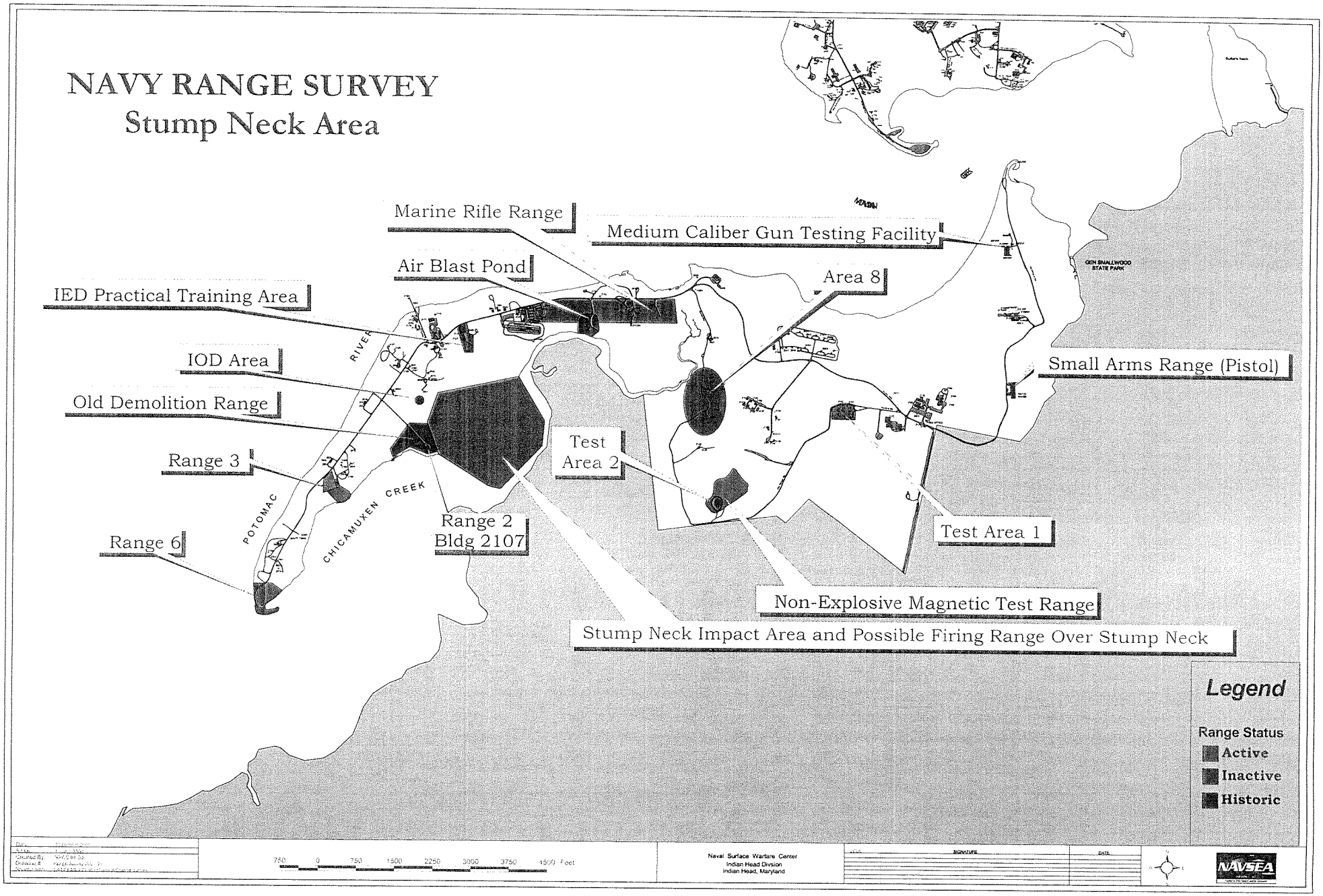


Naval Surface Warfare Center
Indian Head Division
Indian Head, Maryland

SIGNATURE DATE

NAVSEA

NAVY RANGE SURVEY
Stump Neck Area



LEGEND

- Installation Boundary
- Ranges
- Electric Lines
- Stump Neck Sanitary Sewer
- Wells (Monitoring/Potable)
- Potable Water
- Species Protection Areas

Safety Thermal Treatment Point

Old Skeet and Trap Range

Marine Rifle Range

Torpedo Burial Site

Air Blast Pond

Improvised Explosive Device (IED) Practical Trng

Inert Ordnance Devices (IOD) Site

Old Demolition Range

Stump Neck Impact Area

Area 8

Test Area 2

Rum point Skeet Range

Torpedo Casing Disposal Area

Test Area 1

Small Arms Range (Pistol Range)

N

Indian Head Utilities Data

Part Three: Active & Inactive Range Information

IX. Environmental Considerations:

D. Is there any information indicating the presence of any potential or known threatened/endangered species - flora and fauna - on the range?

See the attached State of Maryland Department of Natural Resources letter.

William Donald Schaefer
Governor

Maryland Department of Natural Resources
Tawes State Office Building
580 Taylor Avenue
Annapolis, Maryland 21401

Torrey C. Brown, M.D.
Secretary

January 14, 1992

Mr. P. Charles Mason
EN Safe
5724 Summer Trees Dr.
P.O. Box 341315
Memphis, TN 38184-1315

RE: Potential Superfund site at Indian Head. Area of interest is a 4 mile radius from Indian Head and 15 miles south of Indian Head along the Potomac River. Charles County

Dear Mr. P. Charles Mason:

This is in response to your request for information regarding the above referenced project.

Between the 1/4 and 3 mile radius of the Indian Head Division Naval Surface Warfare Center, is the boundary of the Mattawoman Natural Environmental Area. Enclosed is a copy of a summary report from November, 1987 on this area. This report will be updated shortly to reflect last year's field work. Mattawoman Creek is also an Historic Waterfowl Staging and Concentration Area (HWSCA).

Rare species present within this area are:

Scientific Name	Common Name	State Status
Nelumbo lutea	American lotus	Threatened
Bidens coronata	Tickseed sunflower	Endangered
Pilea fontana	Coolwort	Rare
Fraxinus profunda	Pumpkin ash	Endangered Extirpated*
Ludwigia decurrens		Rare

Telephone: _____
DNR TTY for the Deaf: 301-974-3683
(410) 974-2870

Within 1/2 mile of Indian Head we have a record for:

Haliaeeatus leucocephalus	Bald eagle	Endangered (Federally Endangered)

Within 1 mile, is Smallwood State Park.

Between the 1 and 3 mile radius of the site is Chicamuxen Creek Natural Heritage Area. Enclosed is a summary report on this NHA. We have records for these species within this area:

Scientific Name	Common Name	State Status
Smilax walteri	Red-berried greenbrier	Endangered
Haliaeeatus leucocephalus	Bald eagle	Endangered (Federally Endangered)
Botaurus lentiginosus	American bittern	In Need of Conservation
Arundinaria gigantea	Giant Cane	Threatened
Bidens coronata	Tickseed sunflower	Endangered
Farancia e. erytrogramma	Rainbow Snake	Endangered Extirpated*
Fraxinus profunda	Pumpkin ash	Endangered Extirpated*
Pilea fontana	Coolwort	Rare

We also have an Historic record for these species at Chicamuxen Creek Natural Heritage Area:

Aeschynomene virginica	Sensitive Joint-vetch	Endangered (Federally Threatened)
Liatris squarrosa	Scaling blazing-star	Endangered Extirpated
Ilex decidua	Deciduous holly	Threatened

This species is found within 3 miles of Indian Head near Mason Springs:

Rana virgatipes	Carpenter frog	In Need of Conservation

Within the 4 mile radius is Doncaster State Forest and Myrtle Grove Wildlife Management Area.

Along the Potomac River from Moss Point to Thomas Point we have records for:

Fraxinus profunda	Pumpkin ash	Endangered Extirpated*
Lophodytes cucullatus	Hooded merganser	Highly Rare
Smilax walteri	Red-berried greenbrier	Endangered
Hesperia attalus	Dotted skipper	Historical
Haliaeeatus leucocephalus	Bald eagle	Endangered (Federally Endangered)

The open water areas from Liverpool Point past Thomas Point have been identified as a Historic Waterfowl Staging and Concentration Area. The open waters all along the middle of the Potomac River are considered to be Historic Waterfowl Staging and Concentration Areas.

The forested areas within the site may be potential habitat for forest interior dwelling species.

Note: * This species is listed in COMAR 08.03.08.06 as endangered extirpated. However, viable, naturally occurring populations of this species have been found recently. When a species listed as endangered extirpated is relocated, the regulations state that it will be considered endangered and given protection afforded a State-listed endangered species.

If you have any questions regarding this information, contact Cynthia Sibrel at (410) 974-2870.

Sincerely,

Janet McKegg

Janet McKegg, Director
Natural Heritage Program

JM:cbs

cc: Cynthia Sibrel, Glenn Therres, Larry Hindman
Ren Serey, Jackie Madness
ER# 92830.CH

Enclosures: Mattawoman Creek Critical Area Site report
Chicamuxen Creek Natural Heritage Area Critical Area Site report

Chicamuxen Creek Natural Heritage Area
(Critical Area Site CH NHA-17)

County: Charles USGS Quad: Indian Head

SUMMARY OF ECOLOGICAL SIGNIFICANCE:

This Area is one of the best examples of a fresh tidal and non-tidal wetlands system in the State. In addition, at least six rare and endangered species are present. Tidal wetlands support Tickseed Sunflower (Bidens coronata), an Endangered plant species, and the American Bittern (Botaurus lentiginosus) which is In Need of conservation. Non-tidal wetlands support the Endangered Red-Berried Greenbrier (Smilax walteri), the Threatened Giant Cane (Arundinaria gigantea), and the uncommon Virginia Dayflower (Commelina virginica). Both types of wetlands are used by the Endangered Bald Eagle (Haliaeetus leucocephalus).

ELEMENT SUMMARY TABLE:

Element Name	Common Name	Status
Haliaeetus leucocephalus	Bald Eagle	Endangered
Bidens coronata	Tickseed Sunflower	Endangered
Smilax walteri	Red-berried Greenbriar	Endangered
Arundinaria gigantea	Giant Cane	Threatened
Botaurus lentiginosus	American Bittern	In Need of Conservation
Commelina virginica	Virginia Dayflower	Watch List

OTHER VALUES AND SIGNIFICANCE:

Habitat still exists for the following three species which historically occurred in the Area:

Sensitive Joint-vetch (Aeschynomene virginica), an Endangered plant species

Scaly Blazing-star (Liatris squarrosa), an Endangered-Extirpated plant species

Rainbow Snake (Farancia erytrogramma), an Endangered reptile

The Area also supports colonial waterbirds, waterfowl, shorebirds, forest interior dwelling birds, beaver, and muskrat. Beds of submerged aquatic vegetation are also present.

THREATS AND MANAGEMENT NEEDS:

Timbering of non-tidal wetlands and excessive boat wakes appear to be the major immediate concerns. The latter could be mitigated by enforcing a no-wake restriction. The former concern as well as other potential threats could be precluded by adherence to the intent and specific provisions of the Critical Area Criteria. Specific criteria are discussed in the next section.

BOUNDARY DISCUSSION:

The Natural Heritage Area Boundary includes tidal and contiguous non-tidal wetlands and an upland slip of natural forest vegetation needed to prevent excessive runoff of sediment and other pollutants. Since non-tidal wetlands are contiguous with the minimum 100-foot limit of the Critical Area Buffer, the latter must be expanded to include them. As a result, almost the entire site falls inside the Buffer.

The following activities are specifically allowed by the Criteria in portions of Habitat Protection Areas in the Buffer, assuming rare and endangered species are not affected detrimentally:

Hunting
Fishing
Trapping
Educational Pursuits
Scientific observation
Non-commercial, passive recreation; e.g.,
  Hiking
  Nature photography [14.15.10.N]

Cutting of trees for personal use, if replaced on an equal basis and does not impair water quality or habitat value [14.15.09.01.C(5)c]

Individual private piers installed and maintained by the riparian landowner [14.15.03.01.C]

Public beaches, launching and docking facilities, fishing piers if 5 requirements are met [14.15.03.08]

One subdivision-owned slip, pier, or mooring buoy per 300 feet of shoreline [14.15.03.07]

Water-dependent research facilities [14.15.03.09]

Commercial water-dependent fisheries facilities [14.15.03.10]

The following activities are specifically disallowed in portions of Habitat Protection Areas inside the Buffer:

Development activities, including structures, roads, parking areas and other impervious surfaces, mining and related facilities, or septic systems
EXCEPT: Activities associated with acceptable water-dependent facilities [14.15.09.01.C]

Industrial and port-related facilities, and non-public marinas [14.15.03.05 and .06]

Bridges and utilities unless no feasible alternative exists [14.15.02.04.C(1)(b)]

Dredged spoil disposal except for:

a. backfill for permitted shore erosion protection structures
b. use in approved vegetated shore erosion projects
c. placement on previously approved channel maintenance spoil disposal areas
d. beach nourishment [14.15.03.04(7)]

Clearing of existing natural vegetation except

a. to provide access to private piers
b. to install or construct a legally permitted shore protection device or measure
c. to install or construct a legally permitted water-dependent facility [14.15.09.01.C(4)(e) & (5)(c)]

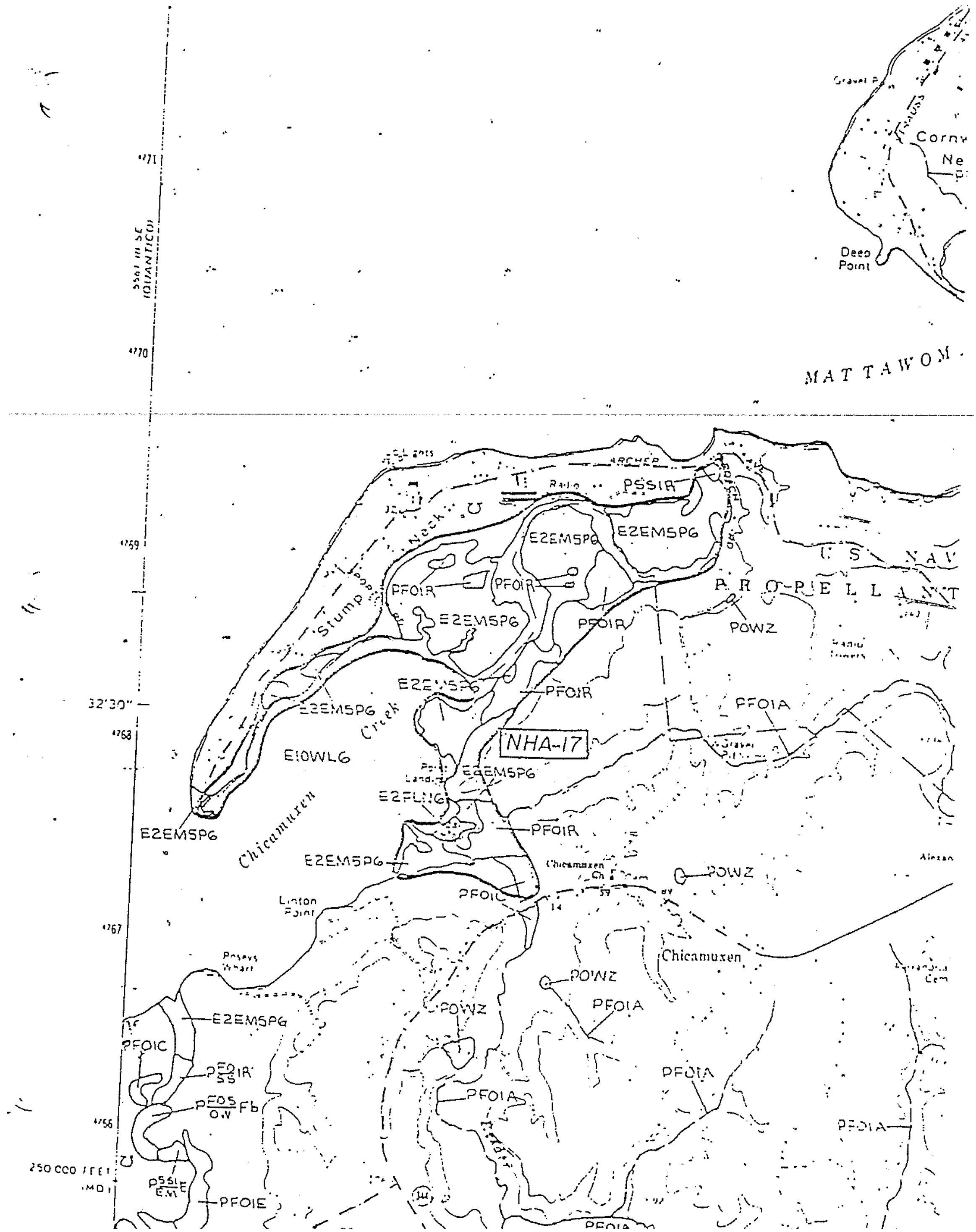
Farming activities, including the grazing of livestock [14.15.09.01.C(4)(F)]

Commercial harvesting of trees [14.15.09.01.C(5)(a)].

In addition to the above provisions, Habitat Protection Areas

for State-listed species are to be protected from development activities and disturbances "...unless it can be shown that these activities or disturbances will not have or cause adverse impacts on these habitats" [14.15.09.03.C(2)(a)]. To assure adequate enforcement of this provision, each proposed activity or disturbance should be reviewed on a site-by-site basis.

(July 1987)



Gravel Pit
Cornw
Deep Point
MATTAWOM
ARCHER
PSSIR
Neck
E2EM5P6
PFOIR
Stump
Creek
E2EM5P6
PROPELLANT
U S NAV
POWZ
PFOIA
NHA-17
E1OWL6
E2FLN6
Chicamuxen
Linton Point
Poseys Wharf
PFOIC
PFOIE
PFOIA
POWZ
32'30"
250 000 FEET

An increase in recreational boating or the use of power boats out of the main channel could damage the American Lotus plants.

Management Needs

Develop a right-of-way management program with the U.S. Navy which includes provisions for restricting herbicide use and for revegetating the railroad right-of-way for the purposes of reducing pollution and improving aesthetics.

Restrict boat traffic, particularly motorboats, to the main channel and enforce no-wake restrictions.

BOUNDARY DISCUSSION:

The Habitat Protection Area boundary encompasses American Lotus habitat, communities associated with the habitat, contiguous steep slopes along the shoreline, and a 100-foot strip of naturally forested vegetation along the edge of slopes.

Pursuant to the Critical Area Criteria, Habitat Protection Areas for State-listed species are to be protected from development activities and disturbances "...unless it can be shown that these activities or disturbances will not have or cause adverse impacts on these habitats" (14.15.09.03.C.(2)(a)). To assure adequate enforcement of this provision, each proposed activity or disturbance should be reviewed on a site-by-site basis. Since the Habitat Protection Area also falls within the Critical Area Buffer, the following provisions also apply.

The following activities are specifically allowed by the Criteria in portions of Habitat Protection Areas in the Buffer, assuming rare and endangered species are not affected detrimentally:

Hunting
Fishing
Trapping
Educational Pursuits
Scientific observation
Non-commercial, passive recreation; e.g.,
    Hiking
    Nature photography [14.15.10.N]

Cutting of trees for personal use, if
    replaced on an equal basis and
    does not impair water quality or
    habitat value [14.15.09.01.C(5)c]

Individual private piers installed and maintained by the riparian landowner [14.15.03.01.C]

Public beaches, launching and docking facilities, fishing piers if 5 requirements are met [14.15.03.08]

One subdivision-owned slip, pier, or mooring buoy per 300 feet of shoreline [14.15.03.07]

Water-dependent research facilities [14.15.03.09]

Commercial water-dependent fisheries facilities [14.15.03.10]

The following activities are specifically disallowed in portions of Habitat Protection Areas inside the Buffer:

Development activities, including structures, roads, parking areas and other impervious surfaces, mining and related facilities, or septic systems
EXCEPT: Activities associated with acceptable water-dependent facilities [14.15.09.01.C]

Industrial and port-related facilities, and non-public marinas [14.15.03.05 and .06]

Bridges and utilities unless no feasible alternative exists [14.15.02.04.C(1)(b)]

Dredged spoil disposal except for:

a. backfill for permitted shore erosion protection structures
b. use in approved vegetated shore erosion projects
c. placement on previously approved channel maintenance spoil disposal areas
d. beach nourishment [14.15.03.04(7)]

Clearing of existing natural vegetation except

a. to provide access to private piers
b. to install or construct a legally permitted shore protection device or measure
c. to install or construct a legally permitted water-dependent facility [14.15.09.01.C(4)(e) & (5)(c)]

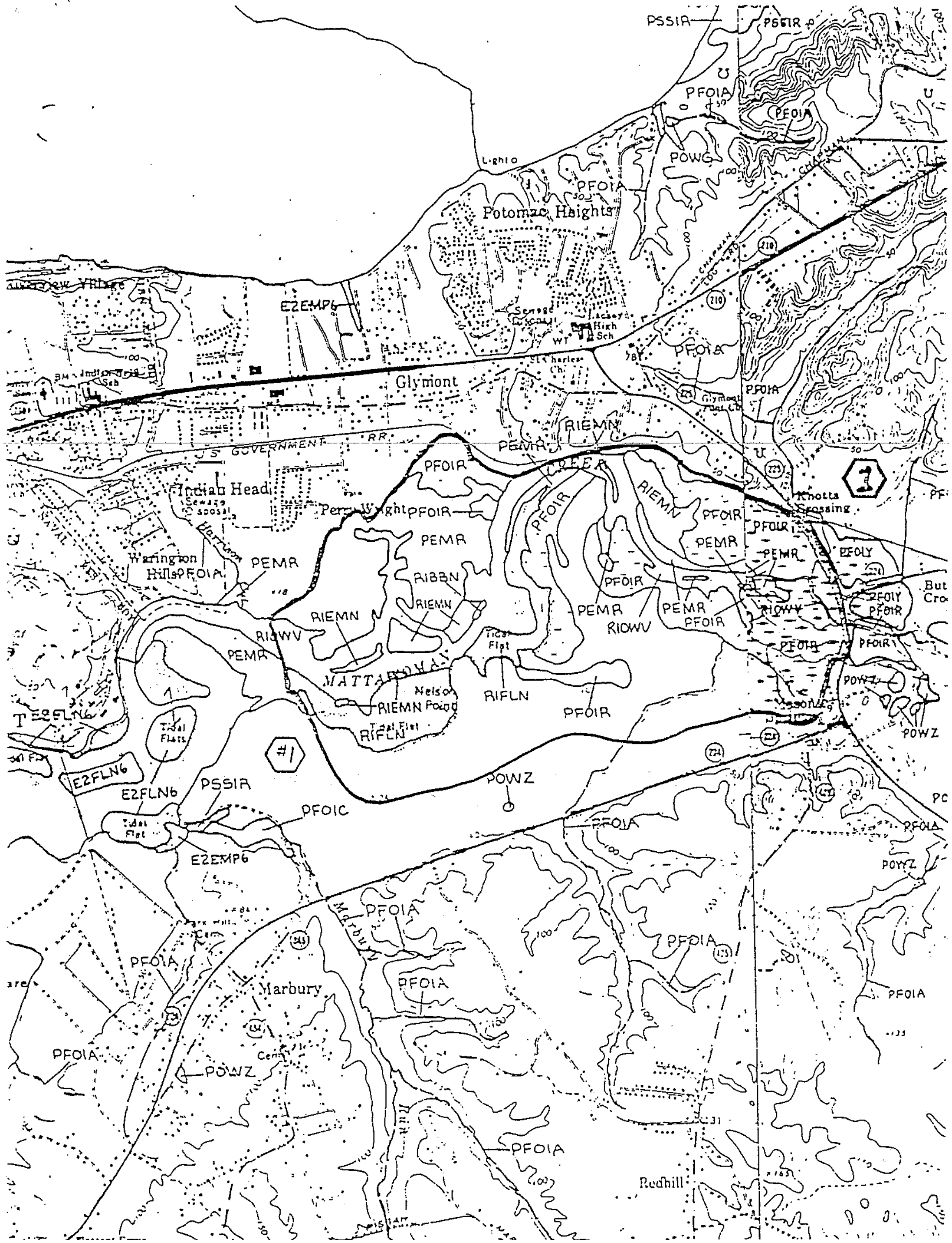
Farming activities, including the grazing of livestock [14.15.09.01.C(4)(F)]

Commercial harvesting of trees [14.15.09.01.C(5)(a)].

SITE DESCRIPTION SUMMARY:

The site is a complex of marshes, swamps, and upland forest along Mattawoman Creek. American Lotus grows in a protected shallow backwater area adjacent to an inlet of Mattawoman Creek. The American Lotus is interspersed with Spatterdock (Nuphar luteum) and is separated from the inlet, the main channel of Mattawoman Creek, and the shore by dense pure stands of Spatterdock. The water is about 6 inches deep at mid tide and the soil is fine-textured, high in organic matter, and mucky.

(November, 1987)



PSSIR
PFOIA
POWG
Potomac Heights
Glymont
Indian Head
Perry Wright
PEMR
PFOIR
RIEMN
RIBBN
RIOWV
RIFLN
PFOIC
E2EMP6
E2FLN6
PSSIR
POWZ
#1
Tidal Flats
Knotts Crossing
Marbury
Redhill
MATTAWOMAN
CREEK
US GOVERNMENT RR
Mason Springs
PFOIY

Magdinec Elaine A IHMD

To: Duffy Suzanne E NSSC

Cc: Mark Yeaton; Susan Adams; Jack Meyers

Subject: Range Datacall Response

Suzanne,

Enclosed is IHDIVNAVSURFWARCEN's response to the range datacall as requested in your e-mail dated November 9, 2000. It includes all ranges at Indian Head and Stump Neck. The file has all of the ranges on separate worksheets.

If you have any questions, please call me on 301 744 2264.

Thank You,
Elaine Magdinec

Insert Claimant Name:		
NAVSEA	*Insert Ranges:*	NAVEODTECHDIV RANGE 3
RANGE/OPAREA SELECTION CRITERIA	DETAILS	
Overall Strategic Value / Ranking	High/ Medium/ Low	HIGH
Is Range Part of Fleet Theater? (identify)	If yes, identify	NO
Primary Users	CLF, CPF, USMC, CNET, NAVSEA, NAVAIR, JOINT	NAVEODTECHDIV
Impact to Navy Mission		
Level of Use (frequency and number of operations)	High/ Medium/ Low	HIGH
Level of Training Provided	IDTC (Basic / Intermediate / Advanced), T/E	EOD SPECIALIZED TRAINING
Operational Capabilities	Airspace (A), Tactical Targets (TT), WISS, TACTS, Strafe, EW, UTR, LTS, Live and Inert Ordnance (LO/IO), NSFS, SACEX, etc.	OB, EOD RDT&E, EOD TRAINING
Unique Capability, if applicable (identify)		EOD RDT&E
Convenience of Location (home base to OPAREA)	High/ Medium/ Low	HIGH

Insert Claimant Name:		
NAVSEA	***Insert Ranges:***	NAVEODTECHDIV RANGE 2
RANGE/OPAREA SELECTION CRITERIA	**DETAILS**	
Overall Strategic Value / Ranking	High/ Medium/ Low	HIGH
Is Range Part of Fleet Theater? (identify)	If yes, identify	NO
Primary Users	CLF, CPF, USMC, CNET, NAVSEA, NAVAIR, JOINT	NAVEODTECHDIV
Impact to Navy Mission		
Level of Use (frequency and number of operations)	High/ Medium/ Low	HIGH
Level of Training Provided	IDTC (Basic / Intermediate / Advanced), T/E	N/A
Operational Capabilities	Airspace (A), Tactical Targets (TT), WISS, TACTS, Strafe, EW, UTR, LTS, Live and Inert Ordnance (LO/IO), NSFS, SACEX, etc.	EOD RDT&E
Unique Capability, if applicable (identify)		HIGH SPEED PHOTOGRAPHY, FLASH XRAY
Convenience of Location (home base to OPAREA)	High/ Medium/ Low	HIGH

Insert Claimant Name:		
NAVSEA	*Insert Ranges:*	STRAUSS AVENUE THERMAL TREATMENT POINT
RANGE/OPAREA SELECTION CRITERIA	**DETAILS**	
Overall Strategic Value / Ranking	High/ Medium/ Low	HIGH
Is Range Part of Fleet Theater? (identify)	If yes, identify	NO
Primary Users	CLF, CPF, USMC, CNET, NAVSEA, NAVAIR, JOINT	NAVSEA
Impact to Navy Mission		
Level of Use (frequency and number of operations)	High/ Medium/ Low	HIGH
Level of Training Provided	IDTC (Basic / Intermediate / Advanced), T/E	N/A
Operational Capabilities	Airspace (A), Tactical Targets (TT), WISS, TACTS, Strafe, EW, UTR, LTS, Live and Inert Ordnance (LO/IO), NSFS, SACEX, etc.	EXPLOSIVE HAZARDOUS WASTE OPEN BURNING
Unique Capability, if applicable (identify)		
Convenience of Location (home base to OPAREA)	High/ Medium/ Low	HIGH

Insert Claimant Name:		
NAVSEA	***Insert Ranges:***	CAFFEE ROAD THERMAL TREATMENT POINT
RANGE/OPAREA SELECTION CRITERIA	**DETAILS**	
Overall Strategic Value / Ranking	High/ Medium/ Low	HIGH
Is Range Part of Fleet Theater? (identify)	If yes, identify	NO
Primary Users	CLF, CPF, USMC, CNET, NAVSEA, NAVAIR, JOINT	NAVSEA
Impact to Navy Mission		
Level of Use (frequency and number of operations)	High/ Medium/ Low	HIGH
Level of Training Provided	IDTC (Basic / Intermediate / Advanced), T/E	N/A
Operational Capabilities	Airspace (A), Tactical Targets (TT), WISS, TACTS, Strafe, EW, UTR, LTS, Live and Inert Ordnance (LO/IO), NSFS, SACEX, etc.	OPEN BURN, THERMAL DECONTAMINATION
Unique Capability, if applicable (identify)		
Convenience of Location (home base to OPAREA)	High/ Medium/ Low	HIGH

Insert Claimant Name:		
NAVSEA	*Insert Ranges:*	TEST POINT
RANGE/OPAREA SELECTION CRITERIA	**DETAILS**	
Overall Strategic Value / Ranking	High/ Medium/ Low	HIGH
Is Range Part of Fleet Theater? (identify)	If yes, identify	NO
Primary Users	CLF, CPF, USMC, CNET, NAVSEA, NAVAIR, JOINT	NAVSEA
Impact to Navy Mission		
Level of Use (frequency and number of operations)	High/ Medium/ Low	HIGH
Level of Training Provided	IDTC (Basic / Intermediate / Advanced), T/E	N/A
Operational Capabilities	Airspace (A), Tactical Targets (TT), WISS, TACTS, Strafe, EW, UTR, LTS, Live and Inert Ordnance (LO/IO), NSFS, SACEX, etc.	GUN TESTING RANGE
Unique Capability, if applicable (identify)		
Convenience of Location (home base to OPAREA)	High/ Medium/ Low	HIGH

Insert Claimant Name:		
NAVSEA	***Insert Ranges:***	SAFETY THERMAL TREATMENT POINT
RANGE/OPAREA SELECTION CRITERIA	**DETAILS**	
Overall Strategic Value / Ranking	High/ Medium/ Low	LOW
Is Range Part of Fleet Theater? (identify)	If yes, identify	NO
Primary Users	CLF, CPF, USMC, CNET, NAVSEA, NAVAIR, JOINT	NAVSEA
Impact to Navy Mission		
Level of Use (frequency and number of operations)	High/ Medium/ Low	LOW
Level of Training Provided	IDTC (Basic / Intermediate / Advanced), T/E	N/A
Operational Capabilities	Airspace (A), Tactical Targets (TT), WISS, TACTS, Strafe, EW, UTR, LTS, Live and Inert Ordnance (LO/IO), NSFS, SACEX, etc.	OPEN BURN
Unique Capability, if applicable (identify)		
Convenience of Location (home base to OPAREA)	High/ Medium/ Low	HIGH

Insert Claimant Name:		
NAVSEA	*Insert Ranges:*	AIR BLAST POND
RANGE/OPAREA SELECTION CRITERIA	**DETAILS**	
Overall Strategic Value / Ranking	High/ Medium/ Low	LOW
Is Range Part of Fleet Theater? (identify)	If yes, identify	NO
Primary Users	CLF, CPF, USMC, CNET, NAVSEA, NAVAIR, JOINT	NRL
Impact to Navy Mission		
Level of Use (frequency and number of operations)	High/ Medium/ Low	LOW
Level of Training Provided	IDTC (Basic / Intermediate / Advanced), T/E	N/A
Operational Capabilities	Airspace (A), Tactical Targets (TT), WISS, TACTS, Strafe, EW, UTR, LTS, Live and Inert Ordnance (LO/IO), NSFS, SACEX, etc.	EXPLOSIVES TESTING ABOVE WATER TO MEASURE CONCUSSION FACTOR
Unique Capability, if applicable (identify)		
Convenience of Location (home base to OPAREA)	High/ Medium/ Low	HIGH

Insert Claimant Name:		
NAVSEA	*Insert Ranges:*	AREA 8
RANGE/OPAREA SELECTION CRITERIA	**DETAILS**	
Overall Strategic Value / Ranking	High/ Medium/ Low	LOW
Is Range Part of Fleet Theater? (identify)	If yes, identify	NO
Primary Users	CLF, CPF, USMC, CNET, NAVSEA, NAVAIR, JOINT	NAVSCOLEOD (CNET)
Impact to Navy Mission		
Level of Use (frequency and number of operations)	High/ Medium/ Low	LOW
Level of Training Provided	IDTC (Basic / Intermediate / Advanced), T/E	N/A
Operational Capabilities	Airspace (A), Tactical Targets (TT), WISS, TACTS, Strafe, EW, UTR, LTS, Live and Inert Ordnance (LO/IO), NSFS, SACEX, etc.	EOD TRAINING
Unique Capability, if applicable (identify)		
Convenience of Location (home base to OPAREA)	High/ Medium/ Low	HIGH

Insert Claimant Name:		
NAVSEA	*Insert Ranges:*	INERT ORDNANCE DEVICES (IOD) SITE
RANGE/OPAREA SELECTION CRITERIA	DETAILS	
Overall Strategic Value / Ranking	High/ Medium/ Low	LOW
Is Range Part of Fleet Theater? (identify)	If yes, identify	NO
Primary Users	CLF, CPF, USMC, CNET, NAVSEA, NAVAIR, JOINT	NAVSCOLEOD (CNET)
Impact to Navy Mission		
Level of Use (frequency and number of operations)	High/ Medium/ Low	LOW
Level of Training Provided	IDTC (Basic / Intermediate / Advanced), T/E	N/A
Operational Capabilities	Airspace (A), Tactical Targets (TT), WISS, TACTS, Strafe, EW, UTR, LTS, Live and Inert Ordnance (LO/IO), NSFS, SACEX, etc.	EOD TRAINING, INERT ORDNANCE DISPOSAL, SIMULATED DEACTIVATION OF UNEXPLODED ORDNANCE
Unique Capability, if applicable (identify)		
Convenience of Location (home base to OPAREA)	High/ Medium/ Low	HIGH

Insert Claimant Name:		
NAVSEA	*Insert Ranges:*	OLD DEMOLITION RANGE
RANGE/OPAREA SELECTION CRITERIA	**DETAILS**	
Overall Strategic Value / Ranking	High/ Medium/ Low	LOW
Is Range Part of Fleet Theater? (identify)	If yes, identify	NO
Primary Users	CLF, CPF, USMC, CNET, NAVSEA, NAVAIR, JOINT	NAVSCOLEOD (CNET)
Impact to Navy Mission		
Level of Use (frequency and number of operations)	High/ Medium/ Low	LOW
Level of Training Provided	IDTC (Basic / Intermediate / Advanced), T/E	N/A
Operational Capabilities	Airspace (A), Tactical Targets (TT), WISS, TACTS, Strafe, EW, UTR, LTS, Live and Inert Ordnance (LO/IO), NSFS, SACEX, etc.	EOD TRAINING
Unique Capability, if applicable (identify)		
Convenience of Location (home base to OPAREA)	High/ Medium/ Low	HIGH

Insert Claimant Name:		
NAVSEA	*Insert Ranges:*	RANGE 6
RANGE/OPAREA SELECTION CRITERIA	**DETAILS**	
Overall Strategic Value / Ranking	High/ Medium/ Low	LOW
Is Range Part of Fleet Theater? (identify)	If yes, identify	NO
Primary Users	CLF, CPF, USMC, CNET, NAVSEA, NAVAIR, JOINT	NAVSCOLEOD (CNET)
Impact to Navy Mission		
Level of Use (frequency and number of operations)	High/ Medium/ Low	LOW
Level of Training Provided	IDTC (Basic / Intermediate / Advanced), T/E	N/A
Operational Capabilities	Airspace (A), Tactical Targets (TT), WISS, TACTS, Strafe, EW, UTR, LTS, Live and Inert Ordnance (LO/IO), NSFS, SACEX, etc.	EOD TRAINING
Unique Capability, if applicable (identify)		
Convenience of Location (home base to OPAREA)	High/ Medium/ Low	HIGH

Insert Claimant Name:		
NAVSEA	*Insert Ranges:*	MEDIUM CALIBER GUN TEST FACILITY
RANGE/OPAREA SELECTION CRITERIA	**DETAILS**	
Overall Strategic Value / Ranking	High/ Medium/ Low	LOW
Is Range Part of Fleet Theater? (identify)	If yes, identify	NO
Primary Users	CLF, CPF, USMC, CNET, NAVSEA, NAVAIR, JOINT	NAVSEA
Impact to Navy Mission		
Level of Use (frequency and number of operations)	High/ Medium/ Low	LOW
Level of Training Provided	IDTC (Basic / Intermediate / Advanced), T/E	N/A
Operational Capabilities	Airspace (A), Tactical Targets (TT), WISS, TACTS, Strafe, EW, UTR, LTS, Live and Inert Ordnance (LO/IO), NSFS, SACEX, etc.	GUN TESTING RANGE
Unique Capability, if applicable (identify)		
Convenience of Location (home base to OPAREA)	High/ Medium/ Low	HIGH

Insert Claimant Name:		
NAVSEA	*Insert Ranges:*	IMPROVISED EXPLOSIVE DEVICE (IED) SITE
RANGE/OPAREA SELECTION CRITERIA	**DETAILS**	
Overall Strategic Value / Ranking	High/ Medium/ Low	LOW
Is Range Part of Fleet Theater? (identify)	If yes, identify	NO
Primary Users	CLF, CPF, USMC, CNET, NAVSEA, NAVAIR, JOINT	NAVSCOLEOD (CNET)
Impact to Navy Mission		
Level of Use (frequency and number of operations)	High/ Medium/ Low	LOW
Level of Training Provided	IDTC (Basic / Intermediate / Advanced), T/E	N/A
Operational Capabilities	Airspace (A), Tactical Targets (TT), WISS, TACTS, Strafe, EW, UTR, LTS, Live and Inert Ordnance (LO/IO), NSFS, SACEX, etc.	EOD TRAINING, TESTING FOR EXPLOSIVE POTENTIAL OF CHEMICAL MIXTURES
Unique Capability, if applicable (identify)		
Convenience of Location (home base to OPAREA)	High/ Medium/ Low	HIGH

11. Soil 13. Topography 14. Vegetation

NAME OF RANGE	NORM Name	NORM Number	FFA Number
Strauss Ave. Thermal Treatment Point			
Caffee Road Thermal Treatment Point			
Test Point			
Range 2			
Range 3			Site 58
Non-Explosive Magnetic Test Range (MTR)			
Safety Thermal Treatment Point (Lower Point)			
Medium Caliber Gun Testing Facility			
Small Arms Range (Pistol)			SWMU 29
Range 6	SWMU 00005	178	Site 61
Area 8	SWMU 00025	4684	Site 63
Improvised Explosive Devices (IED) Practical Training Area	SWMU 00026	4685	Site 64
Inert Ordnance Disposal (IOD) Area	SWMU 00027	4686	Site 65
Air Blast Pond	SWMU 00006	179	Site 62
Old Demolition Range	Site 00031	148	Site 31
Marine Rifle Range			
Test Area 1			
Test Area 2			
SN Impact Area and Possible Firing Range Over SN	Site 00030	147	Site 30
The Valley	Site 00029	146	Site 29
Underwater Testing in Potomac River			
Remnants of Large Motor Test Incidents			
Igniter Area			
Battle Range Firing			
Former Pinkwater Treatment Facility			SWMU 13
Torpedo Burial Site	Site 00035	152	Site 35
Single Base Propellant Grains Spill Area	Site 00010	157	Site 10
Old Skeet Range (Not included in range datacalls because not a military munition range but a recreational range)			SWMU 28

11. Soil
13. Topography
14. Vegetation

Are there fences around entire property at SN?

Vicki Writt -

Suzanne Duffy - 202 781 3437
Navsea & NSWC Guidance
If we close, special mgmt issues, regulators, progra
Can we reopen a closed range, CERCLA is not static

NORM Name	NORM Number
IR Site 00037	154
00022	139
00028	145

Torpedo Range (Torpedo Launch?) 37
NS [illegible] Burning Site 22
28

Magdinec Elaine A IHMD

From: Morris, Jeffrey W (EFACHES) [MorrisJW@efaches.navfac.navy.mil]
Sent: Monday, March 18, 2002 10:36 AM
To: 'Magdinec Elaine A IHMD'; Morris, Jeffrey W (EFACHES)
Cc: Heidi Morgan; Shawn Jorgensen
Subject: RE: NORM Data for Closed Ranges

Elaine,

See below. The first is the "Site Name", the second is the "Site", the third is the "Description".

Jeff

-----Original Message-----
From: Magdinec Elaine A IHMD [mailto:MagdinecEA@ih.navy.mil]
Sent: Monday, March 18, 2002 10:22 AM
To: MorrisJW@efaches.navfac.navy.mil
Cc: Heidi Morgan; Shawn Jorgensen
Subject: NORM Data for Closed Ranges

Hi Jeff,

Since our last e-mail, we've added 3 more range areas:
Causeway IR Site 37 00037, 154 (Causeway)
NG Slums Burning Site IR Site 22 00022, 139 (NG Slums Disposal Site)
Original Burning Ground IR Site 28 00028, 145 (Org Burning Ground)
Torpedo Casing Disposal Area (Not in NORM)

Could I ask you to please provide the NORM name and NORM number for the above IR sites? The Torpedo Casing Disposal Area is not an IR site but it is an alleged torpedo burial site near the water tower at Stump Neck so I am going to include it in the Closed Range Survey.

Thank You so much for your help,
Elaine Magdinec
IHDIVNAVSURFWARCEN Code 044EM
(301) 744-2264

IHDIVNAVSURFWARCENNOTE 5512
Code: 04

IHDIVNAVSURFWARCEN NOTICE 5512

From: Commander

Subj: HUNTING/TRAPPING SEASONS AND HARVEST LIMITS FOR 2003-2004

Ref: (a) IHDIVNAVSURWARCENINST 5512.7B
(b) Guide to Hunting and Trapping in Maryland 2003-2004

1. Purpose. To announce dates and harvest limits for the 2003-2004 hunting and trapping seasons.

2. Background. Hunting and trapping procedures and regulations are defined in references (a) and (b). Hunter safety on the Indian Head Division, Naval Surface Warfare Center (IHDIVNAVSURFWARCEN) and the Stump Neck Annex is of primary concern. Prior to being issued an Activity hunting and trapping permit, all hunters and trappers shall show proof of completion of a state certified Hunter Safety Course. Bowhunters must show proof of completion of an International Bowhunter Education Program Course. Courses completed in other states shall be honored. In addition, all white-tailed deer hunters shall qualify annually with either a firearm or bow.

3. Shooting Hours. General shooting hours, daily, and possession limits are listed in reference (b). Any modifications/exceptions to the general shooting hours are specified in reference (a). Migratory bird shooting hours, daily limits, possession limits, and regulations will be the same as the Maryland's Department of Natural Resources (MDDNR) and the United States Fish and Wildlife Service (USFWS) regulations.

4. Action.

a. Dates and harvest limits for the 2003-2004 hunting and trapping season are as follows (all dates are inclusive):

WHITE-TAILED DEER

Maryland Bonus Deer Stamps are applicable and required on IHDIVNAVSURFWARCEN and the Stump Neck Annex. Hunters may

harvest up to seven (7) deer combined for archery, firearm and muzzleloader seasons. At least five of the seven shall be antlerless. A deer is considered antlered if it has one or more hardened antlers visible, and greater than one inch above the hairline.

The first deer taken on IHDIVNAVSURFWARCEN and the Stump Neck Annex shall be antlerless. Only one antlered deer per hunter shall be taken from IHDIVNAVSURFWARCEN and the Stump Neck Annex. In addition, if a hunter takes three (3) male fawns (button buck), the hunter shall forfeit all antlered tags on the IHDIVNAVSURFWARCEN and the Stump Neck Annex for the current hunting season. Only two antlered deer can be taken annually. The daily limit is two deer.

Archery	19 Sep 03 - 31 Jan 04
Firearm	6,13 Dec 03; 10 Jan 04 (Saturdays Only)
Muzzleloader	18,25 Oct 03; 20,27 Dec 03; 3 Jan 04 (Saturdays Only)
Turkey	17, 24 Apr, 1, 8 15 & 22 May 04 (Saturdays Only) (1) bearded turkey per season

SPECIES	DATES	HARVEST LIMITS
MIGRATORY BIRDS		
*Canada Goose (Resident Early Season)	1-15 Sep 03	5 per day 10 possession
Mourning Dove	1 Sept - 18 Oct 03 13 Nov, 20 & 27 Dec 03 3 Jan 04 (Saturdays Only)	12 per day 24 possession
Woodcock	25 Oct 03 1, 8, & 15 Nov 03 10 & 17 Jan 04 (Saturdays ONLY)	3 per day 6 possession

Waterfowl shooting hours: Official hours are one-half hour before sunrise to sunset for all waterfowl hunting (except for September teal season, when shooting hours are from sunrise to sunset.)

*Evidence of participation in the Migratory Bird Harvest Program is necessary to hunt during this season (HIP sticker).

NOTE: Shooting hours for Mourning doves are 12 noon to sunset during the first split, and 1/2 hour before sunrise to sunset for the remaining two splits.

SPECIES	DATES	HARVEST LIMITS
UPLAND GAME		
Upland game shall be hunted on Saturdays and federal holidays per reference (a).		
Gray Squirrel	4 Oct 03 - 31 Jan 04	6 per day 12 Possession
Quail	1 Nov 03 - 14 Feb 03	6 per day 12 Possession
Rabbit	1 Nov 03 - 7 Feb 04	4 per day 8 Possession
Woodchuck	2 Aug 03 - 31 Jul 04	No limit
Crow	15 Aug 03 - 13 Mar 04 (Wed - Sat only)	No limit
TRAPPING		
Fox (Red or Gray)	2 Aug 03 - 31 Jul 04	No Limit
Beaver	1 Jan - 15 Mar 04 (Closed to Nonresidents)	No Limit
Muskrat and Mink	1 Jan - 15 Mar 04	No Limit
Otter	1 Jan - 15 Mar 04 (Closed to Nonresidents)	5 per season
Raccoon and Opossum	1 Nov 03 - 16 Feb 04	No limit

b. Holidays. Hunting shall be permitted on federal holidays during the Activity's hunting season. Holidays are subject to hunting day restrictions, per reference (a). All white-tailed deer hunting will be closed from 24 Dec-26 Dec.

c. Activity Hunting/Trapping Permit Fees. Activity permits for 2003-2004 are for ages 18 to 65, over age 65 requires no permit fees. The Morale, Welfare and Recreation Department (MWRITT) charges $.75 for an issuance fee for each hunting permit. The MWRITT office shall issue permits at Building 620, (301)744-4850, from Monday through Friday 0830 hours to 1630 hours.

A one-day permit shall be available to guests for $10.75 from the Natural Resources Office in Building D-327, phone (301)744-4705.

Categories-Permit Fees

Categories	E-6 & Below	E-7-03	04 & Above-Ret. Mil. & Active DoD Civ. IHD	Guests
Small Game	$ 5.00	$ 8.00	$15.00	$15.00
Waterfowl	$15.00	$25.00	$30.00	$35.00
Big Game	$15.00	$20.00	$25.00	$30.00
Trapping	$ 8.00	$10.00	$15.00	No Trapping
Combination/ Fishing Included	$25.00	$30.00	$40.00	$50.00

MARC A. SEIDBAND

Distribution:
(NIS) Networked Information Systems

Indian Head – Site Visit
23-27 June 2003

1. **Purpose of Site Visit**: To collect data needed to complete preliminary assessments (PAs) for munitions response sites identified in the Navy range and site inventory. To identify other sites potentially eligible for the Military Munitions Response Program (MMRP).

2. **Site Visit Data Collection Activities**:

- In-brief
- On-site office visits
  - Records review and reproduction
  - Interview with base personnel
- Site walk – visual survey
- Data compilation and analysis
- Exit Brief

3. **Typical On-site Offices Involved:**

- Environmental
- Publics Works
- Engineering/Facilities
- Real Property/Real Estate
- Range Control
- Explosive Ordnance Disposal (EOD)
- Geographical Information System (GIS) Department
- Base historian
- Ammo Supply Point

4. **Assistance Requested from Installation**:

- Access to archival files and records
- Copies of previous environmental studies
- Access to relevant offices/base personnel
- Copies of environmental administrative records
- Access to EOD response reports
- GIS/Map files

5. **Basic Data Requirements:**

- History of site(s) or area(s)
- Land use restriction & access controls
- History of UXO related response actions
- Range demographics
- UXO risk factors
- Basic environmental data

Preliminary Assessment Report Guidance
Small Arms Range Fact Sheet

This Fact Sheet has been developed to provide team leaders and their delivery teams with guidance while completing sections of the Preliminary Assessment Reports for Small Arms Ranges. The Fact Sheet is intended to be a tool in completing the reports and focuses on Skeet and Trap Ranges, Pistol Ranges, and Rifle Ranges. Dan Hains and Al Larkins are excellent resources to provide additional perspectives and answer questions regarding small arms ammunition and range related questions. Dan and Al should also be contacted to obtain the appropriate Ordnance Data Sheets for the ammunition used at your range(s). Amy Atamian and Svend Egholm should be consulted regarding mapping questions. Heather Polinsky and Susan Burtnett should be contacted to discuss questions related to how we are approaching small arms range issues in the PA reports.

Small Arms Range Terms

Range - A geophysically defined parcel of space (i.e., land, water, or air) that is delineated by specific geographic coordinates (i.e., 12 acres located at 000.00'00" by 000.00' 00"). For the purpose of the PA report, we also use the following definition: "A designated land or water area set aside, managed, and used for range activities of the DoD. Ranges include firing lines and positions, maneuver areas, firing lanes, test pads, detonation pads, impact areas, electronic scoring sites, buffer zones with restricted access and exclusionary areas, and airspace areas designated for military use in accordance with regulations and procedures prescribed by the Administrator of the Federal Aviation Administration.**"**

Surface Danger Zone (SDZ) - The ground and airspace designated within the training complex (to include associated safety areas) for vertical and lateral containment of ammunition, bullet fragments, target fragments, and debris resulting from the firing of small arms (weapons). For small arms ranges, the SDZ represented the portion of the former range that included the area where the weapons, when fired from the firing arc/line, were a potential hazard to personnel. The SDZ was used to define the area that included the firing arc/line, target area(s), impact area(s) (i.e., shotfall zone, backstop berm, etc.), ricochet trajectory area, and secondary danger area. The range boundary, in most cases, will include some portion of the SDZ, but typically does not include the entire SDZ.

Small Arms Range - A small arms range is an outdoor area used for practice firing of small arms, defined under the Navy MRP as .50 caliber or below. The types of ranges include, but are not limited to, skeet, trap, pistol, and machine gun ranges. Indoor ranges are not included in the Navy MRP. The use of year round range facilities was required to provide effective defense and security of Navy and Marine Corps stations,

as well as to meet and maintain proficiency requirements in marksmanship. (Reference: *NAVAER 00-100-504, dated March 1958)*.

Munitions Constituents (MC) - Munitions constituents include any materials originating from unexploded ordnance, discarded military munitions or other military munitions, including explosive and non-explosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions. Various technical documents include differing information regarding the constituents associated with small arms ammunition (see Table below). When defining MC at small arms ranges, bear in mind that lead is the primary MC of concern on small arms ranges as lead accounts for more than 85% of the weight of a projectile. PAHs are also primary MC of concern where clay targets were used. While lead is the MC most likely to be found in the environment and is of greatest environmental concern, we want to acknowledge that there are other MC associated with lead shot, shotgun shells, bullets, and/or the gunpowder used to propel the shells and bullets or gunpowder residue. For consistency purposes in preparing the PA reports, please use the descriptions included in the sections for Skeet and Trap Ranges and Pistol (and Rifle) Ranges unless there is strong evidence to the contrary. Note: At a small arms range, there should be no MEC identified. If you identified MEC, you need to include this in the report.

List of Contaminants Potentially Found at Small Arms Firing Ranges (NFESC, 1987)

Constituent	Comment
Lead	Primary constituent of a projectile
Lead Styphnate/Lead Azide	Primary constituent
Antimony	Increases hardness
Arsenic	Present in lead. A small amount is necessary in the production of small shot since it increases the surface tension of dropped lead, thereby improving lead shot roundness.
Copper bullet core alloy	Increases hardness
Tin	Increases hardness
Copper	Jacket alloy metal
Zinc	Jacket alloy metal
Iron	Iron tips on penetrator rounds
PAHs (Polycyclic Aromatic Hydrocarbons)	Concentration of PAHs in clay targets varies from one manufacturer to the next but may be as high as 1000mg/kg. Existing studies show that PAHs are bound within the limestone matrix of the target and are, therefore, not bioavailable.

The following sections provide relevant information that should be discussed in the PA report for small arms ranges. Information regarding skeet and trap ranges is presented first. Information regarding pistol, rifle, and machine gun ranges follows the skeet and trap range guidelines. The text is written in general terms and should be tailored to be site-specific for your range(s) in your report. These guidelines are not meant to be all inclusive in terms of report text, but rather should provide an overview of the level of detail needed. Please keep in mind that each range may vary in size and configuration. The team leader is responsible for making the PA report text specific to the site(s). If you have questions regarding your range, please call and discuss your issues early in the process.

Skeet and Trap Ranges

Note: The following section includes information for Skeet and Trap Ranges. The example text provided was written for a range that was a single field combination skeet and trap range. Skeet and trap ranges may include single field (i.e., a single firing arc) or multiple field (i.e., multiple firing arcs) skeet ranges, single field or multiple field trap ranges, or some combination of both.

History and Site Description

For the PA report, you should include the following information to describe the range:

- Describe size/location of the range: "The range consists of approximately (size in acres) and is located (give direction from a key landmark) in the (give general area) of the installation."
- Describe both military and recreational use and include dates of use: "The skeet club used the range on an almost daily basis for recreational purposes from ___, when the range was constructed, until ___, when it was closed. Military personnel also used the range for shotgun proficiency and moving target orientation training during this period."
- Describe the munitions use: "Munitions use was limited to 12, 16, and 20 gauge and .410 caliber shotgun ammunition."
- Describe other range features: "The two skeet houses, trap house, the firing arc, and the Gun Club Building (including building number if known) have been demolished and removed from the site."
- Describe other non-range features if present or if they existed in the past.

You should include a description of what you observed during the visual survey:

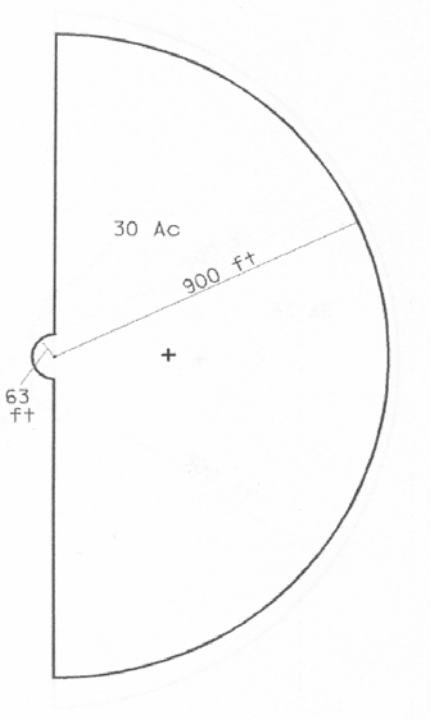
- Did you see shot/broken clay targets? Where? "During the visual survey, a limited number of broken clay targets were observed on the ground approximately ___ feet/yards (direction) of the former firing arc."
- Describe what is there now: "This portion of the range is not in use and vegetation is re-established in some areas."

- Describe other uses within the area where the range was located, both former and current: "Fallow agricultural fields and a concrete-lined irrigation canal, which were in use while the range was operational, are located on or adjacent to the northern, eastern, and western portions of the range. The fields have been fallow for the last three years and the irrigation canal is no longer used."
- Describe structures and use of structures currently at the site: "An inert storage building, asphalt-paved fenced storage area, and asphalt-paved parking area have been constructed on the southern portion of the site where the former range structures were located. This area is currently utilized by Navy personnel as a designated smoking area."

Include a discussion of your findings and a description of the range layout. You should base this on both historical records identified and knowledge of technical manuals and guidance documents. The following paragraph is provided as an example:

"Based on review of historical documents, aerial and still photographs, information obtained from interviews, and observations made during the visual survey, the (site name) was constructed and used as a single field shotgun range. According to Army Technical Manuals (referenced as AR 750-10 and TM 9-855) and the Navy Programming Guide (1958), the shooting field (i.e., firing arc) was laid out as a 63 foot radius semi-circle with concrete/asphalt walkways. The surface danger zone (which includes the down range hazard area and safety fan) consisted of a semi-circle with a 900-foot radius that utilized the same apex as the shooting field (see Figure). For a single field range, the acreage of the surface danger zone was approximately 30 acres.

The site boundary for the (site name), which includes approximately ____ acres, encompasses the firing arc, target area, and impact area where the lead shot and broken clay targets would be found. Whereas, the surface danger zone is the portion of the former range that represented the area where the weapons, when fired from the firing arc, could endanger personnel. The surface danger zone was used to define the area between the firing arc and target area, the impact area, the ricochet trajectory area, and the secondary danger area."



Note: For this example, the range boundary comprises an area that is smaller than the SDZ. The figure to the right shows the typical SDZ for a Single Field Shotgun Range (USACE, 2001). Additional range schematics are included at the end of this fact sheet in the Reference section.

Visual Survey Observations and Results

For this section of the report, you need to identify the Malcolm Pirnie team members that conducted the visual survey and the date of the survey. You should also include Navy representatives that were present. If you returned to the site, note the date and purpose of the return visit.

When describing the visual survey observations, make sure you include a description of the areas walked, site features noted, whether you observed lead shot or broken clay targets on the ground surface, and other relevant observations. For example:

"During the visual survey, the team walked the areas at the site best corresponding to the former locations of the firing arc, skeet houses, trap house, and target impact area. The team also walked the perimeter of the irrigation canal, a portion of the fallow field east/northeast of the canal, the former inert storage area, and along the drainage swale south/southwest of the site. A limited number of broken clay targets were noted approximately ___ feet (direction) of the former firing arc. This portion of the site is not in use and vegetation is re-established."

You should expand on your observations and discuss the following:

- Structures/features that have been demolished and removed from the site. Differentiate between the structures/features that were formerly part of the range and other structures/features that were not.
- Structures/features that have been added since the range was demolished or closed. Include a description of the current use of the site and surrounding area (use general directions to describe uses in the surrounding area, such as north, south, east, and west).
- Remember to include references for your maps: "A visual depiction of the site reconnaissance is provided on Map 5.1-1 located at the end of Section 5.1. Additional range/site details are illustrated on Map 5.1-2, also located at the end of Section 5.1."

Munitions and Munitions Related Materials

This section is standard for small arms ranges and should be modified only as necessary to accurately describe your range(s). Example text is provided below:

"This section describes the munitions or munitions related materials known or suspected to be at the site, including the types and estimated maximum penetration depths. This includes both MEC and non-hazardous munitions related scrap (e.g., fragmentation, base plates, and/or inert mortar fins). However, since the (site name) was used for small arms training only, MEC and non-hazardous munitions related scrap are not known or suspected to have been present at the site.

Munitions use at the (site name), which was used as a single field shotgun range (modify this to describe your range), was limited to 12, 16, and 20 gauge and .410 caliber shotgun ammunition. The exact quantity of shotgun ammunition deployed or fired at the range is unknown. Firing records were not available, and there is no defensible method of determining the amount of ammunition potentially fired at the range. Ordnance technical data sheets for the various shotgun ammunition listed above are included in Appendix E. Based on the information obtained during the data collection process, other munitions types, including special consideration munitions (i.e., chemical warfare materiel filled munitions, electrically fuzed munitions, and/or depleted uranium associated munitions), are not known nor suspected to have been used at the site."

MEC Presence

For the report, you should include the following standard text:

"Because the site was used only for shotgun training and there is no historical or known evidence of explosives used at the site, there is no evidence of MEC. As such, there are no known MEC areas associated with the (site name). There are no suspected MEC areas associated with the (site name). Based on observations made and data collected during the PA process, the (size) acre site, as well as the surface danger zone associated with the (site name), is not suspected to contain MEC."

Note: It is the team leader's responsibility to make sure the text accurately reflects the conditions at your range(s).

Ordnance Penetration Estimates

As with the previous sections, this section includes standard text that should be included in the report:

"The depth to which munitions penetrate below the ground surface depends on many factors, including the type of soil, the angle of impact, the size of the munition, the velocity at impact, and site-specific environmental conditions. Over the years, the DoD has studied and modeled munitions penetration depths and has issued various guidance and technical documents on the subject. For the purposes of the PA, maximum probable penetration depths are estimated following guidance listed in the latest draft (July 2002) of the DoD Directive on Explosives Safety issued by the DoD Explosives Safety Board [*DoD Directive 6055.9* (*DoD Ammunition and Explosives Safety Standards*)]. The Directive refers to *TM 5.855.1* and *NAVFAC P-1080*.

The technical documents, however, apply to air dropped and indirect fire weapons and do not apply to skeet ranges. By design, skeet ammunition is dispersed as pellets over a small area in the direction of fire. According to the *Navy Programming Guide* (1958),

the minimum surface danger zone for a skeet range is 900 feet. Pellets dispersed from a shotgun would be deposited on the ground surface well within this zone and would not penetrate the ground surface unless disturbed."

Munitions Constituents

The type(s) of MC that may be present will vary based on the purpose of the range, the ammunition used, the period of use, and other factors. Reference documents vary in the constituents listed for small arms ranges. For consistency purposes when writing the PA report, you should use the following text unless you have specific information that suggests other constituents may be present:

"The primary MC of concern associated with shotgun ammunition is lead. Metallic lead is insoluble in water, but in the geochemical environment of most ranges it may slowly convert to other oxidized forms. Depending on the environment (e.g., soil characteristics, pH, and organic matter present), oxidation products can become mobile. However, lead mobility is effectively controlled by adsorption under the majority of conditions found on small arms ranges. In general, an exponential decline in lead concentrations has been observed in very short vertical distances due to adsorption or exchange reactions with clays, metal oxides, or organic mater in the soil. As such, lead mobility is not likely to be an issue at most ranges.

Other MC may include antimony, arsenic, copper, nickel, zinc, and constituents associated with black or smokeless powder. However, these constituents are less likely to be of concern since they are either present in the shotgun ammunition in only minor amounts/concentrations or are typically consumed when the shotgun round is fired. Because clay targets were identified at the former range, polycyclic aromatic hydrocarbons (PAHs) associated with the targets may also be present at the site. However, PAHs present in clay targets tend to be tightly bound in the petroleum pitch and limestone matrix of the target and are not readily available to the environment. In addition, the clay targets contain low solubility, high molecular weight PAHs that are not likely to effectively leach into the surrounding soils. Based on discussions with installation personnel, surface soil sampling at the (site name) (has or has not) occurred. Review of IRP documents indicates that groundwater monitoring wells (have or have not been) installed near the site."

Note: Modify your text to reflect actual conditions at your site.

Contaminant Migration Routes and Receptors

The contaminant migration routes and potential receptors should be determined during preparation of the Conceptual Site Model (CSM). Keep in mind that the following needs to be described in the PA report:

- Describe the contaminant migration routes. These may be naturally occurring or may be the result of human activities. You might describe these routes as follows: "Migration of MC may occur naturally through surface soil erosion, plant/animal uptake, or by human activities, including maintenance (e.g., vegetation removal and grading) and demolition/construction (e.g., demolition of former range structures and construction of new structures)."
- Remember to also describe activities that may have resulted in deposition of lead shot and clay targets in the surface soil (i.e., 0 to 2 feet). For example: "Maintenance, demolition, construction, and grading activities that have taken place at the site may have resulted in deposition of lead shot and clay target pieces in the top one to two feet of surface soil at the former range."
- You should also include future activities in your text: "Future construction, excavation, utility installation, or other site work could also be a release mechanism. In addition, wind and surface water erosion during major precipitation events may result in potential MC migration."
- Discuss the potential receptors, which will include both human and ecological receptors, and what activities they may be involved with at the site: "Potential human receptors include Navy and civilian personnel (e.g., security and maintenance), contractors (e.g., maintenance, utilities, construction, excavation, grading, and other site work), and visitors. Potential ecological receptors include small mammals (e.g., ground squirrels and rabbits), reptiles, and birds. Potential ecological receptors also include species of special concern, such as the (list species for your site)."
- Describe the pathways through which exposure may occur: "Human receptors may come into direct contact with MC while conducting security checks or periodic non-intrusive maintenance (i.e., vegetation removal). Ecological receptors may come into direct contact with MC in surface soil while foraging or burrowing. Ecological receptors may also come into contact with MC that has been incorporated into the food chain (bioaccumulated in plants and small animals)."

Summary

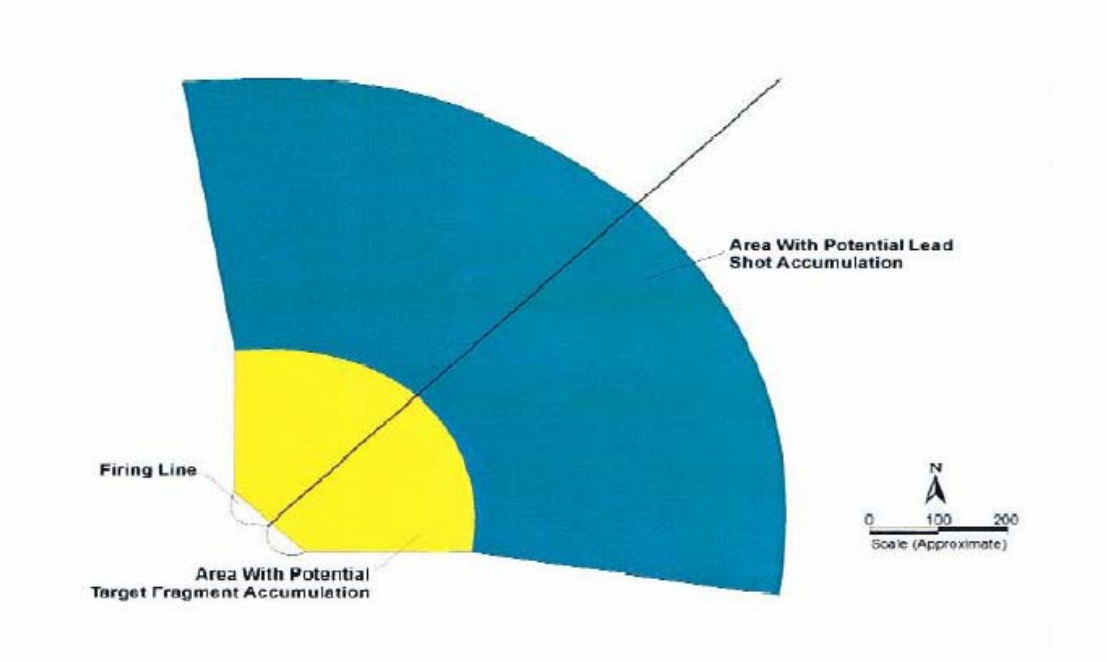
Include site-specific information in the first several paragraphs that provide a summary of the site history, description, features, visual survey observations, and other key points. Conclude with a paragraph summarizing MEC/MC presence. Remember that you typically do not have MEC at small arms ranges. If you identified MEC, your range was also used for another purpose that should be clearly identified in the report. An example follows:

"Information obtained during the site visit and observations made during the visual survey provided no evidence of MEC. MC may include lead, other constituents associated with the ammunition (such as antimony, arsenic, copper, nickel, and zinc), and constituents associated with black or smokeless powder. During the visual survey, a limited number of broken clay targets were noted approximately (distance) feet (direction) of the former firing arc. PAHs may be present from the broken clay targets. MC, if present, would likely be located in surface soils at the range (direction of fire) of

the firing arc. For skeet and trap ranges, the area where the clay targets and lead shot typically accumulated during the active life of the range extended from the firing arc to approximately 600 feet in the general direction of fire. Clay targets typically would be found within the first 300 feet and lead shot would be found from 300 feet to 600 feet from the firing arc. Based on information obtained from the installation, surface soil sampling at the range has not been conducted."

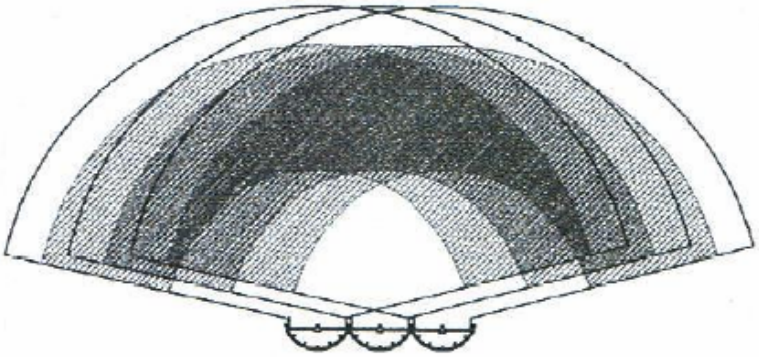
Note: If you have evidence that suggests the lead shot and/or clay targets were moved and stockpiled, you should also describe the area where they were stockpiled.

Several examples of shotfall areas (i.e., the area where lead shot would have accumulated during the active live of the range) for different skeet and trap range configurations have been included on this and the following page for reference. While guidance documents vary in how the shotfall area is depicted, they consistently show the shotfall area for skeet and trap ranges between approximately 300 to 600 feet from the firing arc. To provide consistency in the PA reports, you should make sure your range boundary includes the majority of the shotfall area. Bear in mind that your RPMs and Installation POCs may have different drivers for how they want the range boundary depicted. It is OK to have range boundaries that are site/installation specific, but we want to make sure each range boundary captures the area(s) where the majority of the clay targets and lead shot would be found. For mapping purposes, please include the range boundary (this will be site/installation specific) and the appropriate SDZ (this will provide consistency in mapping for the skeet and trap ranges). If you have questions regarding how to define range boundaries and SDZs, please contact the people identified in the beginning of this fact sheet.

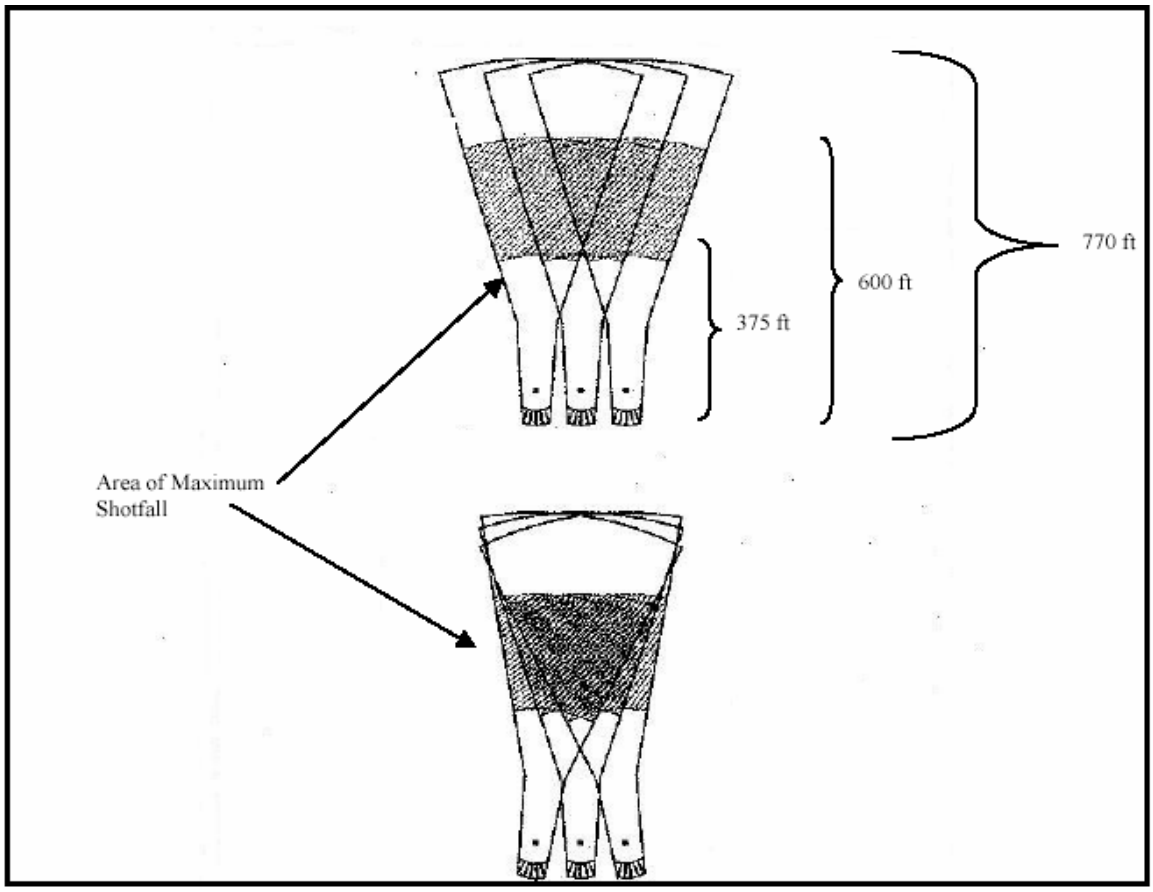


This figure depicts the potential target fragment and lead shot accumulation areas for a double field shotgun (skeet) range.

The following figures depict the shotfall areas for a triple field skeet range and a triple field trap range.



The shaded area represents the Area of Maximum Shotfall.



Pistol, Rifle, and Machine Gun Ranges

Note: The following section includes information for Pistol, Rifle, and Machine Gun Ranges. The example text provided was written for a pistol range. Rifle and machine gun ranges will have slightly different configurations and you will have to modify your report text accordingly.

History and Site Description

For the PA report, you should include the following information to describe the range:

- Describe size/location of the range: "The (site name), consisting of approximately (size in acres), is located (give direction from a key landmark) in the (give general area) of the installation."
- Describe range use (both military and recreational), include dates of use and range layout/features: "Property records indicate that the range was constructed in (date), with (number) fixed firing positions and targets located at (include distances) yards. The range was oriented in a (for example, west to east) direction, with the firing points located on the (for example, westernmost) portion of the range. The earthen butt, or backstop berm, was approximately ___ feet high and ___ feet long. The range was used for small arms training and periodic requalification by military personnel through (date), when it was closed."
- Describe the munitions use: "Based on historical documentation review, information obtained from interviews, and observations made during the visual survey, the (site name) was constructed and used as a pistol range. Weapons use was limited to small caliber (.22, .38, and .45 caliber, and 9 mm) handguns."

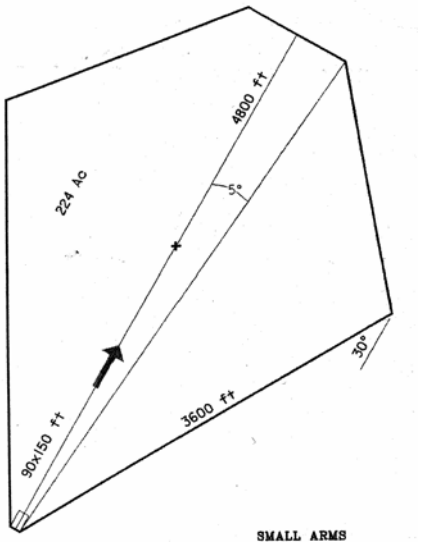
You should include a description of what you observed during the visual survey:

- Describe range features/current conditions. Could you identify the firing points/line, target stands, or backstop berm? Did you see bullet fragments in the backstop berm? For example: "The backstop berm has been demolished and soils from the berm have been stockpiled onsite. During the visual survey, numerous lead bullets and bullet fragments were observed in the stockpiled soil from the backstop berm."
- Describe other non-range features if present or if they existed in the past. Make sure you describe what is there now: "The site is not used and vegetation is re-established over the majority of the former range."
- Describe other uses within the area where the range was located, both former and current. Include a description of structures, if present, and the use of these structures.

Include a discussion of your findings and a description of the range layout. You should base this on both historical information identified and knowledge of technical manuals and guidance documents. The following paragraph is provided as an example:

"Based on review of historical documents, aerial and still photographs, information obtained from interviews, and observations made during the visual survey, the (site name) was constructed and used as a pistol range. According to Army Technical Manuals (referenced as AR 750-10 and TM 9-855) and the Navy Programming Guide (1958), a typical pistol range was approximately 30 yards wide by 50 yards deep. The range was comprised of the firing line, targets, earthen berm (backstop berm), and an area behind the firing line that included the ammunition issue point and administrative area. The backstop berm was typically constructed along the backside of the range, approximately five feet to the rear of the targets. A five degree angle of fire extended from the firing line down range a distance of 4,800 feet, with an additional 25 degree safety fan (on both sides) extending down range 3,600 feet. The surface danger zone, which included the down range hazard area and the safety fan, was roughly diamond-shaped and contained approximately 224 acres.

The site boundary for the (site name), which includes approximately ____ acres, encompasses the firing line, target areas, former backstop berm location, and stockpiled soil from the backstop berm. The site includes the area where the bullets and bullet fragments were observed. Whereas, the surface danger zone represented the portion of the former range that included the area where the weapons, when fired from the firing line, were a potential hazard to personnel. The surface danger zone was used to define the area that included the firing line, target areas, impact area (i.e., backstop berm), ricochet trajectory area, and secondary danger area."



Note: For this example, the range boundary comprises an area that is smaller than the SDZ. The figure to the right shows the typical SDZ for a Pistol Range (USACE, 2001). Additional range schematics are included at the end of this fact sheet in the Reference section.

Visual Survey Observations and Results

For this section of the report, you need to identify the Malcolm Pirnie team members that conducted the visual survey and the date of the survey. You should also include Navy representatives that were present. If you returned to the site, note the date and purpose of the return visit.

When describing the visual survey observations, make sure you include a description of the areas walked, site features noted, whether you observed bullets and/or bullet fragments on the ground surface or in the backstop berm, and other relevant observations. For example:

"During the visual survey, the team walked the areas at the site best corresponding to the former locations of the firing points, target stands, and backstop berm. The team also walked the perimeter of the backstop berm soil stockpile, the dirt roads encircling the site, and along the drainage swale on the eastern perimeter of the site. Numerous lead bullets and bullet fragments were observed in the backstop berm stockpile. Concrete and metal debris from a former structure (building number) also remain at the site. The site is not in use and vegetation is re-established on a majority of the former range."

You should expand on your observations and discuss the following:

- Structures/features that have been demolished and removed from the site. Differentiate between the structures/features that were formerly part of the range and other structures/features that were not.
- Structures/features that have been added since the range was demolished or closed. Include a description of the current use of the site and surrounding area (use general directions to describe uses in the surrounding area, such as north, south, east, and west).
- Remember to include references for your maps: "A visual depiction of the site reconnaissance is provided on Map 5.2-1 located at the end of Section 5.2. Additional range/site details are illustrated on Map 5.2-2, also located at the end of Section 5.2."

Munitions and Munitions Related Materials

This section is standard for small arms ranges and should be modified only as necessary to accurately describe your range(s). Example text is provided below:

"This section describes the munitions or munitions related materials known or suspected to be at the site, including the types and estimated maximum penetration depths. This includes both MEC and non-hazardous munitions related scrap (e.g., fragmentation, base plates, and/or inert mortar fins). However, since the (site name) was used for small arms training only, MEC and non-hazardous munitions related scrap are not known or suspected to have been present at the site.

Munitions use at the (site name), which was used as a pistol range (modify this to describe your range), was limited to .22, .38, and .45 caliber, and 9 mm rounds. The exact quantity of ammunition deployed or fired at the range is unknown. Firing records were not available, and there is no defensible method of determining the amount of ammunition potentially fired at the range. Ordnance technical data sheets for the various small arms ammunition listed above are included in Appendix E. Based on the information obtained during the data collection process, other munitions types, including special consideration munitions (i.e., chemical warfare materiel filled munitions, electrically fuzed munitions, and/or depleted uranium associated munitions), are not known nor suspected to have been used at the site."

MEC Presence

For the report, you should include the following standard text:

"Because the site was used only for small arms training and there is no historical or known evidence of explosives used at the site, there is no evidence of MEC. As such, there are no known MEC areas associated with the (site name). There are no suspected MEC areas associated with the (site name). Based on observations made and data collected during the PA process, the (size) acre site, as well as the surface danger zone associated with the (site name), is not suspected to contain MEC."

Note: It is the team leader's responsibility to make sure the text accurately reflects the conditions at your range(s).

Ordnance Penetration Estimates

As with the previous sections, this section includes standard text that should be included in the report:

"The depth to which munitions penetrate below the ground surface depends on many factors, including the type of soil, the angle of impact, the size of the munition, the velocity at impact, and site-specific environmental conditions. Over the years, the DoD has studied and modeled munitions penetration depths and has issued various guidance and technical documents on the subject. For the purposes of the PA, maximum probable penetration depths are estimated following guidance listed in the latest draft (July 2002) of the DoD Directive on Explosives Safety issued by the DoD Explosives Safety Board [*DoD Directive 6055.9* (*DoD Ammunition and Explosives Safety Standards*)]. The Directive refers to *TM 5.855.1* and *NAVFAC P-1080*.

The technical documents, however, apply to air dropped and indirect fire weapons and do not apply to small arms ranges. By design, a small arms range is a directed fire training range and normally has a backstop (impact) berm located behind the target area that receives/contains the projectiles (bullets) expended on the range. Depending on berm composition, the penetration depths into the backstop berm range from surface to 12 inches. At the (site name), expended bullets and bullet fragments were observed in the stockpiled soil that remains on site from the former backstop berm (make this site-specific…for example, you may have a backstop berm at your site with expended bullets/bullet fragments visible on the surface of the backstop berm…you would need to describe this scenario instead). Because the range was designed such that small arms ammunition was fired toward targets and retained onsite by the backstop berm, expended rounds are not expected to have penetrated the ground surface or accumulated beyond the former location of the backstop berm."

Munitions Constituents

The type(s) of MC that may be present will vary based on the purpose of the range, the ammunition used, the period of use, and other factors. Reference documents vary in the constituents listed for small arms ranges. For consistency purposes when writing the PA report, you should use the following text unless you have specific information that suggests other constituent may be present:

"Small arms ammunition is mainly comprised of lead (approximately 85 percent by weight of the projectile). As such, the primary MC of concern associated with small arms ranges is lead. Metallic lead is insoluble in water, but in the geochemical environment of most ranges it may slowly convert to other oxidized forms. Depending on the environment (e.g., soil characteristics, pH, and organic matter present), oxidation products can become mobile. However, lead mobility is effectively controlled by adsorption under the majority of conditions found on small arms ranges. In general, an exponential decline in lead concentrations has been observed in very short vertical distances due to adsorption or exchange reactions with clays, metal oxides, or organic matter in the soil. As such, lead mobility is not likely to be an issue at most ranges.

Other MC may include antimony, arsenic, copper, zinc, and constituents associated with black or smokeless powder. However, these constituents are less likely to be of concern since they are either present in the ammunition item in only minor amounts/concentrations or are typically consumed when the item is fired. Based on discussions with installation personnel, surface soil sampling at the (site name) (has or has not) occurred. Review of IRP documents indicates that groundwater monitoring wells (have or have not been) installed near the site."

Note: Modify your text to reflect actual conditions at your site.

Contaminant Migration Routes and Receptors

The contaminant migration routes and potential receptors should be determined during preparation of the Conceptual Site Model (CSM). Keep in mind that the following needs to be described in the PA report:

- Describe the contaminant migration routes. These may be naturally occurring or may be the result of human activities. You might describe these routes as follows: "Migration of MC may occur naturally through surface soil erosion, plant/animal uptake, or by human activities, including maintenance (e.g., vegetation removal) and site work (e.g., range demolition)."
- Remember to also describe activities that may have resulted in deposition of bullets/bullet fragments in the surface soil (i.e., 0 to 2 feet). For example: "The former backstop berm has been demolished and soils from the berm have been stockpiled onsite. These activities may have resulted in deposition of lead bullets and bullet fragments in the surface soils (from zero to two feet below the ground

surface) adjacent to the former backstop berm location and the current stockpiled soil location."

- You should also include future activities in your text: "Future construction, excavation, utility installation, or other site work could also be a release mechanism. In addition, wind and surface water erosion during major precipitation events may result in potential MC migration."
- Discuss the potential receptors, which will include both human and ecological receptors, and what activities they may be involved with at the site: "Potential human receptors include Navy and civilian personnel (e.g., security and maintenance), contractors (e.g., maintenance, utilities, construction, excavation, grading, and other site work), and visitors. Potential ecological receptors include small mammals (e.g., ground squirrels and rabbits), reptiles, and birds. Potential ecological receptors also include species of special concern, such as the (list species for your site)."
- Describe the pathways through which exposure may occur: "Human receptors may come into direct contact with MC while conducting security checks or periodic non-intrusive maintenance (i.e., vegetation removal). Ecological receptors may come into direct contact with MC in surface soil while foraging or burrowing. Ecological receptors may also come into contact with MC that has been incorporated into the food chain (bioaccumulated in plants and small animals)."

Summary

Include site-specific information in the first several paragraphs that provide a summary of the site history, description, features, visual survey observations, and other key points. Conclude with a paragraph summarizing MEC/MC presence. Remember that you typically do not have MEC at small arms ranges. If you identified MEC, your range was also used for another purpose that should be clearly identified in the report. An example follows:

"Information obtained during the site visit and observations made during the visual survey provided no evidence of MEC. Numerous lead bullets and bullet fragments were observed in the backstop berm stockpile during the visual survey. MC may include lead, other constituents associated with the ammunition (such as antimony, arsenic, copper, nickel, and zinc), and constituents associated with black or smokeless powder. MC, if present, would likely be located in the stockpiled soil from the former backstop berm, in surface soils located adjacent to the stockpile and former berm locations, and possibly near the firing line (you will need to make this site-specific since the backstop berm may still be in place at some sites, but at others it will have been demolished with soil either stockpiled on-site or, in some cases, removed from the site). Based on information obtained from the installation, surface soil sampling at the range has not been conducted."

Note: If you have evidence that suggests the backstop berm was moved and stockpiled (as described in the example text), you should include a description of the area where the backstop berm soils were stockpiled or used (this may be on-site or off-site).

The following figure depicts the areas at a pistol range where you potentially would find constituents associated with firing small arms ammunition. Specifically, you may find residual constituents in surface soils in front of the firing line and bullets/bullet fragments in the backstop berm. To provide consistency in the PA reports, you should make sure your range boundary includes the firing line/points, target area, and backstop berm. Bear in mind that your RPMs and Installation POCs may have different drivers for how they want the range boundary depicted. It is OK to have range boundaries that are site/installation specific, but we want to make sure each range boundary captures the area(s) where the majority of the residuals and bullets/bullet fragments would be found. In the example text, the backstop berm had been demolished and the backstop berm soil had been stockpiled on-site. If this is the case for your range, the range boundary should include the area where the soil has been stockpiled at the site. For mapping purposes, please include the range boundary (this will be site/installation specific) and the appropriate SDZ (this will provide consistency in mapping for the small arms ranges). If you have questions regarding how to define range boundaries and SDZs, please contact the people identified in the beginning of this fact sheet.

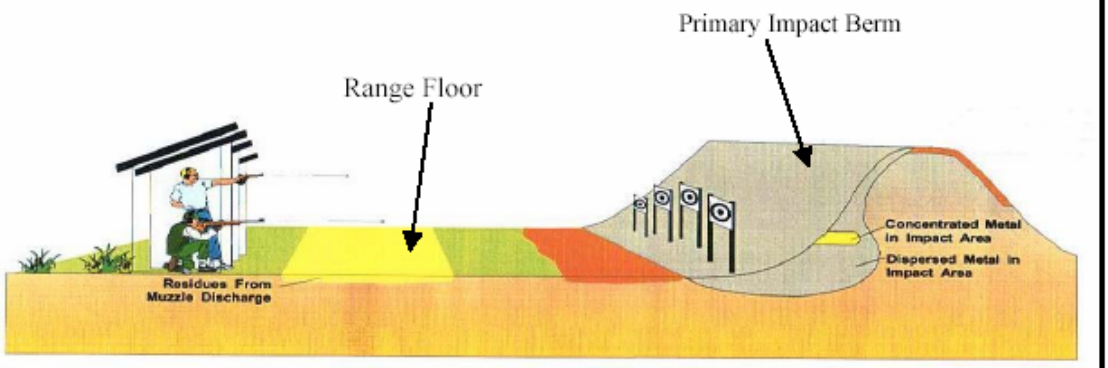


Figure 2-1. Cross Section of a Typical Static Rifle and Handgun Range
(Modified from Figure 1.1 in AFCEE, 2000)

References

Guidance Documents

AR 750-10 and TM 9-855 Army Technical Manuals

ITRC 1/2003 Interstate Technology Regulatory Council, Technical/Regulatory Guidelines - Characterization and Remediation of Soils at Closed Small Arms Firing Ranges, January 2003.

MCO 3570.1B Range Safety

MSDS Remington Arms Co. Inc.

NAVAER 00-100-504 United States Navy Aeronautical Shore Facilities, Programming Guide, Bureau of Aeronautics, March 1958.

OPNAVINST 3591.1C CH-1 Small Arms Training and Qualifications

OSWER #9285.7-37 United States Environmental Protection Agency, TRW Recommendations for Performing Human Health Risk Analysis on Small Arms Shooting Ranges, OSWER #9285.7-37, Office of Solid Waste and Emergency Response, Washington, DC, March 2003.

USACE, Army Range Inventory, Data Collector Instructions, Appendix E, September 2001

Range Descriptions and Figures

The following range descriptions and figures were taken from USACE guidance documents dated 2001. Descriptions and figures have been included for the following ranges:

- Skeet and Trap Ranges (Single, Double, and Triple Field Shotgun Ranges)
- Pistol Range
- Known Distance (KD) Rifle Ranges (200-, 300-, and 500-yard Ranges)

Note: If additional range descriptions and figures are needed for your site, please contact Dan Hains or Al Larkins to obtain them.

SKEET & TRAP (aka: Skeet Range, Shotgun Range)

Range Type: Small Arms

Cell Name(s): SKEET, DSKEET, TSKEET

Typically, skeet ranges should be located in open country. A range facility may consist of one or several shooting fields, which are normally positioned side by side. A shooting field is laid out in a semi-circle with a 63-foot radius. Many ranges utilized concrete walkways. The safety fan consists of a semi-circle with a 900-foot radius that utilizes the same apex as the shooting field. Trap houses may have been constructed of wood, concrete, or brick.

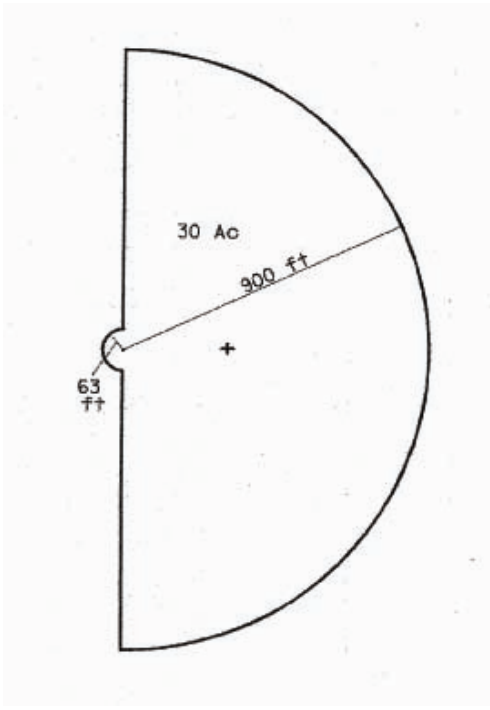
Ammunition (probable)	Max Range (yards)	Muzzle Velocity (fps)
12 gage shotgun	NA	NA

Data sheet(s):

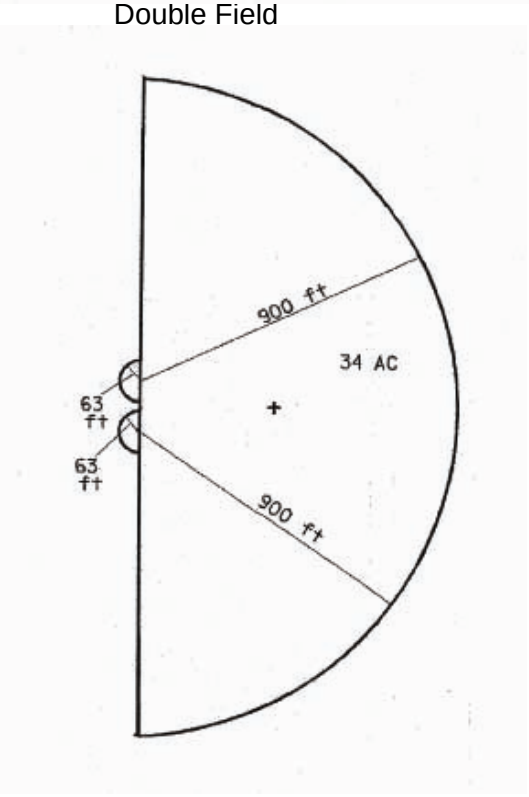
CTT01 Small arms, General

Reference(s): *AR 750-10, Range Regulations for Firing Ammunition in Time of Peace*, May 1939 – January 1944; *TM 9-855, Targets, Target Material, and Training Course Lay-outs*, August 1944 & November 1951

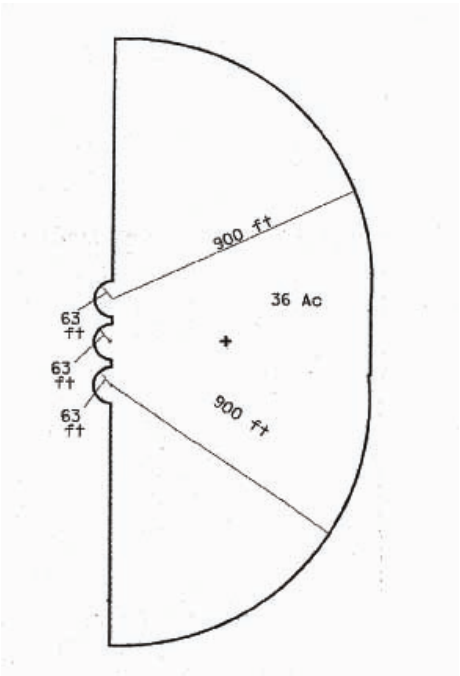
Single Field



Double Field



Triple Field



PISTOL

Range Type: Small Arms

Cell Name(s): PIRAN

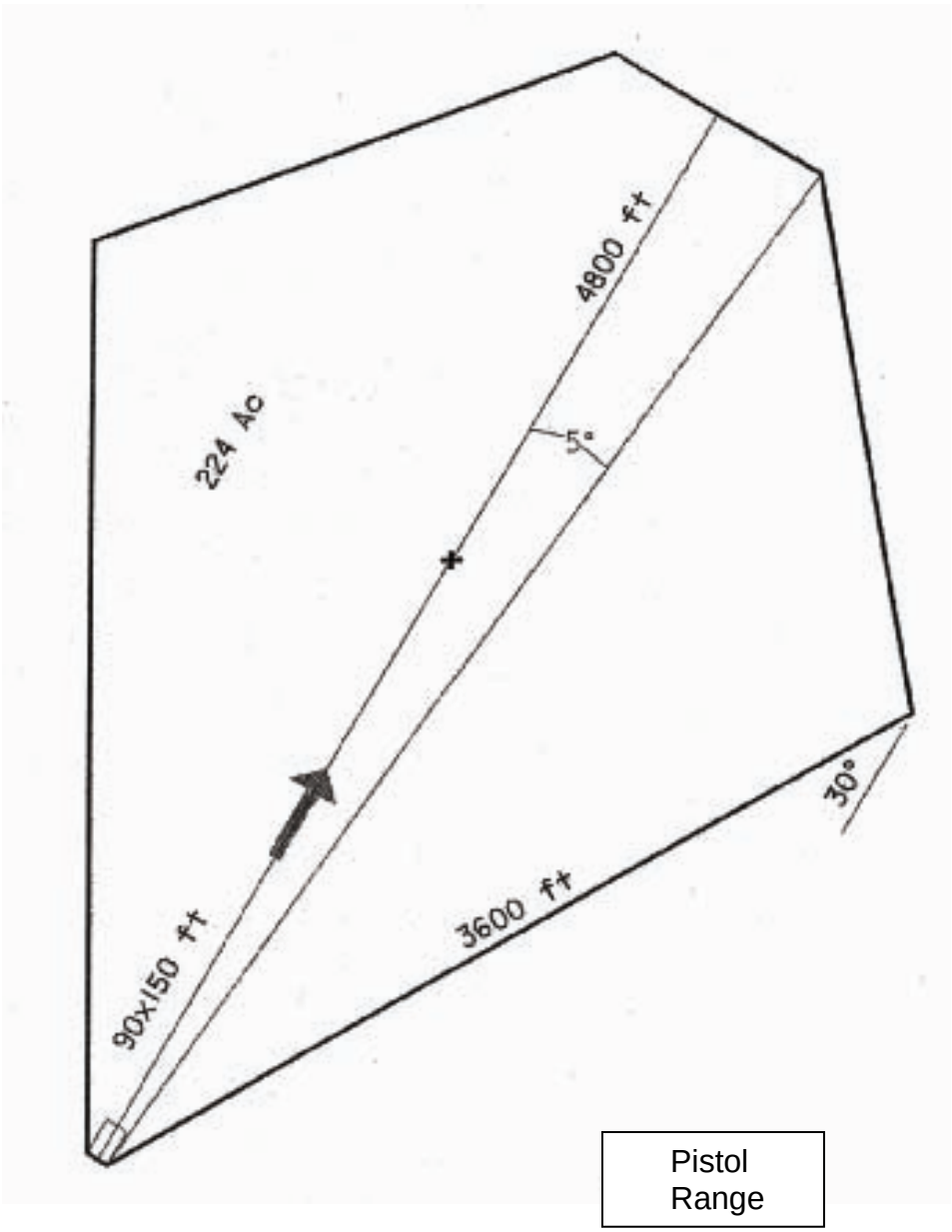
Typically, a Pistol Range accommodated 25 firing positions, and was approximately 30 yards wide by 50 yards deep. A pistol range is comprised of a salvage wall (earthen berm), the targets, the firing line(s), safety fan, and an area behind the firing lines, which typically included the ready line, ammunition issue point, and administrative area. The salvage wall (earthen berm) would have been constructed along the backside of the range approximately 5 feet to the rear of the target line. In situations where bluffs or steep hills were present, a salvage wall may not have been required. A five-foot opening typically separated each target. Firing lines would have been positioned at 5, 10, 15, and 25 yards in front of the targets. A 5° angle of fire extended from each end of the firing line down range a distance of 1,600 yards; and an additional 25° safety fan, which originated from the same points as the angle of fire, extended down range a distance of 1,200 yards.

Ammunition (probable)	Max Range (yards)	Muzzle Velocity (fps)
.45 caliber	1,600	802
.22 caliber	1,500	1,100

Data sheet(s):

CTT01 Small arms, General

Reference(s): *AR 750-10, Range Regulations for Firing Ammunition in Time of Peace*, May 1939 – January 1944; *TM 9-855, Targets, Target Material, and Training Course Lay-outs*, August 1944 & November 1951



Pistol Range

RIFLE, KNOWN DISTANCE (aka: KD Range, Known Distance Range, Qualification Range, Rifle Range, Musketry Range)

Range Type: Small Arms

Cell Name(s): KD500, KD300, RIFLE

A known distance (KD) rifle range was utilized for weapons familiarization and qualifications. KD ranges may be designated 200-yard, 300-yard, or 500-yard. Based on the designation, firing lines were positioned at 100 yd and 200 yd, 100 yd, 200 yd, and 300 yd, and 100 yd, 200 yd, 300 yd, and 500 yd, respectively. An additional 1,000-yard firing line may have been present; although, these firing lines typically consisted of a small number of firing points.

The width of the range would have been determined based on terrain and installation requirements. A range constructed to accommodate 50 men was approximately 400 yards wide. A range is comprised of a salvage wall (earthen berm) constructed directly behind the targets, the targets, the firing line(s), an area behind the firing lines, which typically included the ready line, ammunition issue point, and administrative area. The 30° safety fan originates from the ends of each firing line, extends down range 1,000 yards, at which point it continues an additional 2,900 yards parallel to the direction of fire.

Note: Since the downrange distance is calculated from each firing line, the difference in the down range distance between a 200-yard range (12,000-foot down range distance) and a 500-yard range (12,900-foot down range distance) is 300 yards (900 feet).

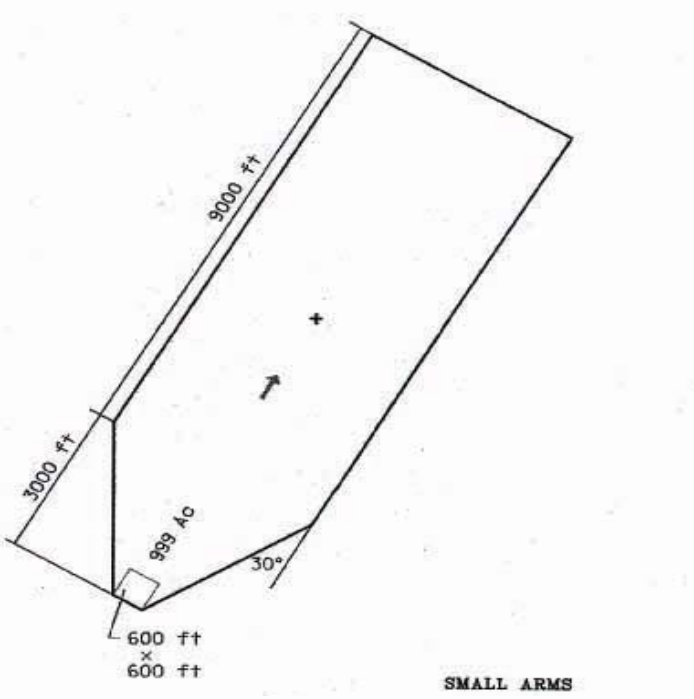
Ammunition (probable)	Max Range (yards)	Muzzle Velocity (fps)
.30 caliber	3,450	2,700
.22 caliber	1,500	1,100
.45 caliber	1,600	800

Data sheet(s):

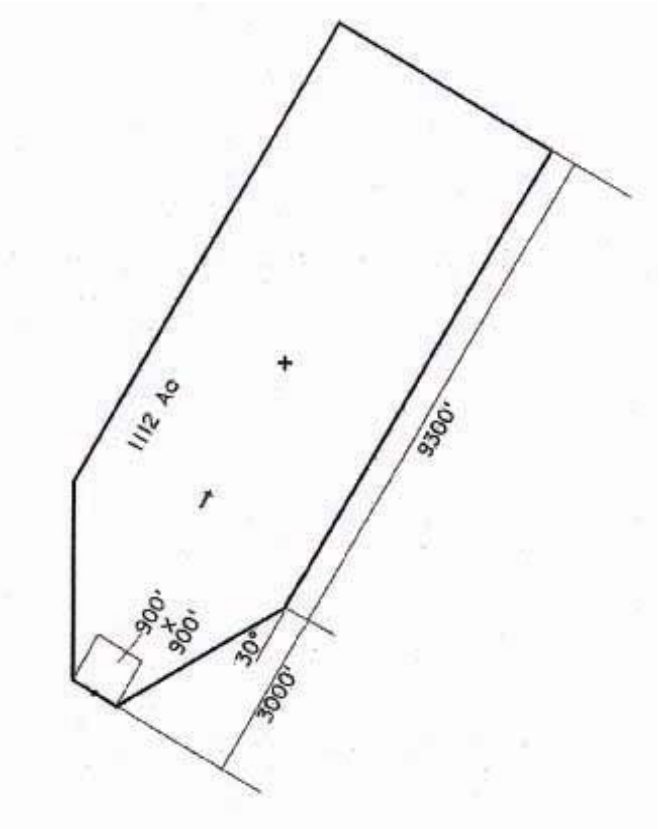
CTT01 Small arms, General

Reference(s): *AR 750-10, Range Regulations for Firing Ammunition in Time of Peace*, May 1939 – January 1944; *TM 9-855, Targets, Target Material, and Training Course Lay-outs*, August 1944 & November 1951

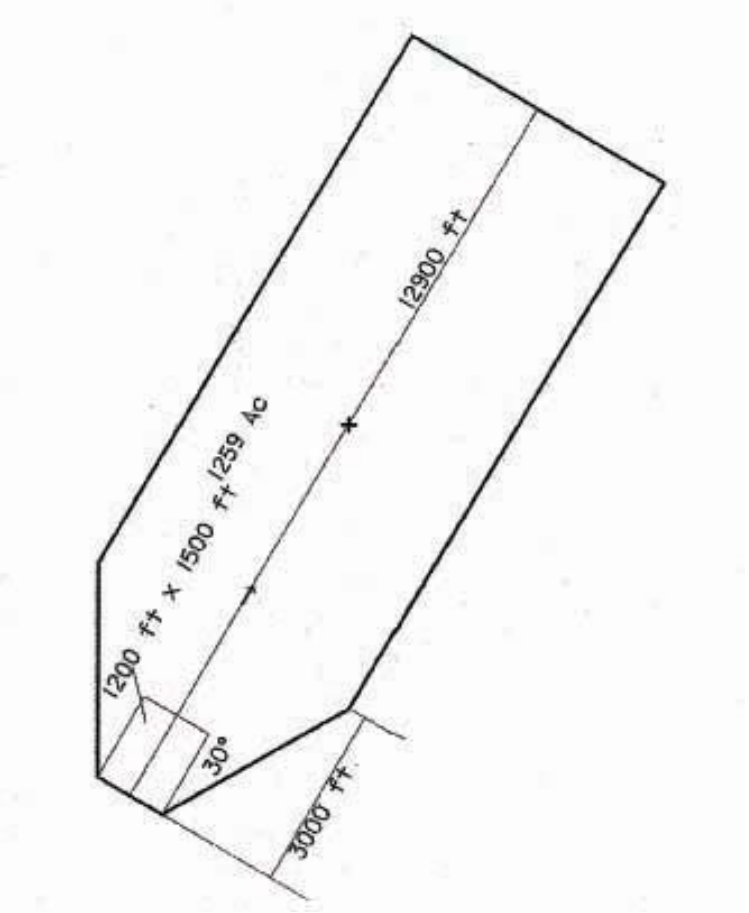
Known Distance Rifle Range (200-yards)



Known Distance Rifle Range (300-yards)



Known Distance Rifle Range (500-yards)



Indian Head Technical Library

WAR-TIME HISTORY OF THE U. S. NAVAL POWDER FACTORY
INDIAN HEAD, MARYLAND

- INDEX -

Chapter		Page No.
I	HISTORICAL BACKGROUND, ...	1-3
II	PRODUCTION, ...	4-24
III	BOTTLENECKS, PROBLEMS & SOLUTIONS	25-36
IV	PERSONNEL, ...	37-41
V	SECURITY, ...	42-46
VI	SUB-ACTIVITIES, ...	47-49
VII	TRANSPORTATION & ROADS, ...	50-53
VIII	HOUSING, ...	54-57
IX	SCHOOLS, ...	58-59
X	MAJOR ACCIDENTS, FIRES & EXPLOSIONS	60-72

- APPENDIX -

Print No.	
1	POWDER PRODUCTION
2	EXPLOSIVE "D" PRODUCTION
3	EXTRUDED POWDER PRODUCTION
4	X-RAY PRODUCTION
5	STATIC FIRING PRODUCTION
6-a	CIVILIAN PERSONNEL CHART
6-b	MILITARY PERSONNEL CHART
7	EXTRUSION PLANT PERSONNEL

Photo No.	
A,B,C,D	ACID PLANT
E	EXPLOSIVE RESEARCH LABORATORY
F	NEW MARINE BARRACKS

CHAPTER I

- HISTORICAL BACKGROUND -

The U. S. Naval Powder Factory is located upon the bluffs overlooking the beautiful, historic Potomac River, approximately twenty-five miles below our nation's capital, on land formerly part of a land grant to Captain Thomas Cornwallis, who, on 8 August 1636, was granted, his heirs and assigns forever, at Portsmouth, England, by the King of England, a tract of land (approximately 5,000 acres), lying on the east side of Piscataway River, called Mattawoman Neck. The original deed reads, in part, as follows:

> " xxx Beginning at a marked Ash Tree in a swamp near by an Indian town, running southeast 960 perches; on south with a line drawn west into a fresh run of a great creek called St. Thomas' Creek, with the said fresh run and creek on west side of said river for 150 perches; on north side with said river for 1600 perches:
>
> "To be held by he and his heirs as Manor of West St. Maries in free and common soccage by fealty only for all manner of services, yielding and paying therefor yearly unto them and their heirs at their receipt at St. Maries at the two usual feasts of the year, viz; at the Feast of the Annunciation of the Blessed Virgin Mary and at the Feast of St. Michael, the Archangell, by even and equall portions the rent of one thousand pound weight of wheat or the value thereof in such commodities as they and their heirs from time to time to collect and receive the same shall accept in discharge thereof at the choice of them and their heirs.
>
> "Given at St. Maries under greater seal January 29, 1661.
>
> "Witnessed by son and heir, Charles Calvert, Esq., Lieutenant General of Province of Maryland."

The birth of the naval station at Indian Head, Maryland, occurred in 1890, when the Proving Ground at Annapolis, was moved to the present site of the Naval Powder Factory. The site consisted of 880 acres and ground was first broken in September, 1890. Ensign R. B. Dashiell, U. S. Navy, was the first Inspector of Ordnance in Charge. In February, 1891, the first piece of ordnance was tested - a six-inch gun. As time went on and tests increased in number and volume, many fishermen and houseboat dwellers downriver wrote indignantly regarding the damage caused to the fishing and housing conditions.

In 1897, while efforts were being made at Newport, R. I., to produce a smokeless cannon powder, the Navy Department decided to build a naval powder factory for the purpose of developing smokeless powder, and the Naval Reservation at Indian Head was selected for the location of the new plant. Congress appropriated $94,000, and work started in 1898. George W. Patterson, Assistant Chemist at the Naval Experimental Smokeless Powder Plant at Newport, was transferred to Indian Head, entering upon duty as Chemist on 1 July 1899. The first powder was made in June, 1900. Since that time the Plant has been in continuous operation.

In 1901, adjoining land amounting to 1,050 acres, known as "Stump Neck" was acquired. Purchase was made primarily due to this property being in line of fire of

the Proving Battery.

Between the years 1904 and 1907, the Powder Factory was enlarged. A nitric acid plant and a sulphuric acid plant were built and a plant for reworking powder was erected, the first reworked powder being made in December, 1907.

Between the declaration of World War I and the Armistice, 10,000,000 pounds of new powder and 800,000 pounds of reworked powder were produced. During those years, the Reservation was enlarged by the purchase of 1,160 acres of adjoining land, and a 14½ mile railroad spur was laid from the Powder Factory to the Pennsylvania Railroad Junction at White Plains, Maryland.

In March, 1915, the Bureau directed the Factory to proceed with the erection of a plant for the manufacture of Explosive "D" (ammonium picrate); the first lot being completed in August, 1916. The first year's full production was 41,000 pounds.

In 1921, all Naval Proving Ground activities were moved to Dahlgren, Virginia. The last shot was fired in Indian Head on 21 July 1921. The Inspector of Ordnance in Charge located at the Lower Station, Dahlgren, with the Assistant Inspector remaining at Indian Head, the Inspector making weekly trips to the Powder Factory for administrative purposes. This arrangement continued until 1 July 1932, at which time separate commands were made of the two activities.

CHAPTER II

- PRODUCTION -

SMOKELESS POWDER -

During 1939 and early 1940, while the remainder of the world was in chaos, and the throes of war and terror had already begun to grip the European countries, the routine schedule of the Naval Powder Factory was approximately 17,224 pounds of new powder and 4,216 pounds of reworked powder per day. The payroll numbered 961 employees, with a complement of 19 naval and marine officers, and 100 navy and marine enlisted personnel. In March, 1940, the first directive was received to speed up production, and on 3 May 1940, the Chief of the Bureau of Ordnance requested the further increase in production to 25,000 pounds new powder per day, with plans for further build up to 40,000 pounds per day within the next year. In June, 1940, a board was convened by the Commanding Officer to obtain data for the Bureau covering equipment and material necessary for the manufacture of 70,000 pounds new and 5,000 pounds reworked powder per day on a six-day-week basis. To meet the demands of the speeded-up program, the Powder Factory would require steam and electric lines and improved railroad lines, plus reconditioning of the dryhouses - a total of between $1,800,000 and $1,900,000 being needed for expansion, and production, and construction facilities could not be

procured, installed and housed by the Station alone. The duPont Company was recommended to effect this expansion. Accordingly, duPont representatives were contacted regarding their availability for such a contract. Numerous conferences were held and voluminous correspondence ensued between the duPont officials and representatives of the Powder Factory.

While plans for the expansion were underway, the Commanding Officer was informed by the Bureau that still greater expansion plans were in line for this Station - that of a separate plant capable of manufacturing 100,000 pounds per day, which would be constructed in the Neck. duPont was again called in regarding cost, etc. No definite information could be furnished. They informed the Commanding Officer they had not built a plant of this kind in sometime and they stated any figure offered would be hazardous. However, they did roughly estimate a figure of $15,000,000. They further stated the workload being undertaken all over the country by their engineers was very great and that they were, at this time, tied up with the contract underway at Indian Head (that of increasing facilities to produce 75,000 to 100,000 pounds new powder per day). Therefore, they could not promise what they might be in a position to undertake. However, shortly after the duPont Company had made this statement, the President decided to obtain the additional powder manufacture from another section of the country, making

the statement that he did not wish to "Put all his eggs in one basket".

The rough original estimate had, by this time, increased to $3,280,900, plus a $20,000 "cost-plus-fixed-fee". On 30 December 1940, the Government entered into such a contract with the duPont Company in the amount of $3,490,000, plus a fixed fee of $69,300. $3,550,300 was the estimated amount set aside to fulfill this contract.

The contract was completed on 23 January 1942, at a cost of approximately $4,484,360, and the plant was turned over to the Powder Factory for operation. Almost immediately, production shot up. (See Print No. 1 attached for production schedule during the war period).

In recognition of the work being performed at the Naval Powder Factory, the Chief of the Bureau of Ordnance, Rear Admiral William H. P. Blandy, forwarded the following quoted letter of commendation:

> " xxx The Chief of the Bureau of Ordnance notes with satisfaction the excellent production record made by the Naval Powder Factory, Indian Head, Maryland, during March, 1943. This production, over 25% in excess of design capacity, was accomplished in spite of a shortage of trained personnel. Much credit should be given to the experienced personnel for the excellent training which must have been given new employees.
>
> "It is a pleasure to commend the Commanding Officer for the continued fine production record of the Naval Powder Factory. It is requested that all personnel be informed that the Bureau notes with pride the work of the Naval Powder Factory in providing basic ammunition components for our Fleet."

On 17 September 1943, the following message was received by the Station:

> "The excellent performance of your smokeless powder (SPDF 4348) received favorable comment in recent combat reports from U. S. destroyers participating in the Sicilian invasion. The fire power of 5-inch projectiles loaded with your powder enabled our landing operations to be effected with a minimum of casualties. On one occasion, a destroyer's 5-inch guns knocked out a Nazi 88 mm. battery in one minute of rapid fire. In another instance, our destroyers broke up a heavy counter-attack by enemy tanks. No misfires or material failures were experienced. The Bureau extends thanks to all of you helping to provide these reliable munitions."

Again, on 18 April 1945, the Bureau acknowledged the achievements of the Powder Factory, as follows:

> "It has been noted that production of smokeless powder at the Naval Powder Factory, Indian Head, Maryland, for the month of March, 1945, has surpassed that of previous months, notwithstanding a mixer fire on 28 March 1945, which delayed production considerably.
>
> "The Bureau is highly appreciative of the past month's achievement at the Naval Powder Factory. It is hoped that this increased production can be maintained."

EXPLOSIVE "D" -

When the First World War was raging in Europe, the cost of many of the materials of military character increased enormously. This condition was especially true of high explosives. In 1915, the Bureau took steps to install a small plant at the Naval Powder Factory for the manufacture of high explosives. The operations of this plant were considerably delayed in the beginning. How-

over, by 1917, the plant had overcome the various handicaps in the line of unskilled labor and machinery breakdowns and was producing 41,000 pounds of standard quality "D". During the year 1918, the "D" Plant facilities were expanded and approximately 240,000 pounds were produced. At the close of the war, there were large stocks of "D" on hand so the necessity for manufacture ceased. The plant was closed down in 1920.

In January, 1931, the Bureau stated that in view of the fact that they anticipated having about 500,000 pounds of Explosive "D" within the next two to three years, from unloading projectiles, the comment of the Naval Powder Factory was desired as to the best means of undertaking this recrystallization. The reply stated that $9,000 would be required to place the plant in condition for such use as required. Work was begun on 6 January 1932, and it was then discovered an additional $2,000 would be required. With appropriation assured, the plant went into operation. On 1 April 1933, the plant was operating to capacity, with a force of eleven men. The monthly production reached approximately 34,378 pounds.

In July, 1933, the Bureau directed the Commanding Officer to recondition the "D" Plant for the manufacture of new "D". The Factory estimated $200,000 would be required to effect this increase in capacity.

In September, 1934, the reconditioned plant was operating at maximum capacity.

On 29 September 1939, the Commanding Officer made recommendation to the Bureau that the Factory be authorized to increase dryhouse facilities of the "D" Plant at an estimated cost of $22,000, and to procure necessary equipment, including drying tubs, heaters, rotoclone, motors, etc.

Plans for a new Explosive "D" Plant were drawn up by the Bureau of Yards and Docks, after consultation with the Bureau of Ordnance and Superintendent of the "D" Plant. The Chief of the Bureau of Ordnance forwarded plans to the Commanding Officer on 10 March 1941 for information and comment. The Bureau of Yards and Docks requested an expression of opinion by the Powder Factory as to whether or not it could arrange for procurement and installation of processing equipment required for this plant, for which $100,000 was included in the estimates of the plant - total estimated cost, $300,000. The Powder Factory was of the opinion that $100,000 would be entirely inadequate in meeting expenses involving procurement and installation of necessary equipment, but that $150,000 would probably be sufficient.

The old plant would be used one day a week for nitrating and at such time as all raw materials were consumed, nitrating would cease and the old plant would be used exclusively to complete the recrystallization of

appromixately 500,000 pounds of "D" from Yorktown (to be completed in approximately four months).

In 1941, an 8' x 30' nickol-clad tank was installed for phenol, enabling it to be purchased in tank car lots, thereby lowering the delivery and handling costs. Time temperature controllers were installed on this tank and on one crystallizing kettle.

On 15 April 1942, the new Explosive "D" Plant commenced operations, turning out 9,000 pounds per day for a seven-day week. (See Print No. 2 attached for production schedule).

ACID -

Sulphuric Acid Plant:

The 70-ton plant was completed in 1918 by the duPont Company for World War I. The plant, under war-time emergency, attained approximately 75 tons per day, reaching an all high in July, 1942, with 83 tons per day - a total of 2,595 tons per month. In closing down the old Soda Plant, full production from this plant was no longer required. There was, however, produced for the war effort, 72,103 tons.

Nitric Acid Plant:

In April, 1940, contract was entered into with the duPont Company to increase facilities to a 15-ton unit. The first acid in this increased plant was produced on 29 August 1940. As war clouds darkened, plans were placed into execution to further expand this plant to a

40-ton capacity. The duPont Company was again awarded the contract at an approximate cost of $1,078,027. The first acid from this new plant was produced on 12 March 1941. A plant of this size was definitely an asset. It sustained HNO_3 production, both here and at other activities at a time when this acid was vitally needed and while other such plants were being rushed to completion. Performance results here shaped both the process and design of all plants built by this company and many others during the war period. From the day of acceptance to 30 June 1945, the end of full production, this plant produced an all-time high average of 48 tons per day. For more than 80% of this time, an average of 51 tons per day was maintained - a total of 70,262 tons were produced during the war period.

An additional Ammonia Oxidation Plant, three sulphuric acid concentrators and three nitric acid concentrators were completed at a cost of $1,244,504.66, and production was begun in February, 1945. The Ammonia Oxidation Plant produced 6,503 tons at a value of $325,163.50 before victory in Europe curtailed the need for production.

See attached photographs A, B, C, and D for a panoramic view of the new plant.

EXTRUDED POWDER -

In June, 1942, the Navy decided to build a small plant at the Naval Powder Factory to extrude ballistite solventless rocket propellant from ballistite in sheet form.

The plant design was based largely upon information obtained from the California Institute of Technology, where scientists had been conducting research into the production and ballistic properties of solventless ballistite propellants. Much of the original equipment, including two extrusion presses, was obtained directly from Cal Tech, or was constructed from plans produced by Cal Tech.

In those comparatively early days before the rocket was proven in actual warfare, there was no conception of the numerous applications or of the huge quantity of rockets which were used by the Allies in the prosecution of World War II. Consequently, the early plans included only five 8-inch hydraulic presses. Two of these presses were obtained from Cal Tech and the other three were obtained by modifying three Naval Powder Factory presses which were originally designed for use in the manufacture of smokeless powder.

Soon thereafter, when the merits of rocket warfare became more evident, the Navy's need for rocket propellant increased from 150,000 pounds per month to several million. Consequently, the Navy ordered the procurement and installation of seven horizontal presses whose cylin-

ders were 10½ inches in diameter. Two 15-inch horizontal presses were obtained and placed in operation early in 1945. As a result, when V-J day arrived, the Naval Powder Factory was operating two 15-inch, six 10½-inch and three 8-inch presses, which is only a small fraction of the Navy's production capacity. It is important to remember this relatively small extrusion capacity when studying the wide variety and small quantities of propellant grains produced at Indian Head during the War.

It was the policy of the Bureau of Ordnance to place the extrusion capacity here in a special status so that when the large production plants were falling behind the production schedule of critically needed designs of ballistite propellant, the capacity of the Naval Powder Factory Extrusion Plant could be quickly converted to give the additional production capacity required to make up the existing production deficiencies.

Also, it was the policy of the Navy to schedule for production at the Naval Powder Factory especially those designs of propellants which were not readily adaptable to mass production type of operation because of the limited quantity desired.

The Extrusion Plant was built by the Naval Powder Factory personnel. As previously stated, the original plans included only a small portion of the present plant. As a result, the Plant has been in a continuous state of expansion since its beginning, in 1942.

Records of the Station indicate the cost of the Extrusion Plant and its equipment to be $1,372,069.45, which may be itemized, as follows:

Equipment: Class 3 -	Buildings, ...	$538,572.19
4 -	Misc. Equipment .	10,603.46
5 -	Plant Appliances	63,102.17
6 -	Machinery, ...	130,811.71
	Current Unclass.	578,974.92
	Total -	1,372,069.45

Sheet ballistite was first placed in an Extrusion Plant press on 1 July 1943. Due to mechanical troubles, however, the press failed to function and, as a result, the first actual extrusion of ballistite took place several days later.

During the period this Plant operated for the war effort, 13,372,211 pounds of acceptable powder was extruded. A total of 1,101,121 pounds was rejected and expended which represents a loss figure of approximately 7.6%.

The design estimate of the capacity of the Extrusion Plant was 609,000 pounds of ballistite per month. (See Print No. 3 for Production Record).

It was indeed fortunate that throughout the period of construction and operation of the Extrusion Plant not one fatality occurred. The only serious accident to personnel under this department occurred at the Burning Ground when rejected ballistite prematurely caught fire. Minor burns were experienced by personnel

during the machining process. Three press ignitions occurred during which no one was injured with a property loss of approximately $32,700.00 and four electronic heating unit fires caused an estimated loss of $2,900. This excellent record is ample evidence of soundness of plant layout, equipment design and operation from the standpoint of safety.

As evidence of the splendid performance of this department, the following quoted telegram was received by the Commanding Officer on 9 August 1944:

> "To the Men and Women of the U. S. Naval Powder Factory, Indian Head, Maryland -
>
> "Rockets for which you have manufactured powder are a powerful new addition to Navy firepower. Landing craft equipped with rocket launchers are helping to blaze the way for our troops in amphibious operations. Rockets are also being used with great success on our combat planes. Rocket-equipped bombers severely damaged a Jap cargo ship at Raboul, set fire to a bivouac area at Bougainville and smashed gunnery emplacements and air-strips at Guam and Rota Islands. Every one of you made me proud of your part in providing the deadly punch for these projectiles."
>
> /S/ C. F. Hussey, Jr.,
> Rear Admiral, U.S.Navy,
> Chief of the Bureau of Ordnance."

Again, on 13 July 1945, the Bureau acknowledged the splendid achievement of this department in the following quoted message:

> "Splendid results obtained with American rockets against Jap shipping are set forth in a report received from the commander of a carrier air group in operation in the enemy home

waters. Fourteen hits with 5-inch rockets were scored on a Jap sub-chaser which was left burning and in a sinking condition. A destroyer blasted by six rockets was left ablaze and badly listing. Two unidentified Jap vessels, one of 5,000 tons and the other 1,000 tons, were heavily damaged and left afire. Rockets of this air group seriously damaged a large fishing vessel or subchaser. The increasing effectiveness of rocket firepower, as shown in this and other reports from the Pacific, should be a constant inspiration to all workers helping to provide these weapons for the Navy."

BALLISTIC LABORATORY -

The Ballistic Laboratory at the Naval Powder Factory is one of the larger activities charged with testing the rocket powder extruded at the Factory. The laboratory has been responsible also for test firing of rocket powder from many of the Army manufacturing activities. Firing was carried out for the Sunflower, Badger and Radford Army Plants as well as for the California Institute of Technology. The laboratory is composed of two static firing bays, three X-ray units, a small inhibiting group and the necessary office force of calculators and stenographers. An auxiliary service group provides stockroom, laundry, cleaning and transportation facilities necessitated by the ballistic activities.

In static firing, at the Powder Factory, the Bourdon Gauge is used as a means of measuring instantaneous pressure and photographing a curve of this pressure against the time of the explosion of the particular type of powder being tested. The static testing of rocket powder is de-

pendent on its actual performance and behavior and is used to determine what may be expected of the powder in combat performance. It has proven one of the most reliable test methods and has been invaluable in developing the finest types of rocket powder.

The inhibiting group is concerned solely with processing and preparation of the grains for static firing.

In 1940, the National Defense Research Committee established the Jet Propulsion Research Laboratory in the Valley at this Station to undertake fundamental research and development of rocket ordnance. In 1941, the committee expanded its program by contracting with the California Institute of Technology for further fundamental research on rocket ordnance of interest to both services with primary emphasis given to rocket weapons for the Navy.

In June, 1942, plans were made in the Bureau of Ordnance for the first extrusion of rocket powder at Indian Head. During the summer months of 1943, the static firing of this first product was done on the afternoon shift, in the Valley, where one Bourdon Gauge and equipment was available. Later, more equipment was acquired from Cal Tech, and firing was begun in what is now known as the "Wave" firing bay on Mattawoman Creek.

On 1 March 1944, the Ballistic's Office was opened. Later in the spring of that year, it was deemed advisable to use naval personnel to supplement the civilian

personnel. The first draft arrived in May, 1944. Both waves and bluejackets were shortly, thereafter, put to work at the Firing Bay. The civilian personnel employed on static firing were removed to the Jet Propulsion Unit No. 2. A new group of buildings was constructed to carry the heavier load of conditioning and firing rocket powder, as the extrusion output climbed steadily higher.

The Naval Powder Factory, at first, carried the responsibility for test firing for some of the War Department activities; but as the various plants acquired the necessary facilities, only every twentieth Army lot was fired. This "Check" firing served as a standard for the uniformity of the instruments and methods in use.

Actually, continuous production and firing was begun with Lot No. 396, in December 1943. The peak firing record was established in February and March, 1945, when approximately 45,000 shots were fired per month by the civilian and naval personnel working twenty-four hour shifts. (See Print No. 5 attached for Firing Record).

Industrial X-ray equipment is used at the Factory to detect internal flaws in the individual "Grains" of rocket powder which would, in all probability, affect its ballistic properties. Prior to the use of X-ray, entire lots of powder were, of necessity, proved entirely by static firing. In the course of this testing, one defective grain was sufficient to cause rejection of the entire lot. By means of X-ray testing, the particular

defective grain could be located and removed, thereby releasing more powder of better quality to serve demands. (See Print No. 4 attached for X-ray production record).

The preliminary research in the use of X-ray in the examination of rocket powder proved discouraging. However, through the work done at the California Institute of Technology and the Ordnance Investigation Laboratory at Stump Neck, sufficient data was collected to open one unit at Indian Head. Dryhouse No. 58, staffed entirely by naval personnel was placed in operation in October, 1944. This unit proved so successful in detecting internal flaws in the powder that construction was begun on two other units, more adequately equipped to carry the heavy load of work during regular operation of the Extrusion Plant. As a result, X-ray unit No. 2 was ready for operation in February, 1945, and Unit No. 1 in May of the same year.

The early lots of powder were accepted on spot X-ray examination, but after adequate facilities were made available, one hundred percent X-ray examination was carried out on each lot. Any lot which failed to meet specifications, either through static fire tests or through dimensional or visual examination, was returned to be completely re-X-rayed. With one hundred percent

radiographic examination of rocket powder, a reduction of 50% was made possible in the static firing and, thereby, a monthly saving of $100,000 in rocket powder, as well as, a monthly increase in production by the same amount of powder. In October, 1944, the Chief of the Bureau of Ordnance set as a desirable goal, during a monthly period, the processing of 300,000 square feet of film. That quota was surpassed during each month of production.

The rocket program was begun both at Cal Tech and the Naval Powder Factory under NORD Contract 500. It was from the original $110,000 allotted under this contract that the first static firing equipment was ordered and purchased. Later, Contract NXSO 38583 was used for the purchase of more static firing Bourdon units. Contract NXSO 47732 with the Carrier Corporation provided $69,860 for the purchase of temperature conditioning cabinets for use in the static testing. NORD Contract No. 6271 provided $52,060 for the purchase and installation of X-ray equipment and auxiliary devices. Allotments from various other contracts were used, in part, to obtain the necessary equipment as the facilities were enlarged.

Records of the Station indicate that the cost of the Ballistic Laboratory and its equipment, built and installed by Station force, to be $589,853, which may be itemized, as follows:

Equipment:	Class 3 -	Buildings,.....	$316,028.00
	4 -	Misc. Equipment .	862.00
	5 -	Plant Appliances	66,032.00
	6 -	Machinery, ...	3,225.00
		Current Unclassf.	203,706.00
		Total -	$589,853.00

A large portion of the equipment was constructed in the shops at the Naval Powder Factory.

On 1 April 1945, the personnel employed in this laboratory totalled 129 civilians and 146 enlisted personnel (103 waves and 43 bluejackets).

The Ballistics Laboratory can be justly proud of its safety record during the entire period of twenty-four hour daily production and rocket testing schedule. No major fires or accidents occurred either in the Firing Bay or at any of the X-ray buildings during the period from 1942 to November, 1945.

EXPLOSIVES RESEARCH LABORATORY -

An Explosives Research Laboratory was completed in 1945, to be used in carrying on varied lines of experimental work and explosives testing, particularly research work on military explosives, propellants and related ordnance materials. One of the functions will be an endeavor to improve the present powders and manufacturing processes, and to develop new propellants and compositions. It is expected that some of the work now underway by the National Defense Research Committee groups will be continued by this laboratory.

The building is U-shaped, two and one-half story, steel and concrete structure with red brick facing. (See Photograph "E" attached).

The building is so designed that it may easily be adapted to various types of research work. The individual laboratory rooms are made with close fitting partitions which are demountable and may be removed, if desired.

In addition to the regular laboratories, many rooms have been designed for special purposes. Among them are a conference room, microscope room, electrical measurements room, spectroscope room, darkroom and oven-room.

A large fireproof vault, located in the center of the building, provides for the safekeeping of files and records.

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During the war period, the Powder Factory manufactured smokeless powder, sulphuric and nitric acids, Explosive "D", Fulminate of Mercury, Chemical Pellets, Torpedo Torch Pots, and extruded powder.

The dawn of V-J day found the Naval Powder Factory flying the 5-star, Navy "E" Pennant, for on 21 October 1941, the Secretary of the Navy informed the Commanding Officer that this Station had been selected to receive the Navy "E" for excellence in production of naval ordnance, being among the first to receive this award.

On Friday, 24 October 1941, the presentation of the Ordnance Flag took place in the office of the Secretary. On 28 November 1941, Rear Admiral William H. P. Blandy, Chief of the Bureau of Ordnance, presented the Ordnance Flag and the Navy "E" Pennant to this Station. At 1100, the Navy Band opened the ceremony. Dignitaries included the Governor of Maryland and Mrs. O'Conor, Congressman L. G. Sasscer, Rear Admiral and Mrs. William H. P. Blandy, Commander and Mrs. R. W. Holsinger, and Dr. George W. Patterson, Former Powder Expert.

On 24 April 1942, the Navy Board for Production Awards granted a six months' continuation of the Navy "E" award to this Plant; the award permitted the Naval Powder Factory to display one white star in the Navy "E" Pennant then being flown.

Subsequently, on 24 October 1942, 24 April 1943, and 24 October 1943, six months' continuation of the Navy "E" award was granted this Station.

On 16 November 1944, the Secretary's office forwarded a new pennant with five stars affixed, and extended to all officers and employees of the Naval Powder Factory, its hearty congratulations on the outstanding production achievements.

The following message was received from the Chief of the Bureau of Ordnance on 6 November 1945, in recognition of the past performance of the Powder Factory.

"The war-time demands on the Naval Powder Factory, Indian Head, Maryland have been numerous and difficult. In the production of propellent powders and explosives, the efforts and results of the Powder Factory have met the requirements beyond expectation.

"For this excellent four year performance the Bureau expresses its sincere appreciation."

CHAPTER III

- BOTTLENECKS, PROBLEMS AND SOLUTIONS -

As the war progressed, the constant cry was "increase production". This resulted in innumerable bottlenecks and problems which were solved as well as possible by cutting corners, where permissible, even if it meant some increased hazard and installing additional units here and there, with Station force. For example:

SMOKELESS POWDER - The temperature of drying powder was increased from 40°C to 55°C (maximum of specifications), thereby shortening the time of drying, although this did not improve the quality of the powder. Otherwise, the number of dryhouses would have been inadequate for drying more than a daily output of 100,000 pounds.

The time in Solvent Recoveries had to be reduced for these also were inadequate for over 100,000 pounds daily production. This resulted in loss of recoverable ether and somewhat increased the hazard.

An improved system of pre-heating the water for purification of the pyro in the boiling tubs and the addition of five new tubs increased the output considerably.

A study and control of pulping in the Jordans increased the output through the Pulping and Poaching Unit and improved output both here and in the next operation - the Dehydrating House.

Water became one of the serious problems. The Powder Factory uses three types of water: (1) fresh water from underground wells, (2) raw Potomac River water, and (3) filtered river water. Unfortunately, in very dry seasons, the salt in the river water increases and the water cannot be used in certain processes if the salt exceeds 300 ppm. Furthermore, the fresh water supply was inadequate for all requirements, such as Power House, housing, barracks, etc., so it could not be drawn upon in an emergency for factory purposes. A still further complication was the fact that the river water becomes warm during the summer and is, therefore, unsuitable for condensing purposes in such units as the other stills, Accumulator House and Ammonia Compressor Plant, during the summer. A final difficulty was the disappointing amount of fresh water obtained from fresh water wells located at Marshall Hall, a point approximately ten miles distant. These wells were constructed on the Ranney Well system and were intended to supplement the fresh water supply of the Powder Factory. Their daily output was about 750,000 gallons instead of double this amount expected from the original estimate. These various problems were solved by conserving and re-using fresh water as much as possible; extending the pipe line and adding pumps at Marshall Hall, installing coolers such as the spray type and Ingersoll-Rand steam expansion; re-using the warmed condensing water from the other stills in the Boiling Tubs; and adding salt recorders in the

river water lines to keep a check on the amount of salt present.

In certain powder manufacturing operations, considerable ether vapor is present in the buildings, such as Press Houses and Mixing House. This is an explosive hazard, is detrimental to employees' health, and is a loss in recoverable material. An Activated Carbon Solvent Recovery was installed, by which the vapors from these buildings were removed and fresh air at controlled temperature was blown in through ducts to replace the vapor-laden air drawn out. This greatly improved safety and health conditions in these buildings and also the recovery of solvent (which otherwise would have been a total loss), made nearly a fifty percent reduction in the purchase of ether for Factory needs, in fact, savings amounted to approximately $25,000 monthly.

The Station had considered moving the alcohol storage tanks since these were originally a temporary installation and did not have concrete collecting troughs, sewer lines; etc., for approval safety conditions. After similar objections were reported by the Navy Inspection Board, twelve tanks holding approximately 1,000,000 pounds alcohol were removed to a new location and all approved safety features incorporated, both in the tank equipment and the mounting of the tanks in a concrete flow-off basin with adequate sewers.

A large amount of unserviceable powder accumulated at various Naval Ammunition Depots to be reworked at the Powder Factory. One of the Factory buildings which had been unused for some years was remodelled and equipped with new facilities for grinding and preparing this unserviceable powder for manufacture into target practice or useful powder.

Early in the war, the need for a flashless powder was reported. Little time was available for experiments, but from past knowledge the Powder Factory was able to produce a suitable flashless powder to about 8-inch calibre. At the same time, in order to provide flashless for charges already loaded or bagged, the Powder Factory developed a type of pellet that could be made in large quantities on a regular pill machine, and added in weighed increments to the powder charge. Machines were set up in another unused building and regular production was undertaken. Instructions and formula were then furnished various contractors in order that these pellets could be made in the desired quantities throughout the country.

Yearly, the raw materials such as cotton, ether, alcohol, etc., used per pound of powder, have been calculated. Improved methods of handling, recoveries installed, reduction of losses in the process, etc., have resulted in a saving of $1,512,300 in the raw materials

required during the War.

ACID - Complaints were received from residents along Mattawoman Creek, through their Congressmen, that the waste acid process water flowing into the Creek from the Powder Factory was killing the fish in the creek. This was confirmed by survey and test as the degree of hydrogen ion concentration of the water indicated too much acidity for fish life. Further studies were also made in cooperation with the Chesapeake Biological Laboratory of Maryland. Steps were, therefore, taken to provide equipment, such as a concrete silo for storage of powdered limestone and the necessary loading and unloading so limestone could be constantly added to the waste water to neutralize the acidity. This greatly improved conditions and restored the creek water to a safe environment for fish life.

The Acid Plant is situated some distance from the Cotton Nitrating area, requiring tank cars for the transportation of the needed mixed acid. Procurement of tank cars was a problem. A pipeline connecting the Acid Plant and Nitrating Houses solved this difficulty, reduced charges, and proved a great convenience.

EXTRUDED POWDER - Probably the greatest problems encountered in the manufacture of this powder were those caused by the changes in atmospheric temperature and humidity. The main sheet ballistite storage magazines were not heated; consequently, in cold weather the sheet ballistite is far below room temperature when it is brought to the

charge rolling houses where it is prepared for transfer to the extrusion presses. To extrude ballistite of acceptable quality, it is necessary, among other things, to feed it to the presses at a uniform temperature of approximately 105° F; consequently, it was necessary to install heating equipment to pre-heat the sheet ballistite. Forced draft hot air heaters were installed which later proved to be unsatisfactory because the rate of heating was so slow that many hours heating time were required to raise the ballistite rolls to the desired temperature. A long preheating time makes a large heating capacity and a large amount of in-process ballistite a necessity to keep the presses in constant operation. From an efficiency and safety viewpoint, the amount of in-process powder should be kept as small as possible. Also, even after five to six hours of heating, there was a wide temperature range between the exterior and interior of the powder roll. After several months of investigation and experimentation had indicated that the electronic type heating was both safe and practical, that type of heating unit was procured and installed. Since the electronic type unit requires a maximum of fifteen (15) minutes to raise the powder rolls to the desired temperature, the amount of ballistite in the heating process is reduced to a fraction of the amount required in the forced draft hot air type heaters. Secondly, the electronic type heating unit

raises the powder temperature uniformly throughout the roll which, of course, is extremely desirable for safe and acceptable extrusion. The electronic-type heating units worked very satisfactorily except when cold powder was processed upon which there was a considerable moisture condensation. Since it was feared that this moisture might cause "arc-over" between the preheater plates, it was necessary to take several hours to heat and dry this wet powder in the hot-air type heater, with the result that the temperature throughout the sheet rolls would be uniform, which, of course, would produce non-uniform extrusion conditions. In the machining end of the extrusion process, since the grains become brittle when cold, and since the grain dimensions vary with the temperature of the powder, it is obvious that the powder-temperature control is necessary. A good solution to this problem would be temperature-humidity control (air-conditioning) throughout the Extrusion Plant, including the sheet storage magazine if such an installation is feasible.

Another problem encountered was the fact that ballistite produced by different manufacturers, and in some cases, the ballistite produced by the same manufacturer, exhibited different coefficients of expansion. Thus, grains of different diametric, as well as length dimensions, were produced when extruded through the same die under similar press conditions. When the variances were

so great as to produce grains outside acceptable specification limits, attempts were made to counteract the trouble by varying the extrusion conditions. Also, oversize grains were salvaged by passing them through a sizing die which was developed here at the Factory.

As previously mentioned, humidity trouble was experienced in the preheating of the sheet when it was wet. Even greater troubles due to high humidity conditions were experienced in the extrusion presses themselves for the extrusion cylinder or basket is evacuated to approximately 15 MM mercury vacuum before pressure is applied to the sheet ballistite rolls. As a result, when the humidity is high, the vapor pressure of the moisture on the powder exceeds that of the air, causing the vacuum pumps additional work to reach the desired vacuum conditions for acceptable extrusion. This additional work on the vacuum pump increases the time of the extrusion cycle and consequently decreases the press output.

Considerable trouble was experienced in the early days of the Extrusion Plant because some of the equipment had been received improperly assembled. This, coupled with the fact that there were no personnel who were experienced in the operation and maintenance of extrusion presses, delayed the rise in production. It was not until December, 1943, after several months production had been rejected, that the importance of temperature control was learned and instituted in the extrusion process.

The extreme shortage of cruciform-type dies which would produce grains of acceptable dimensions caused much grief. In fact, most of the cruciform-type grains did not meet dimension specifications but were accepted when they were found to function properly ballistically. It is thought that a series of approximately five dies varying approximately only a thousandth of an inch in critical dimensions are needed for each type grain for each press to produce grains in which specifications will be met, due to the variance of the coefficient of expansion of different lots of sheet ballistite.

The severe personnel shortage, which was so widely experienced during World War II, was alleviated at this plant by the use of naval enlisted personnel. As far as possible, the civilian and enlisted personnel were not intermingled; instead, they operated as two independent groups. The civil service personnel were engaged in the production of the circular-type grain, the handling of all the raw materials, the packed goods in storage awaiting shipment, and maintenance. The naval service personnel were concerned wholly with the production of the cruciform-type grain. The preheated powder rolls were received from the civil service personnel and it was then handled by service personnel until returned as packed grains ready for transfer to a storage magazine. In other words, the operations of extrusion, in-process transportation, annealing, machining, inspection and packing

of the cruciform type grain were performed by the service personnel. The civil service employees were responsible for the similar operations incident to the production of circular type grains and the other duties mentioned previously.

BALLISTIC LABORATORY - Difficulties and problems were numerous in connection with first instituting and then maintaining production firing. The necessary change and re-design of machinery, as new developments were made in rocket research, was a constant source of difficulty.

The innately inconsistent properties of ballistite sheet gave rise to variations among lots, and even within the same lots of powder. These variations caused constant problems, not only in production, but also in firing samples from these lots.

In the production of smaller grains, especially Mark 3's and 4's, the firing at low temperatures could not be carried out successfully without "chuffing" (intermittent burning of the grain). The solution of this difficulty lay in the re-design of the grain and in the development of a thinner webbed grain which facilitated firing at sub-zero temperatures.

The problems encountered in firing the larger circular grains were concerned principally with loading of the motors. Experimentation indicated that, once burning was initiated, movement of the grain of powder within the

motor tube caused the grain to flatten against the motor nozzle. This flattening against the nozzle prevented the escape of gas pressure and inevitably caused a motor tube explosion. To remedy this problem, the loading plunger was developed and metal grids were cemented to the grains.

The difficulty experienced in attempting to fire "hot" shots was finally proved to result from the high nitroglycerine content of the sheet ballistite. After the nitroglycerine content was reduced approximately 1.0%, shots could be fired consistently and successfully at 140° F.

The introduction of X-ray as a regular step in the routine operation groups necessitated the rearrangement of man power and transportation units in order to prevent any interference with the production routine. After this rearrangement had been provided satisfactorily, it was imperative that the inadequate facilities be kept in a perpetual state of operation, and, in case of machinery failure, repairs be made without delay in order that the flow of production should not be slowed down. The scarcity of industrial X-ray film resulting from the many war demands necessitated a "day to day" plan of operation and prevented the establishment of any reserve supply. As a result, time was lost when scheduled shipments of film could not be made.

The increasingly large size of the grains, as production was perfected, especially Mark 13's and 19's, gave rise to mechanical difficulty in radiographing.

The large grains were developed after construction of the X-ray buildings were completed; as a result, all except one X-ray tube was too small to accommodate these "giant" grains.

CHAPTER IV

- PERSONNEL -

At the time the Bureau of Ordnance directed the first expansion, early in 1940, the Naval Powder Factory, was employing a total of 961 civilian personnel, with a complement of 11 naval and marine officers and 100 enlisted personnel. (See Print No. 6 attached for personnel figures). Plans submitted estimated a total force of 3,998 would be required for a production schedule of 100,000 pounds of powder. The Labor Board immediately began to tender appointments from all existing registers to furnish the labor required to operate the increased plant facilities. The first relieving step was the employment of women to replace male ordnance workers (classified laborers), physical science aides, messengers, storekeepers, and helpers. Existing shortages in the Grounds Department were relieved by the employment of boys between the ages of sixteen and eighteen. To further alleviate the situation, a recruiting staff, consisting of thirteen male employees and four female typists, were given training by a Civil Service Field representative, early in 1944, and five teams were organized to cover the areas of Roanoke, Virginia, Raleigh, North Carolina, Asheville, North Carolina, Charleston and Huntington, West Virginia, and Washington, D. C. Their assignment was to secure 350 employees for existing vacancies. They were furnished with

data on housing, transportation, Civil Service Regulations, including wage schedule, retirement, compensation, etc., and publicity. The recruiting party left the Powder Factory on 14 April 1944, and almost immediately the new employees began reporting in. The staff had been authorized to hire directly at the Recruiting Offices, located in the U. S. Employees' Service Offices in the various cities, accepting medical examinations performed by local physicians, furnishing meal tickets, and rail and/or bus transportation to Washington, D. C., where the last lap of the trip was furnished by Navy bus to Indian Head. Four one-story, wood barracks were moved from Fort Washington to house the bachelor male and female recruits. The recruiting staff secured approximately eleven hundred employees during the year they were in the field, of which approximately six hundred remained for longer than a six months' period. A contingent fund was set aside for small loans for those who needed assistance during the first two weeks of employment, prior to receipt of their first pay. Loans were made by the Senior Administrative Officer, usually for meals and various other necessities.

Just previous to the organization of the recruiting staff, and when the local labor supply had been practically exhausted, and due to the inability of the Civil Service Commission and local recruiting by the Labor Board to obtain civilian employees to replace losses due to resignation, induction and discharge; to obtain necessary

increase in personnel for the new Extrusion Plant; and due to the necessity for obtaining personnel for the extension to the above mentioned plant, a naval ordnance battalion was considered. Duties would include care and maintenance of grounds; handling of powder and explosive shipments; loading and unloading of raw materials, empty powder boxes, etc., relieving a large number of civilian employees who could be promoted to the rating of Powder Factory Attendant and perform the more important attendant work. On 2 November 1943, the Bureau of Ordnance requested the Bureau of Yards and Docks to provide such a battalion with the necessary messing facilities. Necessary recreational and subsistence buildings, including roads, walks and utilities, of a temporary nature, in the amount of $535,000 were approved.

Early in 1944, it was concluded that rather than a labor battalion, the factory required workers with some education and skill, and, therefore, arrangements were made with the Bureau that the Station complement of service personnel be composed of unlimited service classified as in the limited service instead of the previous authorized labor battalion. The first draft of one hundred and twenty-five men arrived on 18 May 1944. Included in the complement was a draft of fifteen musicians who later composed a very excellent band and orchestra. On 27 January 1944, the Secretary of the Navy established the U. S. Naval Barracks as a subordinate command. The site of the

old, temporary marine barracks, vacated upon completion of the new barracks, was chosen for the location of the Naval Barracks. The Barracks consisted of:

2 Barracks
Mess Hall
Ships Service
Bowling Alley & Gymnasium

The Ships Service provided the following services:

Laundry
Store
Fountain
Cobbler
Barber Shop
Tailor Shop
Presser

On 14 January 1944, the Commanding Officer recommended the early establishment of a force of waves sufficient to handle test work and conduct ballistic tests on rocket propellants (estimated complement of 25 officers and 266 enlisted women). The Bureau of Ordnance approved this request, and upon approval by the Bureau of Naval Personnel, requested Yards and Docks to construct housing facilities for this additional personnel. Temporary construction of three 112-man barracks was tentatively approved. The arrival of the first wave officers preceded the completion of the WOQ, so they were domiciled in public quarters. A two-story, frame building formerly used as a Hotel Annex to house bachelor girls was converted to use as a Wave Officers' Quarters. The first wave officer reported on 12 March 1944.

$248,000 was allocated for construction of housing

facilities. Original plans included separate messing facilities. However, after consideration, it was decided to permit the waves to use the messing facilities at the Naval Barracks.

Naval service personnel were engaged in producing the cruciform-type propellant at the Extrusion Plant. Ballistite was received in sheet form from the civilian group and was returned to them in the form of packed propellant, during which time all operations, such as extrusion, annealing, machining, inspection, packing, and process transportation, were performed by service personnel. Thus, the service group functioned as a unit separate from the civilian extrusion personnel. (See Print No. 7 attached for Extrusion Plant Personnel).

PERSONNEL

When the Japanese attacked Pearl Harbor, Captain Mark L. Hersey, Jr., USN, was Commanding Officer of the Naval Powder Factory, with Commander John F. Rees, USN, as his Executive Officer. The officer complement at this activity totalled nineteen naval and two marine officers. Dr. Walter W. Farnum, Chief Chemist, was civilian in charge of production, and the supervisory force was as follows:

Commander W. C. Gray, USN - Engineer & Constr. Officer
Chief Carpenter H. E. Landre, USN - Asst. Constr. Offr.
E. R. Eastburn - Foreman Machinist
B. L. Nicholson - Foreman Mechanic
L. L. Wayland - Foreman Electrician
Chris Lancaster - Master Mechanic
H. F. Lund - Foreman Construction

Lt. Comdr. J. R. Hapley, USN - Proof & Communications Officer

Lt. Comdr. A. M. Hinman, USN (Ret) - Grounds Officer
H. T. Ward - Foreman Laborer

Lt. Comdr. H. J. Orth, Jr., USNR - Experimental Officer (Valley)
Lt.(jg) R. A. Appleton, USNR - Asst. Experimental Offr.
Ens. J. D. DeSanto, USNR - Jr. Experimental Officer
Ens. W. E. Jeromiah, USNR - Jr. Experimental Officer

Lt. J. B. Hupp, USN(Ret) - Safety Engineer & Security Officer
Lt. J. P. Bowling, USN (Ret) - Transportation Officer
Ensign W. R. Coates, USN - Asst. Transportation Officer
J. O. McCracken, Foreman Transportation

Commander W. E. McCain (SC) USN - Supply Officer
Ens. N. C. Groby (SC) USNR - Asst. Supply Officer
Ens. E. I. Steinberg (SC) USNR - Asst. Supply Officer
L. H. Sternberg - Chief Clerk, Supply Department
H. W. Anderson - Chief Clerk, Accounting Dept.

Lt. Comdr. Loon Dancer (SC) USN(Ret) - Disbursing Officer

Lt. Comdr. T. F. Weinert (MC) USN - Medical Officer
Lt. (jg) R. D. Whitley (MC) USN - Asst. Medical Officer

Major P. R. Cowley, USMC - Marine Officer
Chief Marine Gunner Otho Wiggs, USMC - Asst to Marine Officer

A. D. Wilroy, Sr. - Junior Administrative Officer

R. H. Dement - Foreman, Powder Line

H. M. Coster - Superintendent, Acid Plant

T. C. Jenkins - Superintendent, "D" Plant

On 6 May 1943, Commander C. L. Jacobsen, USN (Retired), relieved Commander Rees as Executive Officer, and on 29 November 1943, Captain J. B. Glennon, USN (Retired), reported as Commanding Officer, relieving Captain Hersey. In January 1944, the Executive Officer, Commander Jacobsen, succumbed to an illness, causing his death several months later. During his absence, Lt. Comdr. H. J. Orth, Jr., USNR, acted as Executive Officer. On 1 May 1944, Commander S. K. MacLean, USN, reported for duty as Executive Officer, serving until 2 February 1945, when he was relieved by Captain T. M. Wolverton, USN, the present Executive Officer.

The close of the war found the following supervisory force in charge:

Captain J. B. Glennon, USN(Ret) - Commanding Officer

Captain T. M. Wolverton, USN - Executive Officer

Commander H. J. Orth, Jr., USNR - Engineer & Construction Officer
Lt. E. A. Wadsworth, USNR - Asst Construction Officer
Lt. Olav Johnson, USNR - Relief to Asst Const. Officer
Chf. Carpenter R. Southerland - Asst. to Const. Offr.
E. R. Eastburn - Foreman Machinist
B. L. Nicholson - Foreman Mechanic
L. L. Wayland - Foreman Electrician
Chris Lancaster - Master Mechanic
H. F. Lund - Foreman Construction
H. T. Ward - Foreman Grounds

Lt. C. F. Werner, Jr., USNR - Communications & Magazine Inspection Officer

Lt. V. M. Hopkins, USNR - Safety Officer
Lt. E. S. Hutmacher, USNR - Asst. Safety Officer

Lt. J. J. Welsh, USNR - Transportation Officer
Chief Boatswain H. Chambliss, USN - Assistant Transportation Officer
J. O. McCracken, Foreman Transportation

Lt. G. E. Mintner, USNR - In charge Navy personnel, Extrusion
Lt. (jg) J. D. Black, USNR - Assisting
Lt. (jg) P. A. McKim, USNR - Assisting
Ens. A. D. Mayer, USNR - Assisting
Ens. J. H. Hensinger, USNR - Assisting
Ens. R. W. Reckhow, USNR - Assisting

Lt. J. B. Hupp, USN (Ret) - Acting Executive Officer, Naval Barracks

Lt. H. F. Hall, USNR - Ships' Service Officer

Lt. J. B. Varley, USNR - Hotel Officer

Lt. (jg) J. A. VanGilse, USNR - Welfare and Recreation Officer

Lt. (jg) G. L. Goodding, (W) USNR - Officer-in-Charge WAVES

Ens. J. G. Farabaugh, USNR - Personnel Relations Officer

Captain P. W. Dreifus (MC) USN - Medical Officer
Lt. Comdr. Ralph Volk (MC) USNR - Assistant Medical Officer
Lt. P. P. Gates, (MC) USNR - Assistant Medical Officer
Lt. S. N. Anderson (MC) USNR - Asst. Medical Officer
Lt. A. E. Purkey (DC) USNR - Dental Officer

Commander E. J. Costello, Jr., (SC) USNR - Supply and Accounting Officer
Lt. B. J. O'Neill (SC) USNR - Asst. Supply Officer
Lt. E. I. Steinberg (SC) USNR - Assistant Accounting Officer
Lt. J. P. Byrnes (SC) USNR - Assistant Supply Officer
A. T. Silleman - Chief Clerk, Supply Department
H. W. Anderson - Chief Clerk, Accounting Department

Lieut. D. G. Fink (SC) USN - Disbursing Officer
Ens. C. E. Davenport (SC) USNR - Asst to Disbursing Officer
Lt. (jg) E. H. McMahon, W(SC) USNR - Commissary Officer

Lt. C. B. Upson, Jr., (ChC) USNR - Chaplain

Major D. R. Hyland, USMCR - Marine Officer
Capt. S. M. Butler, USMCR - Post Quartermaster
Capt. W. H. Shanahan, Jr., USMCR - Post Exchange Officer
Capt. J. F. Bushell, USMCR - Guard Officer
Capt. E. W. Adams, USMCR - Post Adjutant
Chief Warrant Officer Frank Cotrufo, USMCR - Company Officer
Warrant Officer R. C. Runyan, USMCR - Guard Officer
Warrant Officer U. F. Cunha, USMCR - Guard Officer

Commander T. F. Darrah, USNR - Officer-in-Charge, OIL, Stump Neck, Md.

A. D. Wilroy, Sr. - Senior Administrative Officer

R. H. Dement - Foreman, Powder Line (after serving 39½ years in Government Service, he retired on 31 October 1945)

H. M. COSTER - Superintendent, Acid Plant

T. C. Jenkins - Superintendent, "D" Plant

R. H. Kray - Chemical Laboratory

F. C. Thames - In-charge-of Extrusion Plant and Ballistic Laboratory

CHAPTER V

- SECURITY -

The Indian Head Volunteer Fire Department, composed of employee volunteers with the Foreman of Grounds Department acting as Fire Chief, functioned as a fire department until October, 1941, when a regularly paid unit consisting of experienced trained personnel was organized. In January, 1942, the Navy Department established fifteen new positions in the rating of Firefighter. The present force consisted of one Fire Chief, three watch standers, and fifteen firefighters, augmented by emergency services rendered by employee volunteer force. Firefighting apparatus consists of two combination pumper and chemical engines and one Fire Chief car. All auxiliary equipment throughout the Station, such as extinguishers, hose, fireplugs, etc., are inspected and maintained by this force.

Water supply to the community is furnished from fourteen artesian wells and three additional Ranney wells sunk at a location approximately ten miles from the Factory. The supply for fire protection and process water is pumped from the Potomac River. Three 2,000 gallon centrifugal electric-driven pumps are located in a fire-resistant pumphouse built on a pier over the river. Separate fire main, process water, and drinking water distributions are installed. Additional fire lines were run through the

new "D" Plant area and the New Dryhouse area, thereby making a loop so that pressure would be available in these areas even though one section or the other of the high pressure would be broken. Additional hydrants were installed at the new Ether House, "D" Plant, Old Coal Dock, and Fulminate area. A new Gamewell Fire Alarm system consisting of thirty-eight boxes was placed in use on 10 January 1942. Extinguishers of the carbon dioxide type are well distributed in most of the buildings and small hose lines used for washing down are available in majority of the units. Automatic sprinklers of the deluge type are provided in the Cotton Picking and Drying Machines in most buildings in the Industrial Area in which there is a hazard of explosive vapors or powder hazard. Control valves on some of the sprinklers were provided with supervisory alarms. A new addition to the Fire House, which is centrally located, provided office and room space for the Gamewell Fire Alarm Board, and tower used for storage of fire hose. On 27 January 1943, eleven additional boxes were added to the present system.

MARINE AND CIVILIAN GUARD

An increase in complement of the marine detachment at this Station was requested in June, 1940, to provide protection for the Factory. The Marine Barracks then in use, temporary, one-story wooden buildings erected during World War I, were filled to capacity and with the antici-

patod increase in complement, request was made for satisfactory barracks to house a marine detachment of approximately two hundred men. Appropriation for $125,000 was made for the construction of a new, two-story, brick barracks, to contain two squadrooms, Sergeant-of-the-Guard room, recreation room equipped with bowling alley and two pool tables, Post Exchange, Mess Hall, Galley, and numerous storerooms. (See Photograph "F" attached of building).

In January, 1941, the Navy Department directed that the size of the marine detachment be such as to provide a military force adequate to insure continuous protection against organized or concerted violence. However, in view of the stand taken by the Marine Corps Headquarters, of reducing the size of shore detachments in order that all available trained men might be used for combat service, the Civilian Guard was established on 27 January. The complement, consisting of fifty patrolmen and five supervisors, was determined by the number of posts required to be manned. The primary function was police duty. However, the complement, due to elimination of two posts, was reduced to thirty patrolmen and four supervisors. The Guard force was composed of employees, who because of age or disability, were not subject to the Selective Service Act. The posts manned by this force were so situated as to control all entrances and exits to the

the force and marine sentries were stationed at field posts at the fence surrounding the plant. Fence alarm system of the vibration detector type was provided with alarm instruments in the sentry boxes. The fence installation was completed and placed in operation in June, 1942; the installation covered approximately 23,000 feet of fence and cost approximately $12,487.60.

In July, 1943, request was made to provide marine guard of approximately thrity-five men for the Ordnance Investigation Laboratory at Stump Neck, Maryland. In view of the extremely confidential and secret nature of the work being performed at this activity, this need was considered to be urgent. An additional complement of two officers and twenty enlisted men was allotted in December, 1943, to provide this additional guard duty.

With cessation of hostilities, order was issued to disband the civilian guard and the duties previously performed by them again be undertaken by the marine detachment.

RIVER PATROL

In January, 1940, a Coast Guard patrol boat, based at the New Dock of the Naval Powder Factory, was assigned to provide additional shore-line and off-shore protection to the Plant. The duties of this patrol included patrolling the shore line and investigation of all traffic on the river for security purposes.

AIR PROTECTION

Anti-aircraft defense of the Naval Powder Factory was provided by Army personnel. A detachment of 125 enlisted men was housed in the old, temporary, Marine Barracks, and mess was provided by the Marine Corps in the new barrack's Mess Hall. Four anti-aircraft tower batteries, placed stragetically throughout the Plant, were manned twenty-four hours per day by this personnel. This contingent was detached from this Station on 1 October 1943.

MEDICAL FACILITIES

During the summer of 1940, the Old Administrative Building, located on a site overlooking the river, was remodeled and the Dispensary was removed to that location on 29 January 1941. The new building provided bed space for twenty, included modern, well-lighted, tiled operating room, and many other modern facilities. Shortly thereafter, a First-aid Station, manned by hospital corpsmen twenty-four hours a day, was opened in the Production area. Medical facilities included the regular Station ambulance and two Army-type ambulances. The complement of one medical officer and four corpsmen was increased during the war period until a staff of four medical officers and twenty-nine corpsmen, plus three Navy nurses, was attached to the Dispensary.

CHAPTER VI

- SUB-ACTIVITIES -

EXPERIMENTAL AND RESEARCH LABORATORY - JET PROPULSION

After removal of the Naval Proving Ground to Dahlgren, Virginia, the site known as the "Valley", formerly occupied as the gun firing line, was abandoned. In October, 1940, the Bureau despatched a naval officer to this Station for the purpose of performing experimental work in the Valley. The old Bombproof building was remodeled and facilities made available for his work. The National Defense Research Council expressed desire to be permitted the use of the facilities of this laboratory to develop the jet propulsion project. The money necessary to set up this laboratory, approximately $100,000 was furnished jointly by the Bureau of Ordnance and the National Research Defense Council. Small scale jet propulsion tests were conducted during the balance of the year, and in the years 1942, 1943 and 1944, the Experimental and Research Unit of the Naval Powder Factory worked diligently and aided materially in the tests conducted by the NDRC scientists on projects involving rocket range tests, rocket flares, chemical mortars, and numerous research problems.

In 1944, the NDRC officials removed its personnel to Pinto, West Virginia, and the Bureau of Ordnance directed the project be transferred to the Naval Ordnance Test Station, at Inyokern, California. The Valley

closed officially in July, 1944. Ballistic tests associated with this unit which were directed by the Bureau of Ordnance to be performed at the Naval Powder Factory were undertaken by the Ballistic Laboratory.

ORDNANCE INVESTIGATION LABORATORY, STUMP NECK.

Early in the fall of 1941, an immediate need arose for a more or less isolated location upon which to handle practical instruction for Advanced Mine School and research with high explosives. It was also deemed desirable to provide a similar location to house equipment for the investigation of dangerous weapons of explosive type. That detached portion of the Naval Powder Factory Reservation known as "Stump Neck" was chosen by the Bureau of Ordnance as being most desirable for the purpose and the Ordnance Investigation Laboratory was established as an activity under the Commanding Officer, Naval Powder Factory. Necessary funds were allocated and construction started on the new laboratory. On 19 January 1942, a Chief Petty Officer was ordered as caretaker of the project. Details of operation were directed by the Officer-in-Charge, Advanced Mine School, under the supervision of the Commanding Officer, Naval Powder Factory.

A farmhouse already upon the location was renovated and assigned to the Officer-in-Charge. On 24 June 1942, the Bureau authorized the construction of bachelor quarters for fifty men (20 officers and 30 enlisted men).

On 8 November 1943, the Bureau recommended the establishment of the Explosives Investigation Laboratory as an adjunct and subordinate command to the Naval Powder Factory.

The medical, disbursing and supply units of the Powder Factory were adequate to provide facilities for the personnel attached to Stump Neck.

Beginning in July of 1942, the Laboratory grew to the degree that it was necessary to establish new departments covering:

Investigation
Experimental
Photographic
X-ray
Maintenance
Supply and Commissary

The original complement allowed 22 officer and 70 enlisted men for this activity.

The complement at the close of the war was 23 officers and 164 enlisted (including waves).

CHAPTER VII

- TRANSPORTATION AND ROADS -

The Naval Powder Factory is situated upon a peninsula bounded on the northwest and south by the Potomac River and on the southeast by the Mattawoman Creek. A Government-owned 14½-mile railroad spur connects with a branch of the Pennsylvania Railroad at White Plains, Maryland, which provides for shipment of freight, powder and equipment, to and from Indian Head. Tug and lighter service on the Potomac River, primarily for Government-manufactured equipment and material, is maintained between Washington, Indian Head, Dahlgren and the Fifth Naval District. Prior to 1942, no bus connection existed between Indian Head and Washington, and residents of the community and outlying districts depended largely upon boat transportation for their mode of commuting to and from the District of Columbia, where they were obligated to do most of their shopping for clothing, household supplies and other necessities, as well as a large portion of their groceries, since the source of supply at Indian Head was so limited. In 1942, the Southern Maryland Bus Lines acquired a franchise for bus service along Route 224, and a daily schedule was inaugurated, providing six trips per day. All during the years since the founding of the Powder Factory, water transportation had been provided for employees, their families, and

steamers and lastly by the USS BERCEAU, a small torpedo boat used in the Spanish-American War, later as a mail boat, and finally as a passenger ferry. It made its last run on 12 June 1940, and was thereafter towed to the Philadelphia Navy Yard for survey.

With the expansion program in view, and with the expected increase in traffic along Route 224, which was already in a deplorable condition, the Commanding Officer, early in 1940, increased his efforts to secure a new or improved access road. Both the Bureau of Ordnance and the Bureau of Yards and Docks, as well as the State Roads Commission and the Works Project Administration, received repeated appeals for action toward securing, at an early date, improved road conditions to this activity. No funds were available for such a road. The Commanding Officer advised that unless repairs were made almost immediately, it would be necessary to close said road about March, since it would no longer bear up with the coming thawing weather and the increase of heavy freight shipments and employee passenger cars daily using this highway. In addition, approximately one thousand low-cost units had been erected in this locality during the past year and with the rise in residential population increased road traffic was anticipated.

In May, 1942, the State Roads Commission advised bids had been advertised and received on the Indian Head road, funds having been allocated by the Public Roads Adminis-

tration for a road to cost approximately $2,000,000.

Portions of the new road have been in use for approximately one year and at the close of the war, there remained about nine miles of roadway now in the process of completion.

Early in 1942, the transportation of employees to and from the Factory became increasingly difficult. With the advent of tire and gasoline rationing, a large number of employees were forced to put aside their cars. The "Share-your-car" clubs and commercial bus lines aided materially in providing the necessary transportation, but with the number of employees steadily rising, the need for further facilities developed. In April 1942, with approximately 1800 employees commuting daily, and with the anticipation of this number increasing further in the near future, the Commanding Officer recommended to the Bureau of Ordnance that the Station provide adequate daily bus service to its employees. Almost immediately, the Bureau allocated ten buses of 60-passenger capacity. Great difficulty and much delay had been occasioned in securing permit from the Maryland Commissioner of Motor Vehicles for the operation of these buses. The Navy Department directed that fare be comparable to those of existing public carriers. Five additional buses were secured, bringing the number allotted to the Station to fifteen.

When the Naval Powder Factory personnel was augmented by the assignment of an ordnance battalion consisting of 834 enlisted sailors and waves, liberty buses were provided for trips to Washington, three days each week.

Since V-J day, the need for this additional bus service became less great and plans were immediately made for its discontinuance. Finally, on 14 September 1945, the service was terminated, having provided service to 2,067,682 employee riders, and a total of $245,240.93 having been collected for tickets, during its three and one-half years' existence.

CHAPTER VIII

- HOUSING -

The residential area of the Naval Powder Factory has always presented a very creditable appearance. The streets are well laid out and the houses are located far enough apart to provide for attractive lawns and flower gardens. The tenants have always taken a great amount of pride in the appearance of their homes. Previous to February, 1941, the housing facilities upon the Reservation totalled 179 civilian and 23 officers' quarters, plus a 30-room Government Hotel.

However, with the expansion of facilities and increasing demand for higher powder production, necessitating procurement of additional labor, an unusual demand was created for housing. Early in 1940, $900,900 was appropriated for the erection of 350 low-cost defense units upon the Naval Reservation, at an approximate cost of $2,400 each (200 single - 4-room, 75 - 3-room and 75 - 5-room units). Streets and alleys were laid out and the contract was awarded to the Harwood Nebel Construction Company. The contract also included two sets of officer's quarters and a Bachelor Officers' Quarters. The officer's quarters were completed and ready for occupancy in August, 1941. The BOQ was completed and occupied in April, 1942. This dwelling, a two-story, brick, 9-bedroom dwelling, was located on the river bank over-

looking the Potomac River, in a most picturesque setting. There had long been the need for such a dwelling. The bachelor officers had formerly been housed in a 3-story, brick dwelling usually assigned as a family unit. On 15 July 1941, the 350 low-cost units were ready for occupancy and by 1 March 1942, the entire project was occupied by Government employees.

The Federal Housing Project at Potomac Heights, located adjacent to the Naval Powder Factory, was rushed to completion and provided housing for approximately 450 families. Of the original 650 units planned for this community, the Commanding Officer requested that 100 units be removed from the present site of the Federal Housing project and placed upon a location to be reserved for negro personnel; this project to be known as "Perry Wright" division.

Isolated as it is, at a distance of approximately thirty miles, by road, from the District of Columbia, and isolated to even a greater degree by the introduction of tire and gasoline rationing, residents of the Naval Powder Factory Reservation depended largely upon the Station for their source of entertainment and recreation.

Within the school grounds are located a fine baseball diamond, with grandstand, soccer and football fields and volley ball courts. Tennis courts are available in several locations throughout the Reservation. Adjoining the several courts located at the Recreation Hall is also

a softball diamond where many furious battles of competition are waged by the various teams.

A small swimming pool was constructed years ago for the use of officers, their families and guests. In the spring of 1944, after analysis of the river water proved that the bacillus content was low enough to permit swimming in the river, a Bathing Beach was provided on the shore near the New Dock. Life guards were stationed during the periods set aside as being open for use, and the attractive picnic grounds provided much pleasure to the whole community, which had, for so many years, been denied this form of recreation and amusement. On 13 May 1944, while plans were being made for the arrival of the ordnance battalion, a request was forwarded for the construction of a swimming pool for the use of enlisted personnel, to accommodate a complement of approximately 1100. However, this request was not approved. In the spring of 1945, the erection of a swimming pool for the use of the entire community was undertaken. Plans were made, materials purchased and volunteer labor furnished by the entire village, and funds provided by Community Welfare. On 5 July, the official opening ceremony took place.

A Picnic Grounds, located on Mattawoman Creek, provides boat berths and picnic facilities for all personnel. A screened-in enclosure housing picnic tables

and benches, including dutch-oven, provides ideal facilities for picnic suppers.

The Naval and Marine Barracks provide recreational and entertainment features for the service personnel, including two bowling alleys.

A 9-hole Golf Course is located upon the Reservation and is made available to both military and civilian personnel.

CHAPTER IX

- SCHOOLS -

The Schools in Indian Head, Maryland, are located upon the Naval Reservation and operated jointly by the Station and County Board of Education of Maryland. The schools consisted of a 9-classroom and Auditorium one-story, frame building, erected in 1919, with an enrollment of 233; the primary grades were housed on the first floor of a two-story, frame dormitory building, housing 260 pupils. (P 14)

During the year 1941, due to rapidly increasing personnel, the need for increased school facilities was fast becoming acute. With the completion of 1,000 low-cost units being erected in the immediate vicinity to house personnel required for the expanded manufacturing program, the Commanding Officer contacted the school officials for a survey of the school facilities, conditions and additional equipment required.

The survey revealed the urgent need for additional facilities and the County Superintendent was advised to submit estimates for the required school. The project covered a new elementary school ($185,000) and a Junior High ($115,000), and the addition of four rooms to the present High School ($40,000). The school was to be located upon the Naval Reservation. The Commanding Officer forwarded Public Works Project request, as previous-

ly submitted by the County Superintendent for identical equipment. On 18 December 1941, FWA notified the Station that if the sum of $250,000 was acceptable, the project could be secured. The Commanding Officer immediately wired his acceptance. Work was begun on 27 April 1942. The building, a one-story brick composed of three wings and gymnasium, was completed in time for the school year beginning September, 1942; and consisted of the following:

Wing No. 1 - 11 classrooms, male restroom

Wing No. 2 - 7 classrooms, Home Economics Kitchen, Girls' dressingroom, Cafeteria, with kitchen.

Wing No. 3 - 5 classrooms, Teachers' room, 3 storage rooms and Gymnasium.

The Gymnasium contains boys' lockers and shower-room and girls' lockers and shower-room. Under Wing No. 2, there is a basement in which is located a Janitor's room, coal storage, restroom and Manual Training Shop.

The enrollment during the war years has been as follows:

October 1, 1940 - 444
" 1, 1941 - 573
" 1, 1942 - 745
" 1, 1943 - 846
" 1, 1944 - 876
" 1, 1945 - 951

A Child Care Center was established early in the war at the Potomac Heights project to care for the children of mother war-workers.

CHAPTER X

MAJOR ACCIDENTS, FIRES, EXPLOSIONS

MIXING HOUSE FIRE, 25 FEBRUARY 1941:

A fire of undetermined origin occurred in No. 1 Block-breaker at 2135, 25 February 1941, in which three men were burned, two of them seriously. Material damage amounted to approximately $25.00, which included the following:

Loss of 300 pounds of pyro, by fire
Damage to 800 pounds of pyro, by water; recovered by reworking
Block-breaker case distorted
Paint in cell scorched and burned

It was found that there was no deviation from the normal operating procedure, no apparent mechanical defect in the block-breaker, and no unauthorized persons were seen in the Powder Line area prior to the fire. The automatic sprinkler system functioned properly and the personnel on duty handled the casualty in an efficient manner. Cause of fire was not discovered. However, as a result of this fire, the block-breakers were separated from the Mixing Houses during the expansion of the Powder Factory. Both of these units were re-designed, upon recommendation of the Board, in an effort to minimize any probable hazards.

ETHER PLANT FIRE, 28 APRIL 1941:

On the night of 28 April 1941, the operators in the Ether Plant had considerable difficulty with the ether

alcohol condensing equipment. Two rectifiers were operating normally and the alcohol column of the rectifier was being warmed to start operation. However, in warming the alcohol of the continuous rectifier, the operators experienced peculiar trouble with the mechanical steam control, and finally, it was necessary to raise the temperature sufficiently to evaporate the alcohol by means of manual operation. Manual operation caused excessive venting. About 0245, while changing from manual to automatic operation, the operators noticed flames at the top of the condenser, apparently starting some place in the vicinity of the condenser unit and below the ceiling. The presence of excess liquid of large quantities discharging from the vents indicated abnormal conditions within the apparatus, most likely from poor temperature and pressure control. Presence of inflammable liquid discharge from vent condenser at the top of the building created a hazardous situation, and the possible discharge of static electricity in the presence of the inflammable liquid could have been the cause of the fire, in spite of the fact that vapor-proof lights were installed in all fixtures in buildings near the condensing equipment and all parts of the apparatus, structural members of the building and electrical wiring in the building was well grounded. The fire destroyed one building, damaged another, and ruined equipment most essential to the manu-

facture of powder. The total loss was estimated at approximately $77,948.65. All operators were able to escape from the building and no injuries were received as a result of the fire.

EXTRUSION PLANT FIRE, 24 APRIL 1944:

At about 1744, 24 April 1944, an ignition occurred inside the extrusion cylinder of No. 2 press at the Extrusion Plant, resulting in complete demolition of the press and damage to No. 2 Press House. Operating conditions were normal, prescribed procedures were being followed, and no neglect on the part of personnel was disclosed. The press and accessories were in good mechanical condition.

The press charge was composed of rejected Mark I ballistite grains which had been cut into lengths of about one inch, which, before loading into the extrusion cylinder, had been preheated in an air-bath oven for a period of from two to not more than three hours. This charge had been preheated and extruded only once prior to the ignition and resultant explosion that demolished the press. This press had been cleaned ten days before the explosion. The rise of pressure in the cylinder was so rapid that the tension-failure member did not fail quickly enough to prevent damage to the ram and rupture of the extrusion and hydraulic cylinders.

Damage due to the accident, based upon the cost of

replacing the press and repairing the building, was approximately $9,500.

BURNING DUMP FIRE, 12 DECEMBER 1944:

The "Burning Dump", an isolated spot selected for the burning of scrap and rejected powder, was the scene of a fire of undetermined origin at about 0945, 12 December 1944, which resulted in serious burns to two employees. A careful inspection by the supervisor, made just prior to unloading a truckload of condemned ballistite sheet powder (in rolls) disclosed no signs of embers or other indication of fire. All employees charged with unloading this double-base powder were wearing conductive sole shoes to eliminate the possibility of sparks caused by friction. It was impossible to ascertain the cause of the fire from the evidence presented. Damage to the truck amounted to approximately $700.00. The two injured employees were seriously burned and were hospitalized.

EXTRUSION PLANT FIRE, 27 DECEMBER 1944:

A charge of powder ignited while being extruded from No. 10 press at the Extrusion Plant at about 1330, 27 December 1944, resulting in major damage to the extrusion press and lesser damage to the building in which the press was located. Approximately 115 pounds of powder was lost. The total damage to press and building, including all accessories, amounted to approximately $11,000.

No personnel were injured; there were no unauthorized persons in the vicinity at the time of the fire; all personnel were properly trained and acting in regular line of duty; all operating conditions were normal, and no evidence of any neglect on the part of personnel was disclosed.

This press had been exceptionally reliable in service. No mechanical defects were observed previous to the fire, nor were there any obvious mechanical defects noted after examination after the fire.

The Press House provided adequate protection to operating personnel, and it was found that the design of this structure was sound since the damage was confined to only the wooden portions of the building. The lot of powder being extruded at the time of ignition was similar to a number of other lots previously extruded in No. 10 and other presses. A chemical examination of a sample of the powder remaining after the fire revealed nothing unusual, nor did any of the powder extruded just prior to the fire show any abnormal condition.

It was concluded that the powder charge ignited at the die end of the extrusion cylinder due to the fact that small sections of unconsolidated sheet powder recovered after being blown through the barricade into the clay backstop showed only a slight amount of burning which indicated that ignition probably occurred at the die end of the cylinder. No definite explanation as to

the cause of the fire could be made. Specific contributory possible causes of the ignition of the powder charge, such as heat of friction from moving parts of the press, inclusion of foreign matter in the charge rolls, conditions of local sensitivity in the sheet powder, and resultant heating of the powder during extrusion due to inclusion of air or due to an unclean die, were given consideration, but none of these could definitely be concluded upon due to a lack of any supporting circumstantial evidence.

DRYHOUSE FIRE, 12 JANUARY 1945:

At about 0325, 12 January 1945, a fire occurred at No. 1 Dryhouse, which resulted in the destruction of the dryhouse and its contents of 3,096 pounds of experimental flashless powder. The concrete dryhouse porch was not damaged. No personnel were injured as result of this fire. The temperature just prior to the fire was 54°C. It had been intended to bring the temperature to 60° C., for the remainder of the drying process. (The specifications for smokeless powder require a temperature of 134.5° C. must be withstood for a period of five hours without explosion). Operating conditions were normal and no neglect of personnel was disclosed. All the lots of flashless powder had been manufactured in and/or by regular production equipment. Total damage was $5,346.00 to the building and $935.00 to machinery and equipment.

A Board of Investigation concluded that the use of regular production equipment in the manufacture of experimental smokeless powder interrupts and delays the production of the regular types of smokeless powder and is a hazard to that equipment.

EXTRUSION PLANT FIRE, 14 JANUARY 1945:

A charge of powder ignited while being extruded from No. 8 press at the Extrusion Plant at or about 2014 on 14 January 1945, resulting in major damage to the press and lesser damage to the building - total damage $12,510.

There was no injury to personnel; no unauthorized persons were present in that area; all operating personnel were properly trained and acting in regular line of duty, and the operating procedure and conditions were normal, with no evidence of any neglect on the part of personnel. No. 8 press was reliable in its operation and no mechanical defects were observed before the fire; the press had been in operation four days since the die had last been removed and cleaned. The tension-failure member on the hydraulic drive functioned as designed, but the tension-failure member on the extrusion cylinder did not function as designed in that the failure took place at the clamping rings and not on the studs as intended. The Press House provided protection to personnel operating the press. It was found that the powder hoist suf-

ferod undue damage from flying fragments due to its improper location.

It was also found that an appreciable amount of foreign matter had been discovered with incoming ballistite, such as string, nails, screws, and short pieces of wire. It appeared that the heat from friction of moving parts of the press, inclusion of foreign matter in the charge rolls, local sensitivity in the sheet powder, heating of powder due to compression of air occluded in the powder, and increased sensitivity of powder due to freezing of the nitroglycerine content might have been contributing factors toward ignition of the charge. Any single factor or combination thereof could have been sufficient to cause the fire. The most probable cause of ignition would be a combination of local sensitivity in the powder, which may or may not have been due to the possible exposure of the charge rolls to abnormally low temperatures while enroute to the Naval Powder Factory, coupled with the inclusion of foreign matter in the powder since those particular conditions seem most likely to occur in combination. This lot of powder had been shipped from Kansas on 16 December 1944, and had arrived at this Station on 30 December 1944, so that it had obviously been subjected to extremely low temperatures in transit.

EXTRUSION PLANT FIRE, 10 FEBRUARY 1945:

At about 0020, a powder fire occurred at the High Frequency Heater No. 2 of the Extrusion Plant, on 10 February 1945. The charge was composed of twenty-four rolls of Sunflower Ordnance Works double-base powder which had arrived at this Station on the previous day. Operating procedures were being followed and an examination by an RCA engineer revealed no trouble in the electrical apparatus which could have resulted in overheating the powder charge. No personnel were injured. Damage to Government property was estimated at $500.00, and 488 pounds of powder valued at $879.00.

Analysis showed the powder to be within specifications. No solution was arrived at and the ignition was due to some unknown factor. The fire must have occurred when some of the powder being heated reached the ignition temperature. It was found, however, that the construction of the building provided adequate security for personnel.

MIXING HOUSE FIRE - 28 MARCH 1945:

A fire started in No. 7 Mixer in the Mixing House No. 169, at 1340 on 28 March 1945. The charge in this mixer was rework powder and had been in the mixer longer than the usual time allowed. When this mixer exploded, the top was blown off and there were at least two explosions approximately three to five seconds apart.

Three employees were injured as a result of this explosion. They were treated at the local Dispensary and one was transferred to hospital in Washington, D. C., for further treatment.

Damage to Government property consisted of damage to No. 7 Mixer, to the exhaust ducts, and sprinkler system of Building No. 169 and extensive damage to building itself as well as the loss of 3000 pounds of powder. Loss amounted to $5700.00. Windows were broken in every room from No. 5 mixer room to blocking press room. Sections of the duct were blown from 25 to 150 feet from the building; some of the pieces weighing as much as 15 pounds. The distance from the source of the fire at No. 7 Mixer to No. 11 Mixer where the second explosion occurred is approximately 40 feet. The doors of No. 8 and 9 mixer rooms had been closed. The operators in the area attempted to fight the fire before turning in the alarm, which is the general custom. As a result of the explosions, the main sprinkler line in the building was broken. The water pressure was very low at the start of the fire and did not increase until some time after the explosion had taken place. After No. 7 Mixer exploded, No. 11 and 12 Mixer Rooms caught fire and the exhaust ducts blow up. The fire spread to all the rooms from No. 5 Mixer Room to the Blocking Press Room at the end of the building. The powder dust accumulated on the filters on the feeder lines to the

main solvent recovery duct causing them to explode when fire reached them.

The fire was of unknown origin. It was recommended that fire plugs be installed to be supplied from a ten-inch water line separate from the one supplying the sprinkler system; that sprinkler lines be installed in such a way as to prevent, as far as possible, a recurrence of a rupture of these lines; that the attic construction be of a safer type; that a new type Mixing House design be considered with less congestion of the equipment therein and with dust collectors for the block press rooms, as well as a series of sprinklers installed along the conveyor line. A master switch was also suggested so that the entire house could be shut down at once.

SOLVENT RECOVERY "D" EXPLOSION - 19 APRIL 1945:

On or about 1752, 19 April 1945, an explosion and fire occurred in Bay No. 5 of Solvent Recovery "D" Building. Three employees working in this bay were killed by blast concussion. All three men were working in their regular line of duty. All were properly trained and qualified workmen.

All blowers in the solvent recovery system of Bay No. 5 had been turned off in accordance with normal operating procedure before any of the workmen entered the bay to remove powder from the powder cans. The opera-

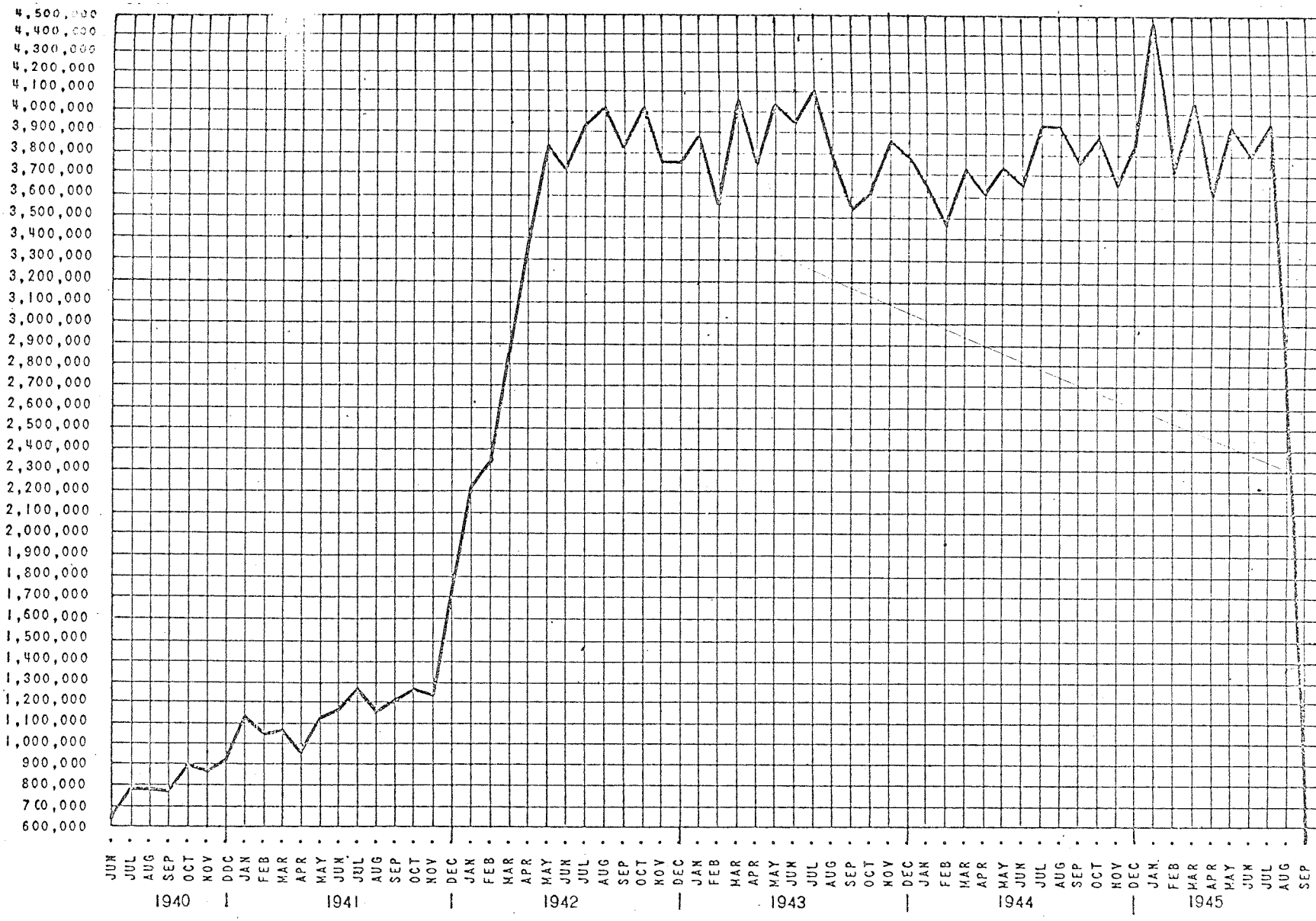
tion of draving powder was commenced immediately after shutdown, as was normal practice. The floor had been wet down with water before removal of the powder was started in order to minimize the possibility of the presence of static electricity and the floor had been wet down one or more times while powder was being withdrawn and the floor was known to have been wet only a few minutes before the explosion. Six of the eight solvent recovery cans for holding powder had been emptied of their charges of approximately 4,000 pounds of powder each and the seventh can had been emptied of about one-half of the charge at the time of the explosion. The greatest damage to property was centered at the midpoint of the row of six empty powder cans. The bodies of the three men killed by the explosion were found near the seventh powder can. The six empty powder cans were completely destroyed, the partially-filled seventh had the bottom ruptured by the explosion and the eighth can, which was full of powder, had only the top blown off. There was no evidence of sabotage.

This unit had been in operation for about four years without any untoward incident and there had been no changes in equipment, methods, or safety measures of recent date.

The damage to Government property was $23,655.00, including approximately 6,000 pounds of powder lost.

It was believed from an inspection of the damaged cans and record of three previous similar fires that a strong presumption existed that the fire originated at the spout of Can Number 7, traveled through the can into the duct of the solvent recovery system before the discharge valve could be closed and ignited the ether and alcohol fumes in that system.

The concentration of fumes in the empty cans and ducts was sufficient, and did, in fact, form an explosive mixture, which ignited with the resultant explosion. Insufficient evidence was found upon which to base any conclusive decision regarding the cause of ignition since all persons in the room at the time of the explosion were killed by blast concussion, and damage to the building and equipment was so extensive that it was not possible to determine with exactitude whether or not the equipment in use was at fault.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PRINT No 1

HISTORY OF NAVAL ORDNANCE STATION
INDIAN HEAD, MARYLAND

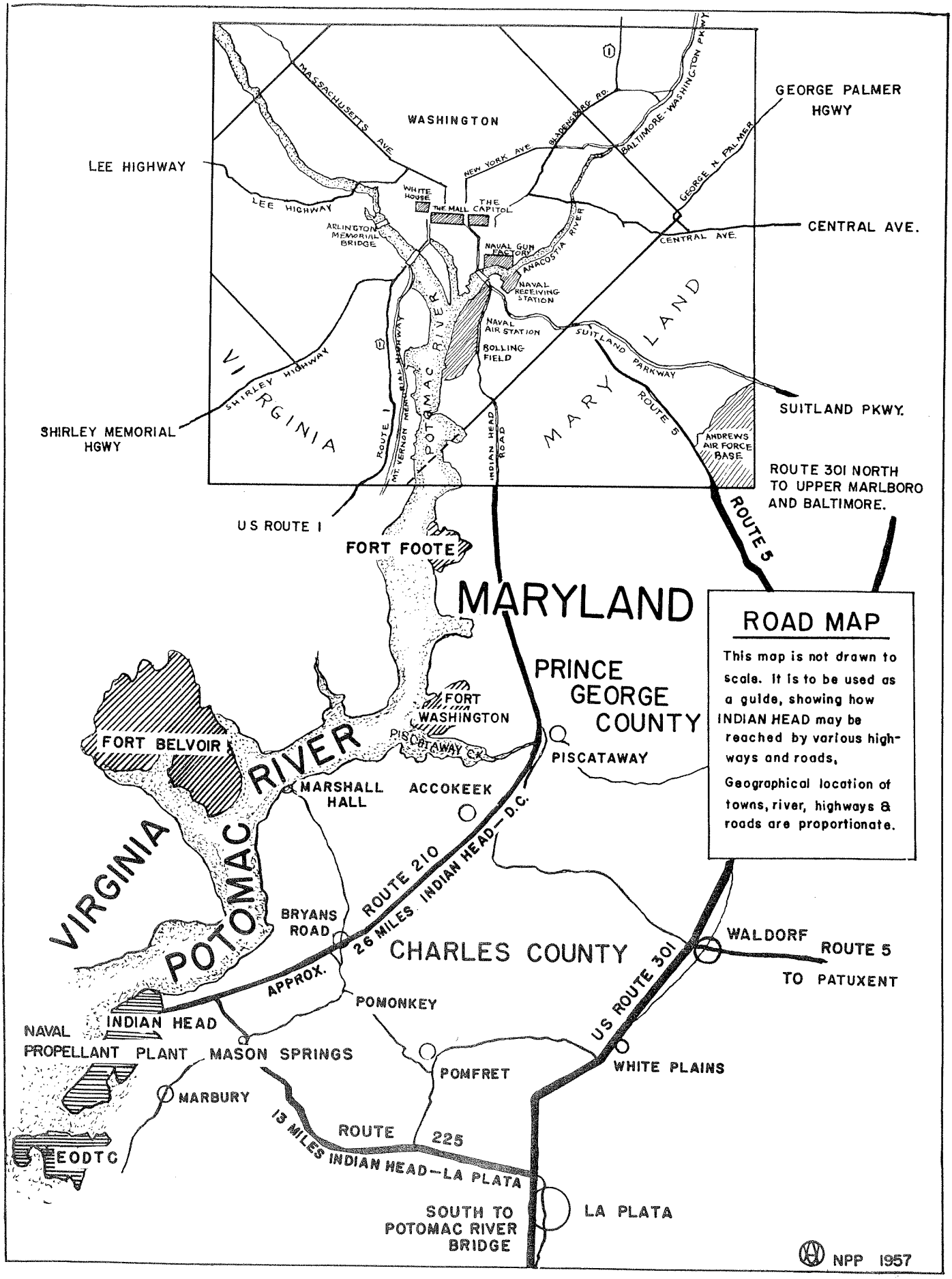
1890	Naval Proving Ground at Annopolis moved to Indian Head
1900	First smokeless powder manufactured
1901	Stump Neck Annex property purchased to extend firing range
1921	All proving ground activities moved to Dahlgren, Virginia
1932	Proving Ground at Dahlgren established as separate command
	Station redesignated Naval Powder Factory
1943	Extrusion Plant built for the manufacture of rocket propellant grains
1945	Propellant research and development added to station mission
1949	Patterson Pilot Plant for experimental production opened
1951 to 1954	Four plants constructed for manufacturing rocket propellants and propellant ingredients
1957	Participation in Polaris Program begun
1958	Station redesignated Naval Propellant Plant
1960	Twenty-three new buildings for Polaris Base Grain completed
1961	RCA 501 "On-Line" Computer assumed ballistic evaluation role - Nitorplasticizers produced for the Polaris Program
1962	Space-oriented programs added: Manufacture of X248 Scout (3rd Stage Delta)
	New liquid monopropellant, Otto Fuel II, developed and accepted for use in Torpedo Mk 46 Mod 1
1963	Construction of Inert-Diluent Demonstration Plant started
1964	Successful firing of motors produced by Pneumatic-Mix and Inert-Diluent Processes
1965	Technical management and production support provided for the increased 2.75 inch FFAR requirements in Southeast Asia
1966	Inert-Diluent Pilot Production Plant construction started Plant redesignated Naval Ordnance Station, Indian Head
	Started producing high-energy casting powder for C-3 second stage Poseidon missile
1967	Production of NACO gun propellant started
	Plant assigned gun primer responsibility for Navy

INFORMATION HANDBOOK

OF THE

U. S. NAVAL PROPELLANT PLANT
INDIAN HEAD, MARYLAND

PREPARED FOR THE INFORMATION AND CONVENIENCE OF MILITARY AND CIVILIAN PERSONNEL REPORTING FOR DUTY WITH THE U. S. NAVAL PROPELLANT PLANT, INDIAN HEAD, MARYLAND



ROAD MAP

This map is not drawn to scale. It is to be used as a guide, showing how INDIAN HEAD may be reached by various highways and roads.

Geographical location of towns, river, highways & roads are proportionate.

INDEX

A

Accessibility. 3
Accidents, procedure in case of. 36
Air Raid Precautions 40-41
Alcoholic Beverages 32
American Red Cross . . . . . 16&50
Athletic Equipment (Military) 16

B

Bachelor Officers' Quarters 9-11
Banking 42
Barber Shop (Military) 16
Baseball 42
Basketball 24
Bicycles 35
Boating 24
Bowling 24-25
Bridge 25
Business in Private Homes 32

C

Cafeteria 23-24
Cameras. 33
Chief Petty Officers' Mess (Open). 19
Children, control of 33
Churches 42-45
Civilian Guard 33
Commissary (Military). 17
Commissioned Officers' Mess (Closed) 17-18
Commissioned Officers' Mess (Open) 18-19

D

Dental Care (Military) 22
Dentists in Area 47
Dining Accommodations. 47-48
Doctors in Area 45-47
Driver's License 35
Drycleaning (Military - Civilian). 21

E

Education Facilities (Courses) 25
Enlisted Men's Club. 20
Explosive Ordnance Disposal
Technical Center 57-61

F

Firearms, restriction on 34
Fires 33
Fireworks 33
Fishing Regulations. . . . . 25-26&34
Fleet Reserve Association. 20

G

Garbage & Trash Collections 13-14
Gasoline Purchase (Military) 20
General Emergency Precautions 40-41
Golf 26-27

H

History of the Station 1-3
Hobby Shop 27-28
Hospitals in Area 48
Hours of Work 8
Household Goods (Military) 6-8
Housing 9-13
Hunting Regulations . . . . . 25-26&34
Hucksters 28

I

Identification Badges 5-6

L

Laundry (Military) 21
Legal Assistance (Military) 21
Library 28

M

Marine Corps Detachment 62
Marine Guard 34
Medical Care (Military). 21-22
Mobile Library 48
Motor Courts 49
Motor Vehicles 36

N

Naval School, Explosive Ordnance Disposal. . 54-56
Navy Exchange (Military) 22-23
Navy Relief Society. 49
Newspapers 49
Notaries Public in Area 49
NPP Movies 28-29

O

Officers' Wives' Club 23

P

Payment of Rent 13
Pedestrians 35
Pets 36-37
Picnic Area 29
Police Assistance 34
Police Regulations 32-39
Publications 29
Public Quarters 9

R

Railway Express 50
Recreation Equipment. 29-30
Rental Housing 11-12
Repairs to Housing 11-13
Reporting for Duty Procedure 4-5
Riverview Village 12

S

Schools 50-51
Scouts 51-52
Searching Quarters 34
Skating Rink. 30
Sleds 37
Smoking 37
Softball 30
Solicitation 37-38
Stores 51
Swimming Pool 30-31

T

Teen Town 52-53
Telephones 15
Tennis Courts 31
Traffic Regulations 35
Trailer Site (Military) 12
Transportation 53
Trash Collection 13-14

U

Uniforms 5

V

Vandalism 39
Veterinarians in Area 53

W

Weapons, restriction on 34
Women's Auxiliary, Commissioned
Officers' Mess (Open) 23

UNITED STATES NAVAL PROPELLANT PLANT

CHAPTER I

A. HISTORY

The Naval Propellant Plant is located on bluffs overlooking the historic Potomac River, twenty-five miles below Washington, D. C., on land formerly part of a land grant to Captain Thomas Cornwallis, who, on August 8, 1636, was granted at Portsmouth, England, by the King of England, a tract of land (approximately 5,000 acres), lying on the east side of Piscataway Creek, called Mattawoman Neck. By land, it is reached via Route 210 from Washington, D. C., and connects with Route 301 at La Plata, Maryland, by way of Route 225.

The birth of the naval station at Indian Head occurred in 1890, when the Proving Ground at Annapolis, Maryland, was moved to the present site of the Naval Propellant Plant. The site consisted of 880 acres and ground was first broken in September of 1890. In February, 1891, the first ordnance was tested - a 6" gun.

In 1897, the Navy Department decided to build a factory for the purpose of developing smokeless powder, and the Naval Reservation at Indian Head was selected for the location of the new Plant. The first powder was made in June, 1900, and the plant has remained in continuous operation since that time.

In 1901, the adjoining land known as "Stump Neck", comprising 1,050 acres, was purchased primarily because the property was in line of fire of the gun batteries.

Between 1904 and 1907, the Propellant Plant was enlarged by the erection of a Nitric and Sulphuric Acid Plant, and a plant for reworking powder. The first reworked powder was made in December, 1907.

During World War I, an Explosive "D" (Ammonium Picrate) Plant was built to make the powder used in torpedoes; 1,160 acres of land were purchased for the expansion of plant facilities, and a 1½-mile railroad spur was constructed to connect with the Pennsylvania Railroad at White Plains, Maryland.

propellants, has been in operation since 23 April 1954. The Cordite "N" Plant, producing new "Cool" burning multi-base gun propellant, has been in operation since 6 August 1954.

On 14 August 1958, the Naval Powder Factory was renamed the U. S. Naval Propellant Plant, by direction of SECNAV Notice 5450 of 11 August 1958. This title was considered by the Chief of the Bureau of Ordnance more appropriate in view of the substantial change in tasks being performed at Indian Head.

B. ACCESSIBILITY

Indian Head is located on a peninsula and has no railroad or steamship line connections. The "WASHINGTON-MARYLAND-ALEXANDRIA" Bus lines operates one bus trip per day from Indian Head to Washington, D. C., and return. The current bus schedule is as follows:

LV Indian Head 6:45 a.m. AR Washington 8:00 a.m.
LV Washington 6:15 p.m. AR Indian Head 7:35 p.m.

Bus stop is located in the vicinity of Strauss Avenue and Earle Road approximately one-half block east from the Pass Office in the town of Indian Head, and in Washington, D. C., from the bus stop located at 11th and Pennsylvania Avenue, N. W.

Indian Head is reached by road via Route 210 from Washington, D. C. and connects with Route 301 at La Plata, Maryland by way of Route 225.

CHAPTER II

A. ADMINISTRATIVE DETAILS

(1) Reporting for Duty

Civilian Personnel

The Industrial Relations Building is located just off the intersection of Strauss Avenue and Patterson Road, to the rear of the Administration Building (see location on map, Appendix I). The Placement Branch, IRO, is located in the south end of the IR Building, first office to the right of the entrance. All civilian employees reporting for duty are processed in this office.

Military Personnel

Officers

The Military Personnel Division, Command Administration Department, is located in the Administration Building, Building No. 20 (see location on map, Appendix I). The Officers' Records Branch, located on the first floor, second office to the right of the entrance, processes orders of all officers reporting for duty at the Naval Propellant Plant and subordinate activities, including student officers attached to the Explosive Ordnance Disposal School. Officers reporting for duty will be advised by the Officers' Records Clerk as to the disposition of pay record, service record, medical record, etc.

Biography Form and Fleet Home Town News Center Release Form, the blue forms following the foreward, should be filled out and returned to the Military Personnel Officer.

Enlisted

The Enlisted Personnel Branch, Military Personnel Division, located on the second floor, across landing on stairs to rear wing, processes orders of all enlisted personnel reporting for duty at the Naval Propellant Plant and subordinate activities, including students attached to the Explosive Ordnance Disposal School.

Fleet Home Town News Center Release Form, the blue forms following the foreward, should be filled out and returned to the Military Personnel Officer.

(2) Uniforms

Officers are requested to report for duty in Service Dress Uniforms, either blue or khaki.

NPP Directives are issued semi-annually prescribing appropriate Uniform of the Day. Such directives are on file in all departments having military personnel.

Enlisted personnel are requested to report for duty in enlisted Uniform of the Day.

(3) Identification Badges

Auto Decals

All residents of the Naval Propellant Plant Reservation who own automobiles must obtain appropriate decalcomania. Entry into the non-industrial area will not require NPP Decals for those residents of the Reservation who possess vehicle identification from Government activities located in the greater Washington area; such as Bolling Air Force Base, Naval Communications Station, Cheltenham, etc.

The BROWN Decal is authorization for the vehicle to enter the residential area of the Station ONLY. Other decals (see NPP Instruction 5540.5B of 11 February 1958), authorize the vehicle to enter the Station; however, each passenger must possess the proper personal identification prior to admittance to the industrial area of the Station. In order to operate a vehicle upon the Naval Reservation each owner shall possess a currently valid operator's license, state tags and public liability insurance.

Identification (Picture) Badges

Identification (Picture) Badges are issued to N.P.P. military and civilian personnel. Such passes are issued at the Pass Office during

working hours and must be worn in a visible place on the left breast at all times while on the Station. NPP Instruction 5540.7 of 29 August 1955 outlines the Badge System in effect at this activity.

Military I.D. and Privilege Card (DD 1173)

Application may be made for the issuance of DD Form 1173:

(1) Upon entry on active duty, or active duty for training for a period in excess of 30 days;
(2) Upon re-enlistment for continuous active duty;
(3) Upon change in dependency status stated on current card;
(4) Upon certification of loss or theft;
(5) Upon retirement or death;
(6) Upon expiration of card.

Form DD 1171 shall be submitted, in duplicate, to the Commanding Officer via the Military Personnel Officer.

(4) Moving of Household Goods and Personal Effects

Incoming Shipments

The Household Goods Section is located in the Supply Department, Building 116, Extension 198. Shipments of household goods and personal effects for members of all branches of the service should be consigned as follows:

Uncrated Household Goods

Consign uncrated household goods to owner's residence whenever possible. When storage at destination is necessary consign to owner, destination - Indian Head, Maryland, for storage in transit at destination. Annotate bill of lading, "Notify Naval Propellant Plant, Indian Head, Maryland. RIverside 3-2111, Ext. 198 prior to placing in storage."

Crated Household Goods

Express & Rail Freight - Consign to:
Receiving Officer
Naval Propellant Plant
Indian Head, Maryland
Via: Indian Head Junction

Motor Freight - Consign to:

Receiving Officer
Naval Propellant Plant
Indian Head, Maryland

It is requested that, immediately following shipment, a copy of bill of lading and supporting papers for all shipments, including Storage in Transit, be forwarded to Supply Officer, Code **S2a4, Naval Propellant Plant, Indian Head, Maryland.**

Outgoing Shipments

This activity makes arrangements for shipments originating in the local area only. Personnel residing in the Washington, D.C. area should make application to the Household Goods Section, Naval Gun Factory, first floor of Bldg. 213, Telephone LI 7-5700, Extension 2561.

Temporary Storage

General

Temporary storage may be authorized in connection with any authorized shipment of household goods with the exception of an intra-city move. This storage is cumulative and may accrue at origin, in transit, at destination, or any combination thereof. However, split periods of storage require additional handling which results in excess cost to the Government and increases the possibility of loss and damage to the property. Therefore, it will be approved only when necessary due to extenuating circumstances arising after shipment has gone forward.

Time Limitation

This storage may be authorized for a period of ninety days. When, because of conditions beyond your control, your goods cannot be removed from storage at the end of this period, an additional ninety days may be authorized subject to approval of the appropriate transportation officer. If the temporary storage is at point of origin, the "Appropriate" transportation officer is the officer who arranged for your storage. If the temporary storage is at destination, the "Appropriate" transportation officer is the household goods shipping activity nearest to the location of your household goods.

To obtain this additional ninety days you will be required to furnish a written statement of facts to support your request. Among the reasons for which additional storage may be authorized are the following:

Serious illness of the member
Serious illness or death of a dependent
Impending assignment to Government quarters
Directed temporary duty after arrival at permanent station
Nonavailability of suitable civilian housing
Awaiting completion of residence under construction
Acts of God.

Nontemporary Storage

Ordinarily, nontemporary storage will be furnished for household goods which will not accompany you when you are ordered to sea or overseas duty. However, it may also be authorized under other circumstances.For details consult the Household Goods Section.

(5) Working Hours

The following work hours have been established for the various departments of the Naval Propellant Plant, as indicated below:

Command Administration Department	0745 - 1615
Comptroller Department	0730 - 1600
Dental Department	0745 - 1615
Industrial Relations Department	0745 - 1615
Marine Barracks	0730 - 1600
Medical Department	0745 - 1615
Production Department	(0730 - 1600 (0745 - 1615
Public Works Department	(0730 - 1600 (0745 - 1615
Quality Control Department	0745 - 1615
Research & Development Department	0745 - 1615
Safety Department	0730 - 1600
Supply Department	0730 - 1600
U.S. Naval School, Explosive Ordnance Disposal	0720 - 1600
U.S. Explosive Ordnance Disposal Technical Center	0745 - 1615

CHAPTER III

A. HOUSING

(1) The Industrial Relations Officer acts for Commanding Officer in the management of rental housing at the U. S. Naval Propellant Plant. The Housing Manager exercises direct control over housing under the direction of the Industrial Relations Officer. The Housing Management Office is located in the Industrial Relations Department, Building No. 325. The Office is open between the hours of 0745 and 1615, Monday through Friday. The Office telephone number is 220.

(2) There are seven hundred and seventy-five (775) houses and apartments, and a small trailer camp located on the Reservation, which consists of BUORD rental housing assigned to civilian personnel employed at the Naval Propellant Plant; Low-cost Rental Housing assigned to military and civilian personnel; TITLE VIII Apartments assigned to military and civilian personnel; Public Quarters assigned to military personnel, and Trailer Sites assigned to military personnel.

(a) BUORD Rental Housing - The BUORD Rental houses are of frame or brick construction, built in 1918 or before. The arrangements and number of rooms vary from one to nine bedrooms. The rentals also vary from $24.00 to $120.00 per month, exclusive of utility costs.

(b) Low-Cost Rental Housing - The Low-Cost Rental units are of stucco or frame construction, built in 1941. These units are both single and double units, with one, two, three and four bedrooms. The rents range from $30.00 to $51.00 per month, exclusive of utility costs.

(c) TITLE VIII Housing - The TITLE VIII Apartments are of brick and frame construction, built in 1954. The project consists of thirty-seven (37) buildings, with eight (8) to twelve (12) apartments to a building. The apartments are one, two and three bedrooms, and rents range from $67.00 to $81.75 per month, including utility costs.

(d) Public Quarters - The Public Quarters are of frame or brick construction. Most of these quarters were built in 1918 or before. Arrangement and number of rooms vary from one to five bedrooms. The basic allowance for quarters is not paid to personnel occupying this type housing.

(e) Trailer Sites - The rental for a Trailer Site is $6.00 per month, exclusive of utility costs, and is primarily available for enlisted personnel attached to the Station.

(3) Applications for Housing

In order to apply for rental housing on the Station, an applicant must apply, in person, at the Housing Office. If housing is not immediately available for assignment, the Housing Manager will notify the applicant when housing is available. Upon assignment of housing by the Housing Manager, the applicant will inspect the house for acceptance or declination. Upon acceptance, the prospective tenant will read and sign the Agreement for Occupancy of Navy Rental Housing. The tenant will pay the charges for the remainder of the month, plus a security deposit. He will be advised of certain rules and regulations regarding payment of bills, etc., and questions he may have will be answered.

(4) Payment of Rent

The rental period extends from the first to the last day of each month. Rent is due on the first day of each month, and must be paid by the date specified in the Rental Agreement. Rent may be paid at the Management Office from 0745 to 1400 each work day, Monday through Friday, except the last working day of the month. Rent payments may be made in cash, money order, or personal check drawn on the local bank. Checks and money orders must be made payable to the "TREASURER OF THE UNITED STATES" for the exact amount of the rental bill, and sent to the Housing Office, Industrial Relations Department, Naval Propellant Plant, Indian Head, Maryland. Tenants failing to pay rent or other charges when due are contacted by the Housing Manager. Disregard of a warning may result in cancellation of the rental agreement by the Commanding Officer. Rental rates and utility charges have been approved by the Commanding Officer, in accordance with prescribed regulations. Rates and charges are subject to periodic revision and/or review.

(5) Inspections

Rental housing units are, at all times, subject to inspection for physical condition, fire hazards, and condition of Government equipment.

Routine inspections are always made in the presence of the occupant. However, in case of an emergency, authorized Station personnel may enter if the occupant is not at home or cannot be contacted.

(6) Telephones

Requests for installation of telephones in housing west of Earle Road shall be made to the Communications Office. Telephones in this area are connected with the Naval Propellant Plant switchboard. Rates are as follows:

Installation Fee - $5.00

Instrument Rental
Public Quarters - $4.00
Rental Housing - $5.85

All rates are subject to 10% tax.

Requests for installation of telephones in housing east of Earle Road shall be made to the Chesapeake and Potomac Telephone Company, La Plata, Maryland.

(7) Fuel

All tenants of Rental Housing shall provide their own fuel for heating. Consult the yellow pages of the County Telephone Directory for local suppliers of fuel oil and coal.

(8) Garbage and Trash Collections

Garbage and trash collections are collected by a private contractor twice weekly on Mondays and Fridays, between the hours of 8:00 a.m. to 4:00 p.m. The contractor is required to pick up only at specified locations. Garbage is defined as all kitchen waste. Trash is considered to include all empty containers, wrappings, ashes, and items of discarded household equipment. If practicable, trash, as defined above, shall be placed in the garbage container provided. Overflow should be placed alongside the can. However, precaution should be taken to prevent littering the area. The Public Works Department provides a garbage can for each housing unit. If garbage can is in poor condition, call Ext. 433 for replacement.

(9) Provisions of Your Lease

(a) Agreement - When you, as a tenant, sign a lease to rent quarters on the Station, you agree to the following:

1. To pay all charges for furniture and utilities (electricity, fresh water, sewer service, heating and refuse removal) furnished by the Station, when due.

2. To use your house as a private residence for yourself and family, and not to sublet any part of it nor allow persons other than your family to live there without written permission of the Commanding Officer, Naval Propellant Plant, citing the circumstances.

3. To permit nothing to be done which constitutes a fire hazard, or to do, or permit to be done, any immoral, illegal or criminal acts.

4. To conduct yourself with regard for the rights of other tenants on the Station.

5. To care for and maintain your grounds, notifying the Public Works Department of any damage or need for repairs to the house.

6. To vacate the premises thirty (30) days after being separated from employment at the Naval Propellant Plant, or thirty (30) days after being detached from duty, provided rent is paid through that date. In cases of emergency requiring a longer period of time, decision will be made by the Housing Officer. The premises, except for reasonable wear and tear, shall be left in good condition.

7. The Station authorities, agents, or employees may enter housing at reasonable hours to make repairs, inspect, or to take such other action as may be necessary.

8. To report promptly to the Housing Office, Ext. 220, any change in occupation, marital status, or family composition, which would affect eligibility for use of Navy housing.

9. That you will not hold the Station responsible for any injury to persons in your family or any other persons who may come on the premises.

Also, you may not hold the Station responsible for any damage done by fire, rain, snow or water to your personal property in the house.

10. No alterations may be made to the premises or to the equipment in your house without the written consent of the Commanding Officer or his agent, and then only subject to conditions under said consent and approval, as stipulated. For example, if a tenant wishes to lay a cement walk, build a porch or a tool shed, a letter should be written to the Public Works Officer, the Commanding Officer's agent, requesting permission to do so. If permission is granted, it is understood the tenant is to defray the expense of material and labor.

11. As a tenant, you are liable for all damages or loss to the premises and contents or other property in the project, if such damage is caused by deliberate or negligent act on the part of the tenant, member of the household, or guest.

12. When you sign the occupancy lease to rent Station quarters, you agree that you have examined the house and know its state of repair.

13. Before terminating your lease, and subject to the conditions agreed upon under paragraph 10. above, you will remove all alterations, additions, and fixtures which you have installed, and restore the premises to the same condition existent at the time of assignment; reasonable wear and tear excepted.

14. Your lease may be terminated at any time, upon thirty (30) days' written notice, by the Housing Officer. You may terminate your lease within fifteen (15) days' notice to the Housing Officer.

15. Rent must be paid by the date specified in the Rental Agreement.

Questions regarding the terms of your lease will be answered by contacting the Housing Office, Ext. 220.

(10) Station Trailer Park

(a) Administration - The administration of the Trailer Park is under the Executive Officer.

(b) Supervision - The Trailer Park is supervised by a tenant of the Trailer Park, designated by the Executive Officer.

(c) Occupancy - Unless otherwise authorized by the Executive Officer, occupancy of the Trailer Park space will be confined to enlisted personnel attached to the Naval Propellant Plant.

(d) Parking - Trailers shall be uniformly parked as to position over drain, with hitch end facing the street and at a sixty degree (60°) angle to the street.

(e) Utilities tie-in - Tenants shall provide necessary utility lines, such as electric, fresh water and sewage, to reach from trailer to Station ground connections. Utility lines to fresh water and sewage connections shall be either reinforced rubber hose or galvanized iron pipe, properly insulated against freezing. All connections and disconnections to and from Station facilities will be accomplished by the Public Works Department.

(f) Maintenance and Upkeep - Tenants are required to keep within the space allotted and to maintain the area in a clean and sanitary manner, and to cut the grass. Gear kept outside of the trailer shall be neatly stowed in the tenant's area. No gear shall be stowed under the trailer.

(g) Garbage and Refuse Disposal - Metal garbage cans, with tight-fitting covers, are provided by the Station and are conveniently located in screened housing. Tenants shall dispose of all garbage and refuse by use of the Station facilities provided. Garbage cans shall be kept securely covered at all times, and the door of the screened housing properly secured. No other garbage containers will be permitted outside this housing, other than containers for inside trailer use.

(h) Fire Protection - Trailers shall be equipped, at all times, with one fire extinguisher in good working order. No open fires are permitted.

(i) Additions - Tenants desiring to erect any type of structure, including fences, must first obtain permission of the Public Works Officer. Structures so erected must be at the expense of the tenant and in accordance with approved design. Such authorized structures must be removed by the tenant before he vacates the premises.

(j) Change in Location - In the event there is a vacancy in the Park, tenants may move to a new location only upon the approval of the Park Supervisor, and after having negotiated a new lease with the Housing Office.

(11) General

Tenants are required to conform to these and all other rules and regulations which are, or may be, prescribed for tenants of rental housing of the Naval Community.

B. HOUSING MAINTENANCE - While you are a tenant on the Station, the Station does a certain amount of repair and maintenance work to your quarters which may be needed due to reasonable wear and tear. The cost of this work is not deducted from the Security Deposit made at the time you rented the quarters.

(1) Maintenance and Repair - The Public Works Department is responsible for the maintenance and repair of housing and for the maintenance and repair of all Government equipment installed therein. In the event of emergency repairs being required, call Ext. 433. Such repairs include those defined as requests to correct a condition which presents an immediate hazard to personnel, equipment or building. The Maintenance Office is open Mondays through Fridays, 7:30 a.m. to 4:00 p.m. After 4:00 pm, an electrician and a plumber stand by for emergency repairs to heating units and plumbing. If Ext. 433 does not answer after 4:00 p.m., call the Station Telephone Operator to report need for plumbing and heating repairs. Requests of tenants for exterior repairs to quarters, clothes lines, walks., etc., will be investigated and scheduled if the Public Works Officer decides it is necessary. Work Request Forms for repairs of this nature can be obtained at the Housing Office. Requests of tenants for interior painting of quarters will be investigated and scheduled if the Public Works Officer determines it is necessary. Workload and money availability permitting, the Public Works Department will paint the interior of your quarters every three or four years, in order to maintain it in proper condition. A priority listing for painting and/or renovation of quarters will be maintained in the Public Works Department.

(2) Additions, Alterations and Modifications - If a tenant desires certain miscellaneous service or work done, not considered as normal maintenance work, a written Work Request shall be prepared by the tenant at the Housing Office and forwarded to the Public Works Department to obtain an estimate of the cost to perform the work. The Housing Office will be informed of the estimated cost of labor, material and Station over-head to perform the work. The Housing Office will advise the tenant of the estimated costs and effect collection, in advance. Upon notification from the Housing Office that the estimated costs have been collected, the Public Works Department will perform the necessary work on a "not-to-interfere" basis. Upon completion of the work, the Housing Office will be notified of the actual costs. Should the estimated costs collected from the tenant exceed the actual costs, the excess collection will be refunded to the tenant. When costs to the Government exceed the estimated collection from the tenant, the additional costs will be collected by the Housing Office. Typical kinds of miscellaneous services or work requested by a tenant are:

Additional electric outlets
Alter the swing of a door
Installation of automatic washer, drier or air-conditioner
Additional house keys

(3) Damages - It is the policy of the Navy to hold the occupant of Navy Rental Housing responsible for -

(a) Damage to structures or furnishings to the extent that the damage is caused by tenant negligence and is beyond normal wear and tear, and

(b) Loss of articles.

The amount of payment required to repair or replace the loss or damage will cover cost of materials, labor and over-head charges. The following scale of charges for loss or damage due to tenant negligence covers typical kinds of loss and damage, and is recorded below for the convenience of the tenant:

1. Replace key/each . . . . . $ .80

2. When key replacement necessitates trip to house to fit key to lock. . . . . $ 2.00

3. Replace window panes $12.67

4. Replace broken door lock . . $15.82

5. Repair hole in wallboard (When require repainting of entire room). $27.64

6. Replace screen wire fabric on door. $18.00

7. Replace light fixture. . . . $13.00

8. Repair stopped drain $15.00

Payment of charges for services and/or damages will cover full collection of costs to the Government.

(4) Absence from Quarters - Tenants are advised to take proper precautions when leaving their quarters unoccupied for a period of twenty-four (24) hours or longer in the winter months by either (1) having a dependable neighbor keep check on the heat in the house, or (2) notify the Housing Office (Ext. 220) to have the house winterized upon leaving quarters. Tenants whose negligence causes water pipes to freeze in their quarters will pay the complete cost to the Government for repairs.

C. GENERAL INFORMATION

(1) Requests - To replace Government-owned equipment (stove, refrigerator or plumbing facilities) which is considered to be worn-out, unsanitary or unsafe, write a letter to the Public Works Officer requesting such replacement. If inspection proves this replacement to be warranted, equipment will be replaced.

(2) Grounds - You are responsible for maintaining the grounds surrounding your quarters. You may plant trees and shrubbery, if you wish, at your own expense. No trees or shrubs may be removed without express permission of the Commanding Officer. Shrubs and trees shall be planted not less than six (6) feet from the curb or sidewalk. Flower-beds and shrubs should be planted three (3) feet away from the foundation of the house to allow workmen to make maintenance repairs.

(3) Gardens - Vegetable gardens are permitted.

(4) Fences - You may fence in your yard if you so desire, at your own expense. However, you are required to first call Public Works Department (Ext. 433) regarding existing regulations covering installation of fences. It must be picket, painted white, and of a certain height. The reason for this is to ensure that Rental Housing is as uniform as possible, presenting a neat, attractive appearance.

(5) Lawn Sprinkling - The use of Station drinking water for sprinkling lawns, gardens, etc., is restricted to Saturdays, Sundays and holidays, unless prohibited by an NPP Notice. In that event, all residents are so informed by mailed Notice.

(6) Fires - No open fires, etc., are permitted except in designated area.

D. B.O.Q. (COMMISSIONED OFFICERS' MESS (CLOSED) -

A 100-room B.O.Q. has recently been completed and is fully furnished for capacity occupancy. In addition to officer personnel, the following civilian personnel are authorized use of the berthing facilities:

(1) Government civilian employees, GS-7 and above in graded positions and Quartermen and Planners and Estimators in ungraded positions, who are travelling on per diem orders issued by competent authority, ensuring that suitable endorsement is placed on orders indicating that Government quarters were utilized.

(2) U. S. Navy Technicians, contractor representatives and official visitors, as approved by the Command Administration Officer, for periods up to thirty (30) days, provided such transient residence involves convenience to, or economy of, the Government rather than the individual.

(3) Civilians visiting as employee recruits and civilian employees (GS-7 and above) of the Naval Propellant Plant awaiting establishment of permanent housing, as authorized by BUPERS, when approved by the Command Administration Officer, for periods up to thirty (30) days. Limited to males only.

Room Charges

Daily Rate

Room	$2.25
Utilities	.20
Furniture	.70
Room Cleaning Service	.50
Linen Service	.85
	$4.50/day

Weekly Rate

Room	$15.30
Utilities	1.40
Furniture	4.80
Room Cleaning Service	2.50
Linen Service	1.00
	$25.00/week

Monthly Rate

Room	$56.00
Utilities	5.60
Furniture	14.40
Room Cleaning Service	10.00
Linen Service	4.00
	$90.00/month

The following category of civilian personnel are authorized the use of messing facilities of the Commissioned Officers' Mess (CLOSED):

Authorized civilians shown above
Guests of members of the Mess
Guests of officers of the Armed Services stationed at this activity
Official visitors to the Station and the Station personnel concerned with the visit

(4) Reservations - All personnel, military and civilian, except Mess members, desiring to mess in the Commissioned Officers' Mess (CLOSED) must make reservations with the Steward Chief (Ext. 402) prior to the meal. No meals will be served unless reservations have been made prior to these times:

Breakfast	1600 of the previous day
Lunch	1000 of the same day
Dinner	1600 of the same day
Saturday meals	1600 Friday
Sunday meals	1600 Saturday

Officers-in-Charge of subordinate activities and department heads shall obtain clearance with the Command Administration Officer before making reservations for parties of official visitors.

(5) Charges for Meals -

(a) The monthly rate, as determined by the Secretary-Treasurer of the Mess, shall be paid in advance by all officers attached to the Station residing in the B.O.Q. not receiving a per diem allowance.

(b) The meal price at the monthly rate, as determined by the Secretary-Treasurer, plus $ .05 each breakfast, $.10 each luncheon, $.10 each dinner, in accordance with Article 430 (Ch 3) of NAVPERS 15847, shall be paid at each meal by the following personnel:

1. Officers of the Armed Services attached to the Station not residing in the B.O.Q., and not receiving Per Diem.

2. Transient officers not quartered in the B.O.Q., and not receiving Per Diem.

3. Authorized civilians not receiving Per Diem.

4. Guests of authorized patrons.

(c) In accordance with Article 430(b)(3)(Ch3) of NAVPERS 15847, officers and civilians receiving Per Diem Allowance shall pay the following rates:

		Surcharge
Breakfast.	$ .50	$ .45 .05
Lunch.	.75	.65 .10
Dinner	1.00	.90 .10
Saturday & Holiday Brunch.	.90	.85 .05
Saturday & Holiday Supper.	1.25	1.15 .10
Saturday Dinner.	1.00	.90 .10
Sunday Supper.	.75	.65 .10

CHAPTER IV

A. FACILITIES

(1) Available for Military Personnel

American Red Cross

The nearest Red Cross Office is located at La Plata, Maryland, West 4-3683.

Local Directors are:

Mrs. Clarece B. Susan,
Indian Head, Maryland - RI 3-3741

Major Frank A. Bolton,
Pomonkey, Maryland - RI 3-5603

Athletic Equipment

The Athletic Storeroom is located in the basement of the Recreation Hall next to the Navy Exchange. Personnel may draw gear necessary for recreational purposes only between 1630 to 1700 on week-days. There is no attendant available to check out gear on Saturday and Sunday. Therefore, personnel are requested to obtain any required items prior to 1700 on Friday. The attention of all personnel desiring to check out gear is invited to NPP Instruction 1710.1 of 28 January 1954, which covers the loss and damage of Recreation Fund Property. Gym equipment such as weight-lifting sets, wall weights, speed-bag, body bag and complete boxing equipment is located in the basement of the Marine Barracks.

Barber Shop

Location: In basement of Recreation Building

Hours: Monday through Friday - 0900 to 1700
Closed - 1200 to 1300

Authorized patrons:
Military personnel and their dependents
Appointments for dependents will not be made during week in which personnel inspection is scheduled.

For appointments call Extension 437.

Commissary Privileges

There are no commissary privileges at the Naval Propellant Plant. There are 3 commissaries located in the southeast Washington Area. Military Dependents Identification Card (Form DD 720) is required at all times.

Bolling Air Force Base

Tuesday, Thursday and Friday	1130 to 1645
Wednesday	1130 to 2000
Saturday	0830 to 1200

Closed Sundays, Mondays and Holidays.

Andrews Air Force Base

Monday	1300 to 1800
Tuesday	0900 to 1400
Wednesday	1300 to 2000
Thursday	0900 to 1400
Friday	1300 to 2000

Closed Saturday, Sunday and Holidays.

Fort McNair

Tuesday, Thursday, Friday and Saturday	0815 to 1400
Wednesday	1230 to 1930

Closed Sundays, Mondays and Holidays.

Note: Check various commissaries for seasonal hours.

Commissioned Officers' Mess (Closed)

Officers of all services assigned quarters in the BOQ, except those in a travel or temporary status who are receiving per diem allowance, are members of the Commissioned Officers' Mess (Closed).

Meal hours are posted in the Mess and BOQ. Arrangements for meals outside regular hours maybe made with the Secretary-Treasurer.

Officers are to be appropriately attired for all meals in the Wardroom. The following are considered appropriate attire:

Uniform - Uniform of the Day (clean and neat working uniform, with necktie, may be worn for breakfast and lunch by those authorized to wear the working uniform, when time does not permit shifting to the Uniform of the Day).

Civilian Clothes

Brunch - Coat and tie not required. Neat appearing casual attire is acceptable.
Breakfast - Lunch - Coat and tie.
Dinner - Coat and tie.

NPF Instruction 1746.17A of 15 October 1957 contains Rules and Regulations of the Commissioned Officers' Mess (Closed).

Commissioned Officers' Mess (Open)

A small Commissioned Officers' Mess (Open) is located on Strauss Avenue opposite the BOQ, which includes Bar, Dance Floor, Television, Lounge, outdoor barbecue facilities, picnic tables and benches, and the operation of a Guest House. Membership in the Mess includes Regular members (commissioned Officers of all armed services on active duty or retired with pay; officers of the armed services of foreign nations on active duty, and officers of the U. S. Coast and Geodetic Survey and U. S. Public Health Service on active duty) and Associate members (commissioned officer of reserve components of the armed services of the United States on inactive duty or retired without pay; fleet reserve personnel who have held temporary commissioned rank and who, in due course, will be placed on the retired list; widows of commissioned officers of the armed services of the United States who are receiving pensions from the Government and widows of commissioned officers who were on the retired list; to dependents of those entitled to regular or associate membership, and civilian employees, GS-7, Planners, Estimators or equivalent and above, of the Naval Propellant Plant associated professionally on an equal footing with the officers participating in the Mess.) Those authorized to participate in the facilities of the Mess may invite guests to use Mess facilities. Guests must be guests in fact and cannot be allowed to make any type of purchase in the Mess or share in the Mess or share in any expenses incurred by their host.

Normally, the Bar is open as follows:

Monday through Thursday (except holidays) 1630 to 1830
Fridays - 1630 - 2030

Regular events held at the Commissioned Officers' Mess (Open) are as follows:

Stag Night
Happy Hour
Ladies Bridge
Family Bridge
Officers' Wives' Club Luncheon
Hail and Farewell Party
Family cook-outs on Memorial Day, Independence Day and Labor Day.

Chief Petty Officers' Mess (Open)

A small Chief Petty Officers' Mess (Open) is located at the corner of Jackson Road and Strauss Avenue, which includes a Bar, Dance Floor and Television.

Privileges of the Chief Petty Officers' Mess (Open) are extended to:

Chief Petty Officers on active duty
Chief Petty Officers on active duty for training
Chief Petty Officers performing inactive duty training, on drill days only
Other Armed Services personnel, in pay grade E-7, who are attached to the Station
Retired Chief Petty Officers and Chief Petty Officers of the Fleet Reserve on inactive duty
Dependents of authorized personnel
Bona fide guests
Personnel in pay grade E-7 on active duty in the other Armed Services

In addition to special events which are scheduled, Bingo is held each week.

Normally, the Bar is open as follows:

Sundays - 1200 - 2330
Mondays thru Thursdays - 1600-2330
Fridays - 1600-2400
Saturdays & Holidays - 1200-2400

Enlisted Men's Club

An Enlisted Men's Club is located in the Navy Recreation Building, which includes Bar, Dance Floor and Television.

Privileges of the Enlisted Men's Club are extended to:

Naval enlisted personnel on active duty
Naval enlisted personnel on active duty for training
Naval enlisted personnel performing inactive duty training, on drill days only
Enlisted personnel of the other Armed Services attached to the Station
Retired enlisted personnel and member of the Fleet Reserve on inactive duty
Enlisted personnel on active duty in the other Armed Services
Dependents of authorized personnel
Bona fide guests.

Normally, the Bar is open as follows:

Mondays through Thursdays - 1700-2200
Fridays - 1700-2300

Branch 205, Fleet Reserve Association and Ladies Auxiliary

Branch 205, Fleet Reserve Association meets the first Thursday of each month at 8:00 p.m., Second Floor, Indian Head Motors Building, Strauss Avenue.

The Ladies Auxiliary of the Fleet Reserve meet the 2nd Thursday of each month at 8:00 p. m., Second Floor, Indian Head Motors Building, Strauss Avenue.

Gasoline Purchase

Location: Naval Propellant Plant Garage, Ward Road
Hours of Operation:
Monday through Friday - 1600 to 1800
Saturday - 0900 to 1200
Authority Patrons:
Military personnel and their dependents

Laundry and Dry Cleaning

Military

Location: In basement of Recreation Building
Hours of Operation:
Monday through Friday - 1130 to 1730
Saturday - 0900 to 1200
Authorized Patrons:
Military personnel and their dependents

Civilian

Lexington Park Cleaners, Great Mills, Maryland - Telephone:Great Mills 220
Pick-up and delivery service

Tower Cleaners located on Indian Head Road in town of Indian Head
Cash and carry - 3 hour service

Legal Assistance

The Military Personnel Officer is the Legal Assistance Officer and will assist military personnel. He is available for consultation and will render advice in the interest and protection of the individual. His Office is located in the Administration Building and his Phone Number is 354.

Medical and Dental Care

The Dispensary is located on Dashiell Rd. near the Potomac River. In-patient and out-patient medical care is available for military personnel who are attached to or reside in the vicinity of the **Naval Propellant Plant.** Military Sick Call - Monday through Friday, 0800 - 0900 and 1300 - 1400. Emergency cases are treated at any time. Refer to pages 45-47 for civilian medical and dental offices in area.

Dependents' Medical Care

It is estimated that there are approximately twenty-five hundred (2500) dependents of military personnel, active and retired, residing in this vicinity who utilize the medical services of the NPP Dispensary. More than half of this number are dependents of military personnel who are assigned for duty at military installations other

than the Naval Propellant Plant. Dependents are furnished out-patient care, including pre-natal. There are no facilities for in-patient care of dependents at this Dispensary. Patients are seen by appointment only during the following hours:

Monday through Friday - 0920 - 1200
2:10 - 3:30

Except in cases of emergency, this professional care is available only during regular working hours of the Station and provided it may be accorded without interference with the Medical Officers' other duties. The Dispensary pharmacy will issue drugs only upon the prescription of active medical officers of the U. S. Armed Forces. Only items which are carried in stock will be issued or dispensed to dependents.

Dental Care

The Dentist's Office is located on the second floor of the Dispensary. Sick Call is held daily for military personnel on weekdays 0800 - 0830 and 1300-1330. Appointments may be made for dental work during the hours 0830-1200 and 1330-1615. Emergency cases will be taken at any time. Phone No. 85.

Refer to page 47 for civilian dental offices in area.

Navy Exchange

A branch Navy Exchange is located in Building D-328, Navy Recreation Hall (back of the Administration Building. The Exchange operates the following services:

Exchange Store
Laundry & Drycleaning Service
Barber Shop
Gasoline Sales

Hours of Operation:

Exchange Store:	Monday thru Friday, 1130 to 1730 Saturday, 0900 to 1200
Laundry & Dry Cleaning Service:	Same as Store hours
Gasoline Sales:	Monday thru Friday 1600 to 1800 Saturday, 0900 to 1200

Barber Shop: Monday thru Friday, 0900 to 1700 (Closed 1200 to 1300)

All military personnel, active and retired, and their dependents, are authorized to patronize the Navy Exchange. Those not in uniform must present an effective Armed Forces Identification Card or Dependent's Identification Card.

Officers' Wives' Club

The Officers' Wives' Club meets in the Commissioned Officers' Mess (Open) Building D324, and participates in Bloodmobile visits, making layettes for Navy Relief and other projects. The following social activities are enjoyed by the Club Members:

Coffee - 10:00 a.m. each third Thursday of the month at the home of a member (announced)

Luncheon - Each fourth Tuesday (announced)

Ladies' Bridge - 8:00 p.m. each Third Wednesday in the Commissioned Officers' Mess (Open)

A Hospitality Committee calls on each officers' wife after arrival at NPP, when further information regarding the activities of the Club is given.

Women's Auxiliary, Commissioned Officers' Mess (Open)

The WACOMO Club is a social and cultural activity engaged in philanthropic work for the benefit of the Community, as desired by the members.

Membership is limited to the wives of members and associate members of the Commissioned Officers' Mess (Open). Meetings are held on the fourth Thursday of each month at 10:00 a.m., in the Commissioned Officers' Mess (Open).

(2) Available for Civilian Personnel

Cafeteria

Breakfast and lunch are served in the NPP Cafeteria located near the Public Works Office. Daily

Menus are distributed with the Monday "Daily Bulletin" throughout the Plant and carry-out orders provide luncheon for those not able to make the trip to the Cafeteria.

(3) Available for all NPP Personnel

Basketball

A Basketball Officer is appointed seasonally to organize schedules and supervisor. The Inter-Plant League teams are composed of both military and civilian personnel. PRNC annually conducts an area Tournament in which military activity teams may be entered. The "Daily Bulletin" furnishes information, in season, regarding Basketball team organization, schedules, etc.

Boating

A Boat Basin is located at the Old Dock for privately-owned boats. Permission to moor privately-owned boats in the Basin may be obtained by submitting request, in duplicate, to the Command Administration Officer. Assigned mooring space will be indicated on the approved request; the original request being retained by the Military Personnel Office and the copy returned to the boat owner as his permit. NPP Instruction 11153.1 of 13 May 1957 contains regulations to be observed in connection with the mooring of boats. Out-board motors may be rented from the NPP Recreation Association.

Bowling

There are four bowling alleys available for use in the basement of the Navy Recreation Hall Building D-328. Free-time bowling is available for a short time following the League Bowling on week nights (9:00 - 9:45 p.m.) and from 1:00 to 5:00 pm. on weekends.

There are two mens' leagues totalling 16 teams, and one womens' league totalling 6 teams. These teams represent personnel both military and civilian personnel from all departments on the Station, U. S. Naval School, Explosive Ordnance Disposal, Explosive Ordnance Disposal Technical Center, and the Army Station at La Plata. Women bowl 7:00-9:00 p.m. on Monday evenings, the men bowl the same hours Tuesday through Thursday. The schedule of the

league bowling is set up so that each team bowls at least once weekly. Trophies will be awarded winning teams and high score and high average individuals. Anyone interested in bowling should contact the Bowling Officer, who will be able to direct them to the appropriate team captain for membership. League bowling costs each player 85¢ per night. Individual free-time bowling costs 25¢ per line.

Bridge

Bridge is played by members and associate members of the Commissioned Officers' Mess (Open) at the Officers' Club as follows:

Ladies - 8:00 p.m. second Wednesdays

Family - 8:00 p.m. third Wednesdays

Education

College courses are conducted by the Industrial Relations Department (Training Division) for all NPP personnel. Information as to courses available, fees, hours, etc., may be obtained by contacting IR4 (Extension 260).

The Charles County Junior College will open its doors on 17 September 1958 at the La Plata School offering two years instruction in three types of courses, arts and science, science specializations and pre-teacher education. Applications and college catalog can be obtained from the Board of Education Office, Court House, La Plata, Maryland.

Fishing, Hunting, Trapping

Fishing, in season, is permitted at the Old and New Dock areas. Maryland State Laws regarding season, catch limits and size of fish must be observed. Written permission must be obtained for this privilege.

Seine haulers are prohibited from operating fish nets in such a manner as to require the utilization as a landing point.

The Naval Propellant Plant constitutes a Wild Game Preserve. Therefore, hunting and trapping are prohibited on the Naval Reservation, except when specifically authorized by the Commanding Officer pursuant to recommendation or request of Federal or State Regional Game authorities.

When authorized by the Commanding Officer, hunting and trapping in the Stump Neck Area shall be under the direct control and supervision of the Officer-in-Charge, Explosive Ordnance Disposal Technical Center.

Golf

A 9-hole Golf Course, operated by the NPP Recreation Association is located (Caddy House) on Strauss Avenue and Hanlon Road.

Membership

A REGULAR or RESIDENT MEMBERSHIP is limited to persons employed by or attached to the Naval Propellant Plant, U. S. Naval School, Explosive Ordnance Disposal or Explosive Ordnance Disposal Technical Center.

A NON-RESIDENT MEMBERSHIP may be extended by the Board of Governors to persons who do not qualify for the Regular or Resident category.

A LIFETIME or HONORARY MEMBERSHIP may be given to former Resident members upon approval of the Board of Governors. Such a person so duly elected shall be afforded all the privileges of the club.

FAMILY PRIVILEGES are limited to a wife or husband of a member and dependent members of a family. The wife or husband of a person, who qualifies for membership but has not joined the club, is entitled to a Regular or Resident Membership.

JUNIOR PRIVILEGES may be extended to persons under 18 years of age not otherwise covered by Family privileges when sponsored by a Resident Member and under such conditions as may be acceptable to the Board of Governors.

TEMPORARY PRIVILEGES are limited to persons temporarily attached to or visiting within the limits of the Naval Propellant Plant for an expected period not in excess of six (6) months.

All enlisted personnel shall pay memberships as listed above at 1/2 the normal cost.

Membership Dues and Greens Fees

Regular (Resident) Member - R (S)
Fifteen Dollars ($15.00) per year

Regular Member - Family Membership - R (F)
Twenty Dollars ($20.00) per year

Non-Resident Member - A (S)
Twenty Dollars ($20.00) per year

Non-Resident Member - Family Membership A (F)
Twenty-Five Dollars ($25.00) per year

Junior Member -
Ten Dollars ($10.00) per year

Temporary Member -
Minimum (90 days) - $7.50
Excess of 90 days - Full Membership

Enlisted Member -
Seven Dollars and Fifty Cents ($7.50) - (Single)
Ten Dollars ($10.00) Family

Green Fees

Guest of Regular Member - $1.00 daily

Guest of Non-Resident Member -
$1.00 - Monday - Friday
$2.00 - Weekends and Holidays

Hobby Shop

The Hobby Shop, operated by the Naval Propellant Plant Military Recreation Association, available to all personnel of the Naval Propellant Plant, is located in Building 421 on Farnum Road near the intersection of Jackson Road.

The Hobby Shop has in stock a good line of hobbycraft including:

Airplanes	Engines
Ships	Weaving Looms
Trains	Paintings
Automobiles	Woodburning
Tanks	Leathercraft

Any hobby needs not in stock can be ordered to arrive within one week of your request. There is a complete woodworking shop and a good supply of lumber of all kinds. Paints, varnishes and glues are also available.

Hobby Shop Hours

Monday	1730 - 2130
Tuesday	1730 - 2130
Wednesday	1730 - 2130
Thursday	Closed
Friday	1730 - 2130
Saturday	1230 - 2130
Sunday	1300 - 1600

Hucksters

Solicitation is not permitted on the Station. However, as a convenience to residents on the Naval Reservation, permission has been granted reliable tradesmen for door-to-door deliveries of newspapers, milk, "Good Humors", bakery products, fish, poultry, eggs and farm produce. The persons granted such permission have been serving the residents for a number of years.

Library

The NPP Library is located in the Navy Recreation Building 328, in the rear of the Administration Building). Books may be withdrawn by both military and civilian personnel.

Hours of Operation:

Monday, Tuesday and Thursday

1615 - 1700 - open
1700 - 1800 - closed
1800 - 2100 - open

The Technical Library is located in the Research and Development Department. For detailed information contact Extension 495.

Movies

The NPP Motion Picture Theatre, operated for military personnel, their dependents, and NPP civilian employees residing on the Naval Reservation, and their guests (A causual guest is defined

as one who is visiting for other than the express purpose of attending the film exhibition) is located in the Navy Recreation Hall, Building 328.

Movies are shown on Mondays, Wednesdays, and Fridays, starting at 2000 (8:00 p.m.)

Admittance by Movie Pass is required. Passes may be obtained from the Military Personnel Office (Administration Building) upon the presentation of proper identification.

Admission Fee - $.15 per person. Tickets go on sale at 1945 (7:45 p.m.)

All children under twelve (12) years of age must be accompanied by an adult or a responsible older child.

Notice of coming attractions appears in the DAILY BULLETIN and PLAN-OF-THE-DAY. Flyers are mailed to home addresses of residents.

Picnic Area

Picnic facilities are available in a wooded area adjacent to the Swimming Pool which is located on Jackson Road opposite the Chief Petty Officers' Quarters. Facilities include tables, benches, horseshoe game areas, badminton and suitable barbecue pits.

Publications

A "Daily Bulletin" is published each day, by the Command Administration Department by 1:00 pm on the day before the effective date. This publication carries all information of interest to NPP personnel. Persons having data desired to be published therein should contact Code A4 (Ext. 46).

"Smokeless Flashes" the Station newspaper is printed by-weekly and is distributed to all personnel at their place of work. Persons desiring to enter data in the paper should contact Industrial Relations Department (Code IR3) - Extension 240).

Recreation Equipment

The following Recreation Equipment is available on a rental basis to personnel attached to the Propellant Plant:

Outboard Motors
Shuttlecocks
Tennis Balls

Skating Rink

The Skating Rink, operated by the NPP Recreation Association is located on Jackson Road, in Building 323. The Rink is open, usually, September to May 15.

Admission: Adults - $.40
Children - $.30 (under 12)

Rental of Skates: $.15

Hours of Operation:

Wednesday	6:00 to 10:00 pm
Friday	6:00 to 11:00 pm
Saturday	1:00 to 4:00 pm
	6:00 to 11:00 pm

Softball

A Softball Officer is appointed seasonally to organize and supervise game schedules. The Inter-Plant League teams are composed of both military and civilian personnel. PRNC annually conducts an area Tournament in which military activity teams may be entered. The "Daily Bulletin" furnishes information, in season, regarding Softball team organization, schedules, etc.

Swimming Pool

The Swimming Pool, operated by the NPP Recreation Association is located on Jackson Road. It is opened usually from 30 May to Labor Day Weekend.

Admission Rates

Season Membership Card

$6.00 for first adult or child in the immediate family;
$1.25 for second adult in immediate family;
$1.10 for each child thereafter in immediate family.

Note: Above prices include tax of 10%

Monthly Membership Card

$2.35 for first adult or child in the immediate family;
$ .50 for second adult in immediate family;
$2.35 for third adult in immediate family;
$ .50 for each child thereafter in immediate family.

Note: Above prices include tax of 10%

Daily Admissions, Weekdays

$.50 for guests over 12 years of age.
$.25 for guests under 12 years of age.

Daily Admissions, Saturdays, Sundays, Holidays

$.75 for guests over 12 years of age.
$.25 for guests under 12 years of age.

Hours of Operation

Monday through Friday - 0900 - 1100
Wading Pool only(Swimming Pool reserved for Class Instruction)

Monday through Saturday - 1100 - 2100
Pool open

Sundays and Holidays - 1300 - 2100
Pool open

Tennis Courts

The two tennis courts located on Jackson Road are under the cognizance of the NPP Recreation Association and may be used by NPP personnel.

The tennis courts located on Strauss Ave. adjacent to the Commanding Officer's quarters may be used by officer personnel and their families.

Tennis balls are available on rental basis. Tennis rackets are not available.

CHAPTER V

A. BASIC POLICE AND SECURITY REGULATIONS

(1) Alcoholic Beverages

The possession, use,or sale of alcoholic beverages, including beer,is prohibited on the Naval Propellant Plant Reservation(including Stump Neck Annex), except as specifically authorized or noted as follows:

The sale and consumption of beer are authorized in the following places:

Commissioned Officers' Mess (Open)
Chief Petty Officers' Mess (Open)
Enlisted Men's Club
Caddy House, Indian Head Golf Club

The sale and consumption of alcoholic beverages over the bar are authorized in the following places:

Chief Petty Officers' Mess (Open)
Commissioned Officers' Mess (Open)

The sale of intoxicating liquor, other than malt beverages, in package form is prohibited in the Commissioned Officers' Mess (Open) and the Chief Petty Officers' Mess (Open).

The possession and consumption of alcoholic beverages are authorized in the following places, in addition to those listed above:

In public quarters
In rental housing

Possession of alcoholic beverages is authorized for purpose of transporting them from an authorized place of sale to an authorized place of consumption.

The sale and use of alcoholic beverages shall be in compliance with Federal,State and County laws.

(2) Business in Homes

Residents may not use their private homes as a place to conduct a business of any kind.

(3) Cameras

No cameras or photographic equipment shall be taken into the restricted areas without the written permission of the Commanding Officer. The use of private cameras within the residential sections of the Station is permitted.

(4) Children

Each Family residing upon the Station is expected to exercise the necessary control over their children. The yard surrounding quarters is intended for the private use of the occupant and no one else may enter it without express permission except marines, repairmen and Housing Office representatives. No children under 16 years of age are permitted to enter the restructed areas, unless specific permission is granted by the Commanding Officer, the Executive Officer, or the Commanding Officer, Marine Barracks. Persons residing upon the Reservation will be held responsible, at all times, for the actions of their children.

(5) Civilian Guard

The Civilian Guard Force is maintained to assist the Command Duty Officer, Security Officer and the NPP Officer of the Day in the enforcement of security and safety regulations within the non-restricted and residental areas of the Station, and to protect against unlawful entry, theft, sabotage, weather, arson and fire. The headquarters for the Guard Force is the Pass Office, located at the intersection of Strauss Avenue and Earle Road. Phone No. Riverside 3-2111, Extension 218.

(6) Fires and Fireworks

No open fires are permitted in the residential area. Burning of trash, rubbish, leaves, etc., is prohibited. Authorized burning is performed at the Burning Dump by Station personnel. Bonfires or campfires are allowed only in places designated by the Commanding Officer and then only under competent supervision.

THE INTRODUCTION AND USE OF FIREWORKS ANYWHERE ON THE STATION IS PROHIBITED.

(7) Firearms and Weapons

Firearms will not be permitted on the Reservation unless they are registered in the office of the Commanding Officer, Marine Barracks. Registered firearms will be kept in secure locations (not accessible to children) inside quarters, as will be the ammunition for them. At no time, shall they be carried about the Station, except when being carried from or returned to their place of storage or following use off the Reservation. Except when specifically authorized by the Commanding Officer, air rifles, slingshots and such devices are strictly prohibited on the Station.

(8) Hunting and Fishing

The Naval Propellant Plant constitutes a wild game preserve, and hunting and trapping is prohibited, except with written permission of the Commanding Officer. Seine haulers are prohibited from operating fish nets in such a manner as to require them to utilize the Reservation as a landing point, except with written permission of the Commanding Officer. Trapping is not permitted on the Reservation.

(9) Marine Guard

The orders of the Marine sentries on duty are to be obeyed at all times. These sentries are carrying out the orders of the Commanding Officer. They are not permitted to discuss the merit of such orders. Persons questioning the propriety thereof should report the alleged impropriety to the Commanding Officer, Marine Barracks, Extension 39.

Searching Quarters

The Commanding Officer may order a search of any building or house located upon the Station, whenever, in his opinion, such action is necessary to ensure good order and compliance with the policy of the Station.

Police Assistance

Requests for police assistance may be obtained by calling the Sergeant-of-the-Guard, Marine Barracks, Extension 110.

Traffic Regulations

Speed-limit - 20 miles per hour, unless otherwise posted.

Parking - Permitted only in authorized areas; and not within 15 feet of fire hydrants.

When passing through gates to the Naval Propellant Plant, all vehicles must come to a F U L L STOP until definitely signalled by the sentry to proceed.

Whenever emergency vehicles (Fire Engines, Ambulance or any Navy vehicle following close behind) are responding to call, other vehicles are required to pull to the side of the road while these emergency vehicles pass. Emergency vehicles responding to call shall not be preceded or followed to the scene of emergencies.

Non-emergency personnel and vehicles are required to remain completely clear of emergency areas. Such persons and vehicles are prohibited from entry within a radius of 500 feet of the scene of a fire.

Driver's License

The drivers of all vehicles on the Reservation shall be in possession of valid state driver's license. The drivers of a l l Government vehicles are required to possess a valid Government Operator's Permit.

Pedestrians

Pedestrians will, at all times, use sidewalks where available. In areas where there are no sidewalks, pedestrians will walk on the left side of the street so that they face on-coming vehicular traffic.

Bicycles, Motor Scooters

Persons riding bicycles or motor scooters shall travel on the right side of the street or road, and shall not travel on sidewalks. They shall observe all stop signs and other pertinent traffic signs. Such vehicles being ridden at night, shall be equipped with a white light to the front and a red light or red reflector to the rear.

Accidents

Persons involved in or witnessing motor vehicle accidents on the Station shall take the following action:

Render all possible assistance to the injured person. Contact the Naval Dispensary, if necessary.

Take reasonable precaution to further prevent accident on the scene.

Notify the Marine Barracks (Extension 110)and in cases involving Government vehicles, the Safety Officer (Extension 37).

Motor Vehicles

No motor vehicles shall be driven on the Reservation which do not have the following parts and accessories in good working order:

Brakes
Horn
Steering Mechanism
Lights (head and tail)
Tires
Windshield Wiper
Rear vision mirror
Muffler

All motor vehicles operated on the Reservation shall, at all times, be equipped with a muffler in good working order.

(10) Pets

All dogs kept on the Reservation must be tagged with non-expired NPP Dog Tags, which may be obtained (7:00 a.m. to 4:30 p.m.) at the Pass Office (Extension 218), upon presentation of a valid certificate of inoculation. Yearly inoculation of dogs and cats is compulsory. (NPP Notice annually informs residents of the time and place for the annual inoculation service of dogs and cats provided by the Veterinary Department, Bolling Field Air Force Base. At the time of inoculation, the owner of the dog is issued a tag. Untagged ill-tempered dog or dogs that have become a nuisance, will be handled in accordance with NPP Instruction 6250.2 of 23 September 1955.Female dogs must be restrained indoors or in a commercial kennel while in heat.

Owners of pets are required to exercise such control that they will not menace or annoy other residents nor destroy property, grounds or wild life.

Domestic fowl may be kept in locations approved by the Commanding Officer, provided there are no valid objections by neighbors. Complaints regarding pets, fowl or other animals, should be made to the Sergeant-of-the-Guard, Extension 110 or Civilian Guard, Extension 218. If you must report a case outside of working hours, call either Extension 110 or the Officer of the Day, Extension 374. Persons residing upon the Reservation will be held responsible, at all times, for the action of their pets.

No pets are permitted within the Industrial Area at any time.

(11) Sleds

Sleds will not be towed by automobiles anywhere on the Reservation. Sleds will not be used on any thoroughfare unless authorized by the Commanding Officer.

(12) Smoking

Smoking is prohibited inside the restricted area, except as shown in NPP Instruction 5100.5A of 27 April 1955 and then regulated by the head of department having jurisdiction.

Personnel violating this regulation will be subject to disciplinary action.

(13) Solicitation

Solicitors, agents, etc., are not permitted to operate upon the Station without special permission from the Commanding Officer. If a salesman comes to your door, ask to see his permission before transacting any business with him. The circulation of advertising matter can be done only with written permission of the Commanding Officer. These regulations are enforced for your comfort, convenience and protection. When reporting unauthorized solicitation, call RI 3-2111, Ext. 110.

NPP Instruction 5340.1A prescribes the fund-raising program at NPP.

Periodic fund-raising drives are authorized for the following agencies during working hours:

The American National Red Cross
Community Chest or combined welfare drives including all organizations associated with the combined drive
National Health Agencies
- American Cancer Society, Inc.
- American Heart Association, Inc.
- Arthritis and Rheumatism Foundation
- Muscular Dystrophy Associations of America, Inc.
- National Association for Mental Health, Inc.
- National Multiple Sclerosis Society
- National Society for Crippled Children and Adults, Inc.
- National Society for the Prevention of Blindness
- United Cerebral Palsy Associations, Inc.

International Voluntary Agencies (campaign concurrent with approved National Health Agencies)
- CARE, Inc.
- Crusade for Freedom, Inc.

Navy Relief Society, and Intra-station welfare organization (NPP Welfare Association)

Subject to the approval of the Commanding Officer, the solicitation of subscriptions and collections of funds may be permitted outside of working hours for the following listed organizations:

NPP Recreation Association
Recognized veterans' organizations, such as Veterans of Foreign Wars, American Legion, etc.
Labor and other organizations of which employees are members when the solicitation is of members only
Boy and Girl Scouts (including subordinate organizations)
Charles County Children's Aid Society

(14) Vandalism

Unwarranted and illegal destruction of Government property and equipment should be promptly reported. In the interest of maintaining a safe environment and a pleasant and respectable community for NPP personnel, such acts cannot and will not be tolerated. All employees, military personnel, and other residents of the Station are requested to report any acts of vandalism and damage observed, and the presence of any prowlers or unauthorized persons, as follows:

	Phone No.	
	Office	Home
Officer-of-the-Day	374	
Commanding Officer, Marine Barracks	39	90
Corporal-of-the-Guard	110	

In making a report concerning the above mentioned incidents, the following information is desired:

Name of individual, if known. If name is not known, a description of the person(s) involved.
The act committed, including exact location.
Any other pertinent information that would be helpful to the investigating officer.

Appropriate disciplinary action, including summons to appear before the U.S. Commissioner for the more serious offenders, will be taken on all persons apprehended, including parents when minors are involved. Parents will be held accountable for the action of their children.

With the whole-hearted support of all personnel and residents of the Naval Propellant Plant, it is believed such incidents as vandalism, including damage to property, and presence of unauthorized prowlers can be effectively eliminated.

CHAPTER VI

A. INFORMATION

(1) Air Raid and General Emergency Procautions

NPP Instruction 3050.2 of 8 July 1955 outlines action to be taken when air raid and general emergency signals are sounded.

Air Raid

Signals

Alert Signal

Steady blast of three to five minutes duration from siren atop Building 600. This signal indicates Air Raid is possible. No specific action will be taken on this signal other than to be prepared for the Take Cover Signal.

Take Cover Signal

A wailing or fluctuating tone of three minutes duration from siren atop Building 600. This signal indicates Air Raid is imminent. All hands will proceed to their assigned air raid shelter, if in the vicinity, otherwise to the nearest improvised shelter or covering.

All Clear

Three 20-second steady tones from siren atop Building 600. This signal indicates the probability that the Air Raid has passed.

What to do

KEEP CALM-DON'T PANIC-PASS THE WORD

In the Plant

Discontinue operations
Secure equipment in accordance with locally posted instructions
Go the nearest Emergency Shelter

In other areas

Turn off all heaters, stoves, electric irons, televisions, radios, etc.

Go to the nearest Emergency Shelter
DO NOT attempt to escape by automobile. All automobile traffic will be halted.
DO NOT rush to school or other location for your children. Such action reduces both your and their chance for survival.
If not near an emergency shelter, get into a ditch, ravine, culvert, manhole, basement or other convenient shelter.
Lie down or against a slope or wall nearest the factory area to get best shelter against probable direction of blast.
Cover face against burns.

When ALL CLEAR is sounded, return to normal duties.

General Emergency

Signals

A two minute series of ten second blasts from the Power House whistle, indicates a state of emergency.

T wo short blasts from the Power House whistle, indicates the state of emergency has passed.

What to do

KEEP CALM-DON'T PANIC-PASS THE WORD

Discontinue plant operations and secure equipment in accordance with locally posted instructions.

If assigned duties by the Naval Propellant Plant Passive Defense Recovery Plan, proceed quickly to your station and report to your leader.

If not assigned specific duties by the Naval Propellant Plant Passive Defense Recovery Plan, go to the nearest EMERGENCY SHELTER and await instructions.

Note: Upon hearing the General Emergency Signal or otherwise learning that an emergency exists at the Naval Propellant Plant all employees, including off duty shifts, are expected to report to their assigned station as quickly as conditions permit.

(2) Bank

The Charles County Trust Company is located on Strauss Avenue at the intersection of Indian Head Avenue.

Hours:

Monday thru Friday 0900 am to 2:00 pm
Saturdays 0900 am to 11:00 am

The Bank is also open special hours from 3:30 p.m. to 5:00 p.m. on Thursdays. If a legal holiday falls on Thursday, the Bank is open on Wednesday from 3:30 p.m. til 5:00 p.m.

(3) Baseball

The Indian Head Baseball Diamond is located off Indian Head Highway to the rear of Indian Head Recreation Center, one block below intersection of Summers Road and Route 210.The Indian Head team belongs to the County League.. Schedule of games are noted on road sign. In addition to this diamond, a school diamond is located to the rear of the Elementary School Annex.

(4) Churches

BAPTIST

Bryans Road Baptist Mission
The Grange Hall, Bryans Road, Md.

Reverend Parker S. Hooper
Warrington Hills,
Indian Head, Md. - RI 8-5091

Worship Service - 9:30 am-6:00 pm
Sunday School - 10:45 am
Training Union - Sunday, 7:00 pm
Midweek Prayer - Thursday, 7:00 pm
Choir Practice - Wednesday, 7:00 pm

Indian Head Baptist Church
Indian Head Ave., Indian Head, Md.

Reverend Parker S. Hooper
Warrington Hills,
Indian Head, Md. - RI 8-5091

Worship Service - 11:00 am-8:00 pm
Sunday School - 9:45 am
Training Union - Sunday, 7:00 pm
Midweek Prayer - Wednesday, 7:00 pm
Choir Practice - Wednesday, 8:30 pm

Marbury Baptist Church
Marbury, Maryland

Reverend Charles L. Wentling
Marbury, Maryland - RI 3-3703

Worship Service - 11:00 am - 7:30 pm
Sunday School - 9:45 am
Training Union - Sunday, 6:30 pm
Midweek Prayer - Wednesday, 7:00 pm
Choir Practice - Wednesday, 8:00 pm

Potomac Heights Baptist Church
Glymont Road, Potomac Heights, Md.

Reverend Dale W. Chapman
1 Fairmont Place,
Potomac Heights, Md. - RI 8-2481

Worship Service - 11:00 - 8:00 pm
Sunday School - 9:45 am
Training Union - Sunday, 7:00 pm
Midweek Prayer - Wednesday, 8:00 pm
Choir Practice - Wednesday, 7:00 pm

CHURCH OF GOD

Marbury, Maryland

Reverend R. E. Smith
Marbury, Maryland - RI 8-2229

Worship Service - 10:45 am
Sunday School - 9:45 am
Midweek Prayer - Wednesday, 7:30 pm
Youth Fellowship - Thursday, 7:00 pm
Choir Practice - Wednesday, 8:30 pm

EPISCOPAL

St. James, Potomac Ave., Indian Head, Md.

Reverend Herbert S. Costain
Potomac Avenue,
Indian Head, Maryland - RI 3-3411

Holy Communion - 8:00 am
Church School - 9:45 am
Morning Prayer - 11:00 am
(Holy Communion celebrated first Sunday of each month)
Young People's Fellowship - 5:30 pm
Choir Practice - Wednesday, 7:00 pm

FULL GOSPEL

Old Indian Head Highway, Indian Head, Md.

Reverend Harold S. Bilotta
Box 54A,
Indian Head, Maryland - RI 8-2741

Worship Service - 11:00 - 7:30 pm
Sunday School - 10:00 am
Bible Study &
Prayer Meeting- Thursday, 7:30 pm
Choir Practice - Sunday, 7:00 pm

LUTHERAN

Church of Our Saviour, Glymont Road,
Indian Head, Maryland

Reverend Carl C. Reiter
5523 Belfast Drive,
Rosecroft Park,
Oxon Hill, Maryland - CH 8-4322

Worship Service - 11:15 am
Sunday School - 9:30 am
Choir Practice - Wednesday, 6:30 pm

METHODIST

Indian Head Methodist, Mattingly Ave.,
Indian Head, Maryland

Reverend Andrew L. Gunn
17 Mattingly Avenue,
Indian Head, Maryland - RI 3-7490

Worship Service - 11:15 am
Sunday School - 10:00 am
Intermediate
Fellowship - Sunday, 6:00 pm
Choir Practice - Wednesday, 7:00 pm

NAZARENE

Church of the Nazarene, Raymond Ave.,
Indian Head, Maryland

Reverend Richard Smith
35 Raymond Avenue,
Indian Head, Maryland - RI 3-3611

Worship Service - 11:00 am - 7:45 pm
Sunday School - 10:00 am
Prayer Meeting - Wednesday, 7:30 pm
Young Peoples
Meeting - Sunday, 7:00 pm
Choir Practice - Wednesday, 8:30 pm

ROMAN CATHOLIC

St. Mary's Star of the Sea, Mattingly Avenue, Indian Head, Maryland

Reverend Aloysious O'Connor
Reverend John Stack
Mattingly Avenue,
Indian Head, Maryland - RI 3-4211

Mass - Sunday, 6:45 am - 9:00 am
11:00 am - 7:00 pm
Weekday Masses -
Mon., Wed., and Fri. - 6:30 pm
Tues. and Thurs. - 8:00 pm
Novena - Wednesday, 7:30 pm
Confessions - Saturday, 4:00 pm to 5:30 pm
7:00 pm to 8:30 pm

St. Charles, Glymont, Maryland

Reverend Aloysious O'Connor
Reverend John Stack
Mattingly Avenue,
Indian Head, Maryland - RI 3-4211

Mass - Sunday, 8:00 am - 10:00 am
Mass - Saturday, 8:00 am
Confessions - Saturday, 4:00 pm to 5:00 pm
7:00 pm to 8:00 pm

(5) Doctors

ANDREWS, Dr. James E. - RI 3-5881

Office: Gering Court, Indian Head, Md.

Hours: Monday through Saturday
10:00 am - 12:00 noon
4:00 pm - 7:00 pm
Sunday - By appointment

CHEN, Dr. Paul - FAIRVIEW 2-5121

Office: Route #210 - Accokeek Road,
(Sowell Market)
Accokeek, Maryland

Hours: Weekdays except Thursday
9:00 am - 12:00 noon
4:00 pm - 7:00 pm
Sunday - 1:00 - 5:00 pm

EDELEN, Dr. Edward J. - WE 4-8131

Office: Edelen Medical Center,
La Grange Avenue,
La Plata, Maryland

Hours: Monday - 9:00 am - 2:00 pm
Wednesday - 6:00 pm - 8:00 pm
Thursday - 9:00 am-2:00 pm
Friday - 9:00 am - 2:00 pm
Saturday - 9:00 am - 2:00 pm

JARBOE, Dr. J. Parran - WE 4-3661

Office: Jarwood Clinic
La Plata, Maryland

Hours: By appointment only

JOHNSON, Dr. Frederick M. - WE 4-8401

Office: Jarwood Clinic
La Plata, Maryland

Hours: Monday - 9:00 am - 12:00 noon
Tuesday)
Thursday) - 4:00 pm - 6:00pm
Friday)
Wednesday) - 9:00 am-12:00noon
Saturday)

RUSSELL, Dr. Alexander L. - RI 3-2671

Office: Professional Building,
Indian Head Avenue,
Indian Head, Maryland

Hours: Monday - 1:00 pm - 4:00 pm
By appointment only

SUSAN, Dr. Frank - RI 3-2671

Office: Professional Building,
Indian Head Avenue,
Indian Head, Maryland

Hours: Monday)
Tuesday) - 9:00 am - 11:00 am
Thursday) 4:00 pm - 6:00 pm
Friday)
Saturday - 9:00 am - 11:00 am
Sunday - 10:00 am - 11:00 am
By appointment only.

WOODDY, Dr. Arthur O. - WE 4-3671

Office: Jarwood Clinic
La Plata, Maryland

Hours: By appointment only

(6) Dentists

BLUE, Dr. I. M. - WE 4-8311

Office: Charles & Somerset,
La Plata, Maryland

Hours: Monday)
Tuesday) - 9:00 am - 5:00 pm
Thursday)
Friday)

HOGGE, Dr. George W. - RI 3-3501

Office: Professional Building,
Indian Head Avenue,
Indian Head, Maryland

Hours: Monday &
Wednesday - 9:30 am - 6:00 pm
First and Third Friday -
1:00 pm - 6:00 pm

WIENER, Dr. E. R. - RI 3-6111

Office: Parran Building, Route 210,
Indian Head, Maryland

Hours: Tuesday - 3:30 pm - 6:00 pm
Wednesday - 8:30 am - 11:00 am
Friday - 3:30 pm - 6:00 pm

(7) Dining Accommodations

CINDY'S

Strauss Avenue, Indian Head, Md.

CLUB BELRAY

Indian Head Highway,
Bryans Road, Maryland

CLUB MARYLAND

Strauss Avenue,
Indian Head, Maryland

GATEWAY

Strauss Avenue,
Indian Head, Maryland

RIVER TERRACE

Glymont Road,
Potomac Heights, Maryland

SMITTY'S STEAK HOUSE

Bryans Road, Maryland

SOUTHERN

Bryans Road, Maryland

(8) Hospitals

Physicians Memorial Hospital

Phone No. WE 4711
La Plata, Maryland

St. Mary's Hospital

Phone No. GR 5-2241

Leonardtown, Maryland

D. C. Hospitals are listed in DC phone Directory.

(9) Mobile Library

The Bookmobile Headquarters is located in the Court House, La Plata, Maryland. Fiction and non-fiction books for adults and children are carried on the Bookmobile. Books not carried such as technical books, etc., can be obtained upon request. For additional information call WEST 4-8141, Extension 7.

Hours of Operation:

Indian Head, Maryland - between Strauss and Mattingly Avenues:
10:00 - 11:30 am - every other Thursday

Potomac Heights, Maryland

Schedules may be obtained at the Bookmobile

(10) Motor Courts

KING CHARLES - Faulkner, Maryland

LA PLATA - La Plata, Maryland

PARKWAY - La Plata, Maryland

SOUTH WINDS - La Plata, Maryland

THUNDERBIRD - Bel Alton, Maryland

(11) Navy Relief

Navy Relief Society
District of Columbia Auxiliary
Room 1638, Main Navy
Washington, D. C.

Phone: LIberty 5-6700, Extension 62335

(12) Notaries Public

A. J. Klaas
26 Raymond Avenue,
Indian Head, Maryland

Phone: RI 8-5191

R. P. Martin
10 Green Meadows Drive,
Indian Head, Maryland

Phone: RI 8-4333

J. H. McWilliams
1101 Strauss Avenue,
Indian Head, Maryland

Phone: RI 3-3651

J. D. Rowe, Sr.,
69 Mattingly Avenue,
Indian Head, Maryland

Phone: RI 8-5251

(13) Newspapers

Home delivery for the Washington, D. C. papers, Evening Star, Post-Times Herald and Daily News are permitted.

The following local papers are available for sale at the local stores or by subscription:

The Waldorf Leaf
Maryland Independent
Times Crescent

(14) Railway Express

The nearest Railway Express Office is located at La Plata, Maryland, approximately 13 miles from Indian Head on Route 225.

Hours of Operation:

Monday through Friday
8:00 am - 5:00 pm

(15) Red Cross

The nearest Red Cross Office is located at La Plata, Maryland, WEst 4-3683.

Local Directors are:

Mrs. Clarece B. Susan,
Indian Head, Maryland - RI 3-3741

Major Frank A. Bolton,
Pomonkey, Maryland - RI 3-5603

(16) Schools

PUBLIC

Indian Head Elementary School
Indian Head, Maryland

Phone: RI 3-5421

Indian Head Elementary School Annex
Indian Head, Maryland

Phone: RI 8-2921

Lackey High School
Indian Head Highway
Indian Head, Maryland

Phone: RI 3-5411

La Plata High School
La Plata, Maryland

Phone: WEst 4-5791

Indian Head Cooperative Kindergarten
441 Stark Road,
Indian Head, Maryland

Phone: RI 8-5451

PAROCHIAL

Archbishop Neale School
(Elementary & High)
La Plata, Maryland

Phone: WEst 4-3761

(17) Stores

A&P Food Store, Indian Head, Md.
COMSTOCK'S Market, Raymond Avenue, Indian Head, Maryland
HANCOCK'S Store, Old Gymont Road, Indian Head, Maryland
INDIAN HEAD MARKET (DGS), Strauss Avenue, Indian Head, Maryland
LEE'S Market, Old Indian Head Road, Indian Head, Maryland
MARSHALL'S Store, Old Indian Head Road, Indian Head, Maryland
MOODY'S Store, Old Indian Head Road, Indian Head, Maryland
SMITTY'S Super Market, Bryans Road, Maryland
WARD'S Store, Cedar Lane, Potomac Heights, Maryland
WOOSTER'S Market, Bryans Road, Md.

(18) Scouts

CUB

Indian Head, Maryland

St. James Episcopal Church
Pack Meeting - Second Tuesday of each month - 7:30 pm
Mr. P. F. Richards - RI 3-2111, Ext. 115

Potomac Heights, Maryland

Community Building
Pack Meeting - Last Tuesday of each month - 7:00 pm
Mr. Donald Lowenstein - RI 8-4271

BOYS

Indian Head, Maryland

Boys' & Girls' Club
Jackson Road & West Patton Rds.
Thursday - 7:30 pm
Mr. Macolm Smith, Ripley, Md.

Marbury, Maryland

10th District Fire Department
Monday - 7:00 pm
Mr. Fred Bostain, RI 3-3125

Potomac Heights, Maryland

Community Building
Wednesday - 7:00 pm
Mr. O. L. Wright, Bryans Road, Md.

GIRLS

Bryans Road, Maryland

Home of Mrs. Robert L. Michel
9 Green Meadows Drive,
Indian Head, Md. - RI 3-6364
Wednesday - 3:30 pm

BROWNIES

Bryans Road, Maryland.

Home of Mrs. Robert L. Michel
9 Green Meadows Drive,
Indian Head, Md. - RI 3-6364
Thursday - 3:30 pm

Potomac Heights, Maryland

Community Building
Wednesday - 3:45 pm
Mrs. Robert T. Aker - RI 3-4564

(19) Teen Town

"Teen Town" operated by the NPP Recreation Association for the provision of recreational opportunities for the teen-agers of NPP, is located in the NPP Recreation Hall,

Building 323, on Jackson Road. The facility operates from September to May 15 each year.

Equipment is available for the following entertainment:

Ping Pong
Variety of Games
Roller Skating
Dancing
Snack Bar

(20) Transportation

Indian Head is located on a peninsula and has no railroad or steamship line connections. The "WASHINGTON-MARYLAND-ALEXANDRIA" Bus lines operates one bus trip per day from Indian Head to Washington, D. C., and return. The current bus schedule is as follows:

LV Indian Head 6:45 a.m. AR Washington 8:00 a.m.
LV Washington 6:15 p.m. AR Indian Head 7:35 p.m.

Bus stop is located in the vicinity of Strauss Avenue and Earle Road approximately one-half block east from the Pass Office in the town of Indian Head, and in Washington, D.C., from the bus stop located at 11th and Pennsylvania Avenue, N. W.

(21) Veterinarians

Anacostia Animal Hospital
1628 - Good Hope Road, S. E.
Washington, D.C. - LUDLOW 1-4200

Bay Country Hospital
Dr. E. P. Newman, Jr.,
Clinton, Maryland - CYPRESS 7-8789

Bosty Dog & Cat Hospital
317 - Massachusetts Avenue, S. E.
Washington, D.C. - LINCOLN 6-8800

Indian Head Animal Hospital
8285 - Indian Head Highway,
Oxon Hill, Maryland - CHERRY 8-4146

Peterson, Dr. E. D.,
Hughesville, Md. - BRIDG 4-3289

CHAPTER VII

A. U. S. NAVAL SCHOOL, EXPLOSIVE ORDNANCE DISPOSAL

The U. S. Naval School, Explosive Ordnance Disposal is a sub-activity of the Naval Propellant Plant and is located on the Naval Reservation.

(1) Mission

The U.S. Naval School, Explosive Ordnance Disposal has the mission of training officers and enlisted personnel of the Navy, Marine Corps, Army and Air Force in the best methods and procedures for the recovery, evaluation and disposal of the surface and underwater explosive ordnance employed by the United States and other nations.

(2) History

In explaining the existence of the school, a brief history of its evolution is in order.

As a result of conditions in Europe, and the experience of the British in the beginning of World War II, it became apparent to the Navy Department that a disposal system of underwater and surface ordnance would be a dire necessity. In anticipation of the future need, a Mine Disposal School was established in the spring of 1941 at the Naval Gun Factory, Washington, D. C. In January 1942, a U.S. Navy Bomb Disposal School was also established at the Naval Gun Factory. Due to the rapid expansion of the Bomb Disposal School, it was moved to an area adjacent to the American University in Washington, D. C. Both of these schools utilized the facilities of the Ordnance Investigation Laboratory located at the Stump Neck Annex of the Naval Propellant Plant, Indian Head, Maryland, for practical field training. The Ordnance Investigation Laboratory was engaged in evaluating recovered foreign ordnance.

After the end of hostilities, training ceased in both schools. In November, 1945, the Chief of Naval Operations requested that the Bureau of Ordnance utilize its wartime experience in carrying out a peacetime program of explosive ordnance disposal research, development and training. A short time later, the Explosive Ordnance Disposal Unit, under the operational control of the Chief of Naval Operations, was formed with the greatly reduced

staffs of the Bomb and Mine Disposal Schools serving as a nucleus. Originally, the Unit was under the immediate jurisdiction of the Naval Ordnance Laboratory, White Oak, Maryland, but in August, 1946, it was moved to the Naval Propellant Plant, where facilities for expansion existed.

In March 1947, the Chief of Naval Operations directed the Bureau of Naval Personnel to assume operational control of the Ordnance Disposal Training Program. As a result, the U.S. Naval School, Explosive Ordnance Disposal was established as a subordinate unit of the Naval Propellant Plant, under the management control of the Bureau of Naval Personnel. All services were invited to enroll trainees and the first class convened 1 July 1947. Both the School and the Unit continued to function under one Officer-in-Charge, the staff personnel performing two services: training, and frequent disposal operations as directed by the Chief of Naval Operations.

The steady increase in students made it necessary for the School and the Unit to become separate activities. Thus, in May 1951, a separate officer-in-charge reported to take command of the School. Because of its continuous operational commitments, the Unit was unable to carry out efficiently the research and development phases of its mission. Recognizing this shortcoming, the Navy Department established other Explosive Ordnance Disposal Units to carry out the operational requirements, and in June 1953, replaced the Unit at the Naval Propellant Plant with the Explosive Ordnance Disposal Technical Center, under the management of the Bureau of Ordnance. The Technical Center, given a mission of research, development, testing and evaluating disposal techniques of explosive ordnance, moved to the Stump Neck Annex.

The Technical Center and the School presently work in close liaison, the new information developed by the one being utilized in the training program of the other.

As a tenant activity, the School receives all of its logistic support from the Naval Propellant Plant. It is unique in the fact that although under the direction of the Navy Department, the staff and student body consist of members of all the military services.

The Army, Air Force and Marine Corps personnel receive a three-month course in the disposal of surface ordnance. The Navy course is more extensive, covering surface ordnance,underwater ordnance, and six weeks of deep-sea and shallow water diving.

The necessity of the Explosive Ordnance Disposal man will evidently be a lasting one. The clearing of various Pacific Ocean Islands of World War II ordnance is far from finished and the scenes of Civil War Battles are still producing live loaded ordnance from that area.

CHAPTER VIII

A. U. S. EXPLOSIVE ORDNANCE DISPOSAL TECHNICAL CENTER

The U. S. Explosive Ordnance Disposal Technical Center, which is under the management control of the Bureau of Ordnance, is located at the Stump Neck Annex of the U.S. Naval Propellant Plant, Indian Head, Maryland.

(1) Mission

It is the Mission of this activity to perform the following functions in cooperation with and for the benefit of other agencies having cognizance of explosive ordnance matters within the Department of Defense:

> Formulate and submit to the Bureau of Ordnance requirements and military characteristics for new and modified specialized tools, equipment and techniques for recovery, rendering safe, and disposal of specific types of dangerous explosive ordnance;
>
> Conduct evaluation of foreign and enemy ordnance from field evaluation reports, recovered ordnance material, and information furnished by the Office of Naval Intelligence and the Bureau of Ordnance;
>
> Prepare explosive ordnance technical information for submission to the Bureau of Ordnance for publication and dissemiation, which includes rendering safe procedures and the necessary data, including photographs, drawings and sketches to facilitate recognition, recovery and disposal of explosive ordnance;
>
> Prepare drafts of explosive ordnance disposal material for the Bureau of Ordnance to be used in Ordnance Pamphlets;
>
> Advise the Bureau of Ordnance of requirements for research in the field of explosive ordnance disposal;

Assist the U. S. Naval School, Explosive Ordnance Disposal in the preparation of training aids.

(2) History

The early British experience of World War II demonstrated the need for a group of officers and men trained in recognition recovery analysis and disposal of bombs, mines and other types of unexploded ordnance. Throughout the War, under the technical supervision of the Bureau of Ordnance, the Bomb Disposal and Mine Disposal Schools (under the Potomac River Naval Command) trained selected volunteer Reserve personnel in bomb and mine disposal. At first, this training was narrow in scope and was confined, for the most part, to bombs at the Bomb Disposal School, and mines and torpedoes at the Mine Disposal School. Field experience required a broadening of this training as the War progressed, so that the end of the War found the experienced field personnel largely familiar with the operation and disposal of explosive ordnance of all types, and rendering valuable services to the fleets and Bureau of Ordnance in a variety of technical capacities.

It appeared evident that disposal services would be needed by the Navy for peace-time research, development and training. However, almost to the man, the personnel engaged in bomb and mine disposal work were Reserves, and very few of these officers and men remained in the Navy during peace-time. This gave rise to a serious problem of how to preserve, for the Navy, the skills and experience gained during the War in months of recovery and disposal of explosive ordnance.

The Chief of Naval Operations, recognizing these needs, set up an Ordnance Disposal Program for peace-time needs. In view of the primary interest of the Chief of the Bureau of Ordnance in explosive ordnance, it was only natural that the continuance of appropriated research in the disposal of explosive ordnance and the supervision of the technical phases of training should remain as a main Bureau of Ordnance function.

To carry out a part of the Ordnance Disposal Program, an Ordnance Disposal Unit, under the Potomac River Naval Command, was established on 2 October 1945 at the Naval Ordnance Laboratory,

for the purpose of maintaining mine and bomb disposal technical services and having personnel available for the disposal of all types of ordnance.

On 18 July 1946, the Ordnance Disposal Unit was transferred, with its billets and equipment, to the U. S. Naval Propellant Plant at Indian Head, Maryland. The officers and men, in addition to carrying out the technical phase of their mission, were under the operational control of the Chief of Naval Operations and were frequently called out on operational explosive ordnance disposal problems throughout various parts of the world inerting or disposing of explosive ordnance material.

On 11 June 1953, the Ordnance Disposal Unit was re-designated as the U.S. Naval Explosive Ordnance Disposal Technical Center, with the Chief of Naval Operations portion of the peace-time mission deleted, and it was placed under the management control of the Bureau of Ordnance. This change was made in order that the Navy could better discharge its duties under the agreement of the Joint Chiefs of Staff, as set forth in the mission stated above.

(3) Personnel

The Explosive Ordnance Disposal Technical Center is headed by an Officer-in-Charge holding the rank of Commander, who is qualified in explosive ordnance and special weapons disposal; with an officer allowance of fifteen (15) naval officers, all qualified in explosive ordnance disposal, and an enlisted allowance of sixty-six (66) men, of which twenty-six (26) are qualified in explosive ordnance disposal. In addition, there is assigned to the Technical Center, three (3) Army Liaison Officers, qualified in explosive ordnance and special weapons disposal. The three officers represent the Army Ordnance Corps, the Army Chemical Corps, and the Army Corps of Engineers. The Air Force is represented, in a liaison capacity, by representatives from the Air Material Command and the Air Research Development Command. Both officers are qualified in explosive ordnance disposal and special weapons disposal. One officer, qualified in explosive ordnance disposal and special weapons disposal, is assigned liaison duties at the Technical Center as the U. S. Marine Corps representative.

(4) Activity

The Technical Center receives logistic and administrative support from the Naval Propellant Plant. In addition, it is also assigned the Special Weapons and Explosive Ordnance Disposal Team, consisting of one officer and two enlisted men, of the Potomac River Naval Command.

(5) Operations Department

The Operations Department makes available to the Potomac River Naval Command the services of an assigned Special Weapons and Explosive Ordnance Disposal Team, when desired. It also carries on the activity training to maintain proficiency of assigned personnel and inerts explosive-filled ordnance, as directed.

(6) Maintenance and Material Department

The Maintenance and Material Department coordinates material, maintains and supplies, and accounts for all Technical Center supplies and equipment.

(7) Test and Evaluation Department

The Test and Evaluation Department conducts such tests and evaluation, as directed, to exploit all explosive ordnance disposal tools, equipment and techniques for purposes of assisting the Officer-in-Charge in formulating the requirements indicated in the mission of this activity.

(8) Publications and Technical Library Department

The Publications and Technical Library Department collects, evaluates and maintains all explosive ordnance disposal intelligence acquired by the Explosive Ordnance Disposal Technical Center; maintains a Technical Library; prepares rough drafts on explosive ordnance disposal material for submission to the Bureau of Ordnance, and prepares drawings and photographs.

(9) Special Weapons Department

The Special Weapons Department is responsible for the development of rendering safe procedures, tools and equipment in conjunction with special weapons and guided missiles.

(10) Administrative Department

The Administrative Department coordinates and supervises the administrative requirements of the other departments.

(11) Summary

The Explosive Ordnance Disposal Technical Center is constantly receiving items of inert and loaded explosive ordnance from the various agencies within the Department of Defense, and, in addition, the foreign items of ordnance received require exploitation for intelligence purposes. These items cover the various fields of atomic weapons, guided missiles, underwater and surface ordnance. In addition, the activity receives technical reports, manuals, blueprints and drawings on the aforementioned items.

After receipt of the above mentioned items and technical information thereon, the data is processed into joint Explosive Ordnance Disposal Technical Bulletins, where techniques for recovering and rendering safe are compiled. In addition, military characteristics for new and modified specialized tools and equipment are formulated, which are, in turn, submitted to the Bureau of Ordnance.

Since establishment of the new mission, the workload of this activity has more than doubled, with every indication of further increase, due to new weapon developments.

The products of this activity are utilized by the U. S. Naval School, Explosive Ordnance Disposal, where students from all branches of the armed services are instructed and qualified as explosive ordnance disposal and special weapons disposal technicians.

The field of explosive ordnance disposal is a very broad one, with many varied forms of ordnance items, both of U.S. and foreign origin. Several of these items date back to the Civil War cannon balls. With recent developments in the atomic weapons and guided missile field, new emphasis is being placed on the Explosive Ordnance Disposal Program, necessitating many revisions to the present procedures in tool, equipment and rendering safe procedures.

CHAPTER IX

A. U. S. MARINE CORPS DETACHMENT AT THE NAVAL PROPELLANT PLANT

The Commanding Officer of the Marine Barracks also performs collateral duty as Security Officer and Traffic Control Officer.

(1) Mission

The Marine Barracks provides security for the Naval Propellant Plant by controlling entrances and exits to the Station, and patrolling the Industrial, Magazine and residential areas; maintains established sentry posts; renders Station colors at 0800 and sunset; and acts as provost marshal of the activity.

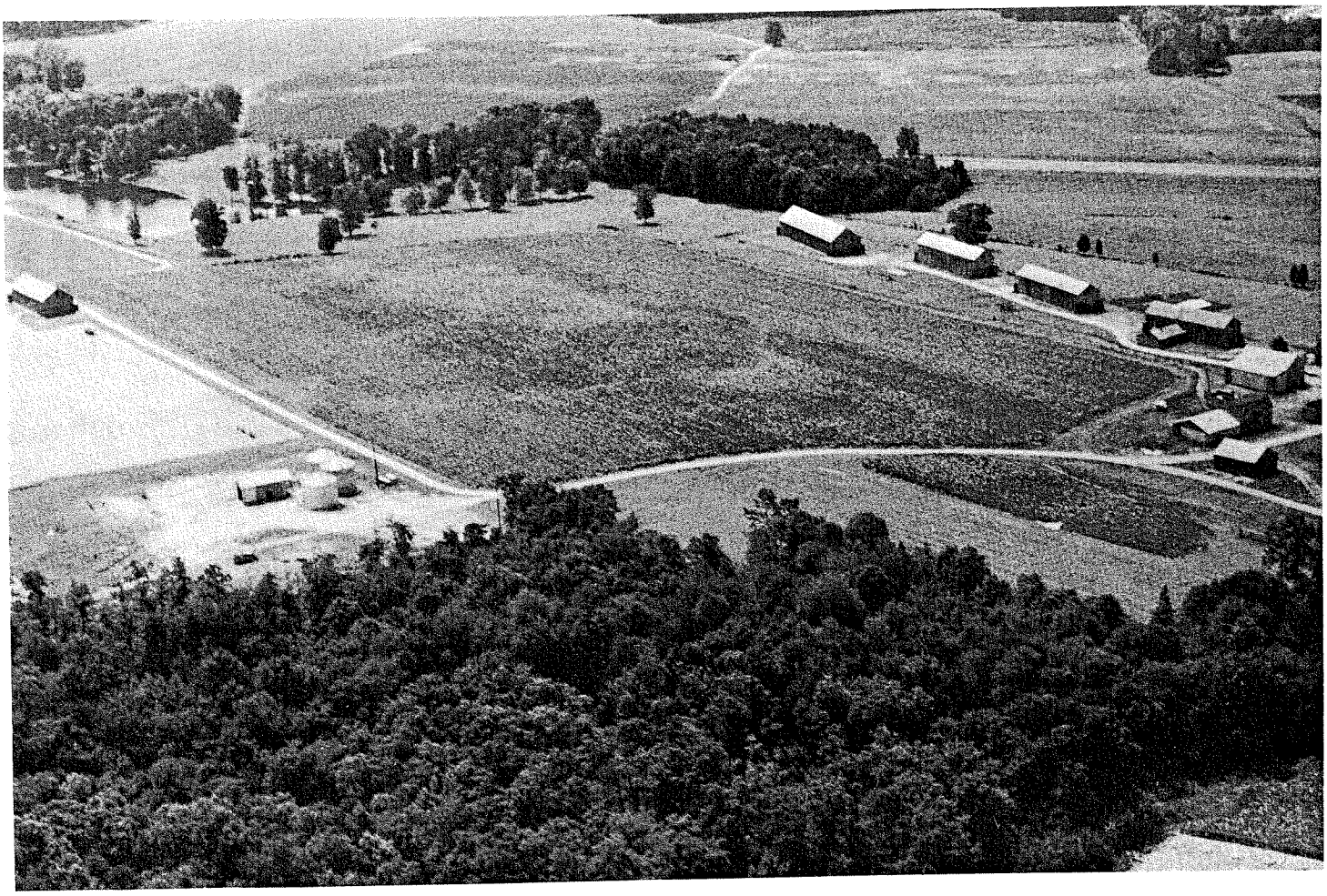
(2) History

The marine detachment landed early in the 20th Century at the Naval Proving Ground (as the station was then called). The first Marine Corps officer assigned to this activity was Second Lieutenant R. E. Messersmith, USMC, who reported for duty on 17 June 1915.

The first barracks were a group of one-story frame buildings built in 1907 and located in the area now occupied by the Industrial Relations Building and Navy Galley. In 1940, $125,000 was appropriated for a new two-story brick, building to house one hundred and twenty-five (125) men, including galley mess hall, recreation room, heads, showers, brig, storeroom, and headquarters office. This building was completed and occupied in 1941.

SOIL SURVEY OF

Charles County, Maryland



United States Department of Agriculture
Soil Conservation Service
In cooperation with
Maryland Agricultural Experiment Station

Issued July 1974

Contents

	Page
How this survey was made	1
General soil map	2
1. Beltsville-Gravelly land-Bourne association	2
2. Beltsville-Exum-Wickham association	3
3. Westphalia-Eroded land-Gravelly land association	4
4. Beltsville-Evesboro-Sassafras association	4
5. Leonardtown-Beltsville association	5
6. Magnolia association	5
7. Elkton-Othello-Keyport association	5
8. Sassafras-Mattapex-Othello association	6
9. Evesboro-Keyport-Elkton association	7
10. Bibb-Tidal Marsh-Swamp association	7
Descriptions of the soils	7
Alluvial land	7
Aura series	9
Beltsville series	10
Bibb series	11
Bourne series	12
Chillum series	13
Coastal beaches	14
Croom series	14
Cut and Fill land	15
Elkton series	15
Eroded land	15
Evesboro series	16
Exum series	16
Fallsington series	17
Galestown series	18
Gravel and Borrow pits	19
Gravelly land	19
Iuka series	19
Keyport series	20
Kitchen midden	22
Leonardtown series	22
Magnolia series	23
Marr series	24
Matapeake series	25
Matawan series	26
Mattapex series	26
Ochlockonee series	27

Descriptions of the Soils—Continued	Page
Osier series	28
Othello series	28
Rumford series	29
Sandy land	30
Sassafras series	30
Swamp	31
Tidal marsh	31
Westphalia series	31
Wickham series	33
Woodstown series	34
Use and management of the soils	34
Capability grouping	34
Estimated yields	46
Use of the soils as woodland	47
Management of woodland	47
Woodland classes and subclasses	52
Wildlife	54
Habitat elements	54
Classes of wildlife	55
Engineering uses of the soils	55
Engineering classification systems	73
Estimated engineering properties	73
Engineering interpretations	73
Engineering test data	74
Use of the soils for town and county planning	74
Use of the soils for recreational facilities	81
Genesis, morphology, and classification of soils	85
Genesis and morphology	85
Parent material	85
Climate	86
Plant and animal life	86
Relief	87
Time	87
Classification of soils	87
General nature of the county	89
Climate	90
Farming	91
Surface features	92
Water supply	92
Literature cited	92
Glossary	93
Guide to mapping units	Following 94

Issued July 1974

SOIL SURVEY OF CHARLES COUNTY, MARYLAND

BY RICHARD L. HALL AND EARLE D. MATTHEWS, SOIL CONSERVATION SERVICE

SOILS SURVEYED BY M. H. BAILEY, N. J. BECKETT, E. Z. W. COMPY, F. J. GLADWIN, R. L. HALL, M. F. HERSHBERGER, R. M. KIRBY, AND J. W. TURBITT, SOIL CONSERVATION SERVICE

UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE MARYLAND AGRICULTURAL EXPERIMENT STATION

CHARLES COUNTY is to the west of Chesapeake Bay in Southern Maryland (fig. 1). The Potomac River bends around it and forms the 75 miles of boundary on the south and west sides. It is bounded on the north by

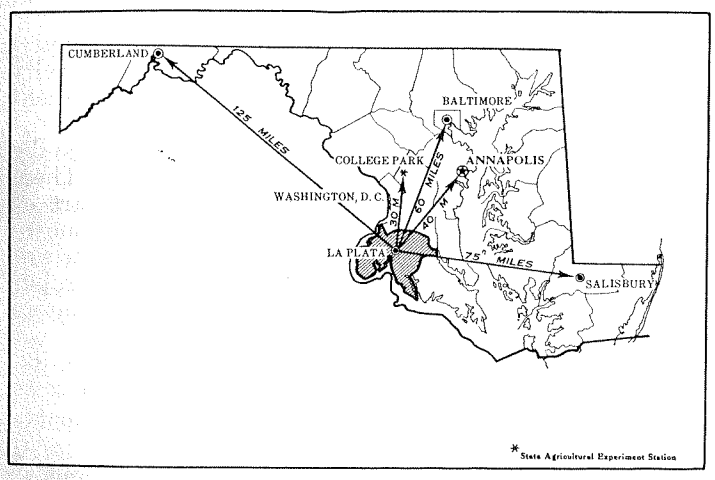


Figure 1.—Location of Charles County in Maryland.

Prince Georges County and on the east by Prince Georges County and St. Marys County. Charles County is about 32 miles from east to west and about 28 miles from north to south. It is 293,120 acres, or 458 square miles, in area. La Plata, the county seat, is near the center of the county. Other important towns and communities are Waldorf, St. Charles, Indian Head, Hughesville, Benedict, and Cob Island.

Most of the soils of the county are suitable for many farm and nonfarm uses. The main exceptions are marshy tidal areas and swamps that are too wet for most uses. About 80 percent of the land is suitable for cultivation.

Of the land suitable for cultivation, about 60 percent has a moderate to severe hazard of further erosion, 32 percent needs artificial drainage, and about 7 percent is severely limited by sandiness and droughtiness. The remaining 1 percent has few, if any, limitations for farming and needs no special management.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Charles County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Mattapex silt loam, 0 to 2 percent slopes, is one of several phases within the Mattapex series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map in the back of this publication was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the

management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Soil complexes are shown on the soil map of Charles County.

A soil complex consists of areas of two or more soils, so intermingled or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Exum-Beltsville silt loams, 2 to 5 percent slopes, moderately eroded, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Gravelly land, steep, is a land type in Charles County.

While a soil survey is in progress, samples of soils are taken, as needed, for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in such a way as to be readily useful to different groups of users, among them farmers, managers of woodland and rangeland, and engineers.

On the basis of yield and practice tables and other data, the soil scientists set up trial groups. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others, then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this publication shows, in color, the soil associations of Charles County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, drainage, and other characteristics that affect their management.

The 10 soil associations in Charles County are each described in the following pages. The terms for texture used in the titles of the associations apply to the surface layer unless otherwise stated.

1. Beltsville-Gravelly Land-Bourne Association

Level to moderately sloping, moderately well drained, loamy soils that are only moderately deep to a dense, root-inhibiting fragipan, and steep, gravelly soil material

This association is in most parts of the county except in the northeast and extreme southwest. The area is well dissected except on small upland flats, and it has many V-shaped ravines. Almost half of the soils are either severely eroded or are subject to the severe hazard of erosion.

This association occupies about 28 percent of the county. It is about 40 percent Beltsville soils, 25 percent Gravelly land, and 8 percent Bourne soils. The remaining 27 percent is minor soils.

Beltsville and Bourne soils are similar, but Beltsville soils are more silty and less sandy than Bourne soils. These soils have a hard, dense fragipan in the lower part of the subsoil. This fragipan prevents the downward movement of water. Late in winter and early in spring, the soil above the fragipan commonly is saturated with water, but little or no free water is in the fragipan and immediately below.

Gravelly land is steep, and it consists of gravelly deposits of soil material. The gravel content is about 20 to 80 percent, and the pebbles generally are less than 2 inches thick.

Many minor soils are in this association. Most extensive are the well-drained Aura, Croom, Sassafras, and Wickham soils, the moderately well drained Exum and Mattapex soils, and the poorly drained Bibb soils on some of the flood plains. This association is also made up of Eroded land on the uplands and of Alluvial land along many small streams.

Beltsville and Bourne soils are suited to most crops grown in the area, including corn, soybeans, and pasture. Tobacco is the most important single crop. Gravelly land generally is not used for farming.

A large part of the association formerly was cultivated but has reverted to woodland consisting mainly of hardwoods and Virginia pine.

A number of residential developments are along the major highways. They generally are on large lots and are individually owned. All of the major soils have a severe limitation for the disposal of effluent from septic tanks; consequently, special means of sewage disposal are necessary. Beltsville and Bourne soils are moderately limited for most other nonfarm uses. Gravelly land is so steep that it is severely limited for practically all uses.

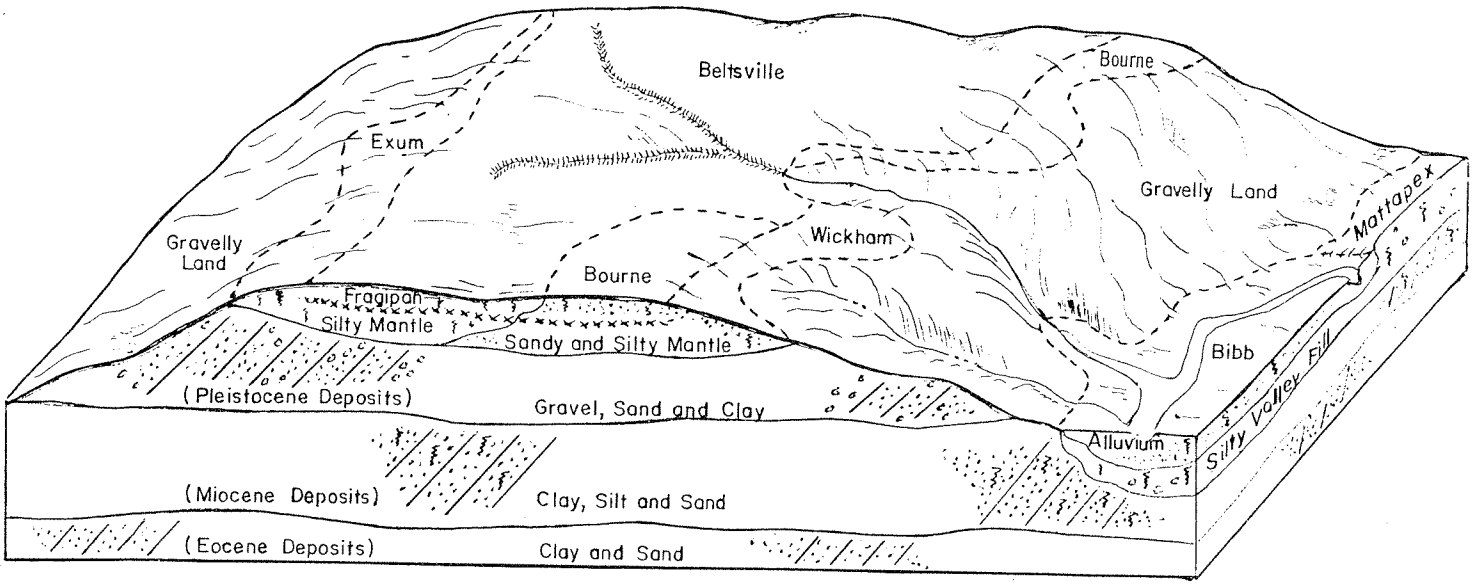


***Figure 2.*—Cross section of association 1 showing topography, important soils, and underlying material.**

Figure 2 is a diagrammatic cross section of a representative area of this association. Figure 3 is an aerial aspect of the same association.

2. Beltsville-Exum-Wickham Association

Level to moderately sloping, moderately well drained and well drained loamy soils, some of which are only moderately deep to a hard, dense, root-inhibiting fragipan

This association is mostly on elevated areas that are moderately dissected by the major streams and rivers of the county. In the western part of the county, parts of the association border the Potomac River and the Nanjemoy Creek. Many moderately sloping areas near drainageways are severely eroded.

This association makes up about 22 percent of the county. It is about 35 percent Beltsville soils, 21 percent Exum soils, and 9 percent Wickham soils (fig. 4). The remaining 35 percent is minor soils.

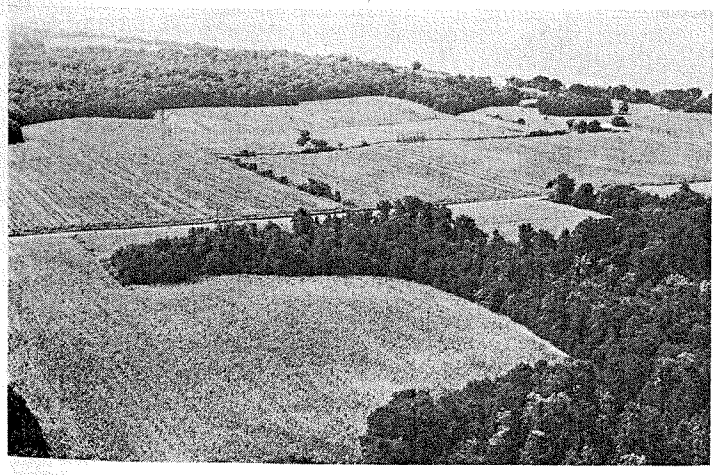


***Figure 3.*—Landscape bordering the Potomac River south of Popes Creek in the Beltsville-Gravelly land-Bourne soil association.**

The moderately well drained Beltsville soils are very silty and have a hard, dense fragipan in the lower part of the subsoil. This fragipan inhibits the downward growth of roots and the downward movement of water. Late in winter and early in spring, the soil above the fragipan commonly is saturated with water, but little or no free water is in the fragipan and immediately below.

Exum soils are moderately well drained and have a silty surface layer. The subsoil is very thick and is mainly clay loam. The water table is seasonally within 1½ to 2½ feet of the soil surface, but it is not perched above a fragipan as in Beltsville soils. The deep, well-drained Wickham soils typically have a surface layer of fine sandy loam and a subsoil of clay loam to sandy clay loam.

Many minor soils are in this association. Most extensive are the well drained Sassafras and Magnolia soils, the moderately well drained Bourne and Keyport soils, and the poorly drained Elkton, Leonardtown, and Bibb soils. Also in this association are small areas of Alluvial land, Eroded land, and Gravelly land.

About one-third of the association is cleared. These areas are mostly near U.S. Route 301 in the central part of the county. They are used mainly for crops, especially where slopes are less than 5 percent. Comparatively little tobacco is grown. A large part of the association formerly was cultivated, but it has reverted to woodlands consisting chiefly of oaks, beech, gums, and Virginia pine.

Many residential developments are along Route 301, in the area south of Marbury, and along other major roads. Several of these areas are large and are individually owned.

Beltsville soils are severely limited for the disposal of effluent from septic tanks. Exum soils are moderately to severely limited for this use. These soils commonly require special means of sewage disposal. They have moderate limitations for most other nonfarm uses. Wickham soils have few limitations for nonfarm uses except those imposed by steepness of slope.

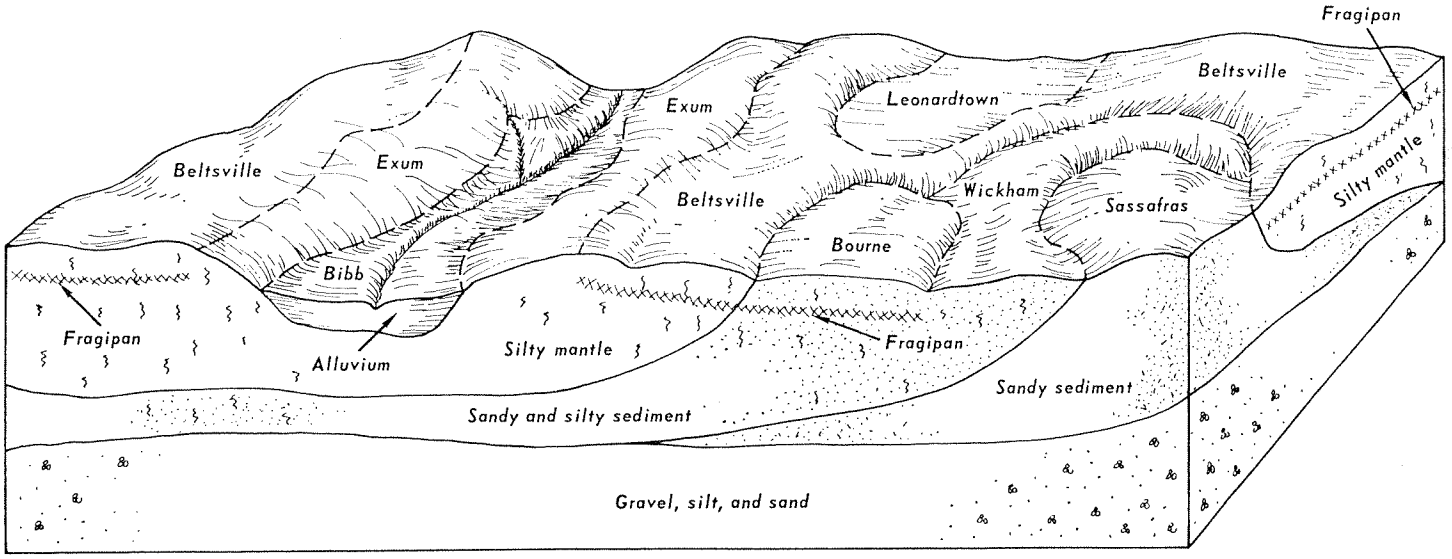


Figure 4.—**Cross section of association 2 showing relief, important soils, and underlying material.**

3. Westphalia-Eroded Land-Gravelly Land Association

Gently sloping to strongly sloping, well-drained, dominantly loamy soils; steep, severely eroded soil material; and gravelly soil material

This association is in one area in the eastern part of the county. It extends from near Benedict westward to near Hughesville and then northward where it adjoins the Prince Georges County line. In most of the association, slopes are greater than 5 percent. Many small streams and drainageways dissect the areas, and there are also many valleys. Erosion is extensive and severe, and in many places the subsoil is exposed. Gullies are common in this association. Some of them are deep and caving.

This association makes up about 4 percent of the county. It is about 35 percent Westphalia soils, 25 percent Eroded land, and 10 percent Gravelly land. The remaining 30 percent is minor soils.

The well-drained Westphalia soils have a surface layer and a subsoil of fine sandy loam. The subsoil is friable to very friable and is relatively thin. Underlying this material is loose loamy sand. Eroded land consists of areas where the surface layer and most of the original subsoil are eroded. Many of these areas are severely gullied. Gravelly land consists mainly of gravelly deposits of soil material. The gravel content is about 20 to 80 percent, and the pebbles generally are less than 2 inches thick. Eroded land and Gravelly land have slopes of about 15 to 50 percent.

Many minor soils are in this association. Most extensive are the excessively drained Evesboro soils, the somewhat excessively drained Rumford soils, the well-drained Croom and Sassafras soils, the moderately well-drained Beltsville soils, and the poorly drained Bibb soils on flood plains of streams.

The gently sloping and moderately sloping soils on uplands are suitable for farming, and most of the tobacco harvested in the county is grown on these soils. The tobacco generally is of very good to excellent quality. Corn and soybeans are also major crops. Supplementary irrigation is particularly beneficial for cultivated crops.

A large part of the association formerly was farmed but has reverted to hardwoods or Virginia pine. In places areas of Eroded land are idle, are in weeds or shrubs, or are almost barren of plants. Valleys are mostly in native hardwoods.

Slopes limit the use of these soils for residential developments and septic tank absorption fields. A few residential developments, however, are along Route 231. These soils commonly have no wetness limitations for foundations for buildings with basements.

4. Beltsville-Evesboro-Sassafras Association

Level to moderately sloping, moderately well drained to excessively drained, loamy and sandy soils, some of which are only moderately deep to a hard, dense, root-inhibiting fragipan

This association occupies one large area in the northern part of the county. It extends from north of Bennsville westward along the county line to near Malcolm, and then southward beyond Beantown to Hughesville and the St. Marys County line. The soils are dominantly undulating, but in places slopes are as much as about 15 percent. They are moderately dissected by drainageways that carry water mainly to Mattawoman Creek, Zekiah Swamp Run, and Gilbert Swamp Run. The association contains much of the highest land in the county.

This association occupies about 16 percent of the county. About 30 percent is Beltsville soils, and about 30 percent is Evesboro and Sassafras soils in equal parts. The remaining 40 percent is minor soils.

The moderately well drained Beltsville soils are very silty and have a hard, dense fragipan in the lower part of the subsoil. This fragipan inhibits the downward growth of roots and the downward movement of water. Late in winter and early in spring, the soil above the fragipan commonly is saturated with water, but little or no free water is in the fragipan and immediately below.

The excessively drained Evesboro soils are droughty. They are very sandy and extend to a depth of 5 feet or more. In some areas these soils are gravelly, and as much as 30 percent consists of fine, smooth, subangular quartz pebbles. The well-drained Sassafras soils have a sandy loam surface layer and a well-developed subsoil of sandy clay loam.

Many minor soils are in this association. Most extensive are the somewhat excessively drained Rumford soils, the well drained Aura and Croom soils, the moderately well drained Bourne and Exum soils, and the poorly drained Fallsington and Bibb soils. Also in this association are large areas of Gravelly land.

The major soils of this association are suited to most crops grown in the area, but farming is not extensive. Most farms are small and are used mainly for tobacco. A large part of the association formerly was farmed, but it has reverted to oaks and Virginia pine or is used for grazing.

Much of this association is in the path of community expansion from the Washington, D.C. area. A number of residential developments are in the county, particularly along State Route 5. Beltsville soils are severely limited for the disposal of effluent from septic tanks, but they have moderate limitations for most other nonfarm uses. Evesboro and Sassafras soils have fewer limitations, but slopes limit use for nonfarm purposes. Evesboro and Sassafras soils commonly have no wetness limitations for foundations and basements and few limitations for sewage disposal. Effluent moves rapidly and for considerable distances through Evesboro soils, and the hazard of polluting streams, shallow wells, and other water sources is serious.

5. Leonardtown-Beltsville Association

Level to gently sloping, poorly drained and moderately well drained, loamy soils that are only moderately deep to a dense, root-inhibiting fragipan

This association is in two areas in the northern part of the county. The larger area extends from north of Middletown eastward through Waldorf, and the smaller one is near Pomonkey. The soils in this association are level to gently sloping, and are somewhat dissected.

This association makes up about 2 percent of the county. It is about 60 percent Leonardtown soils and about 30 percent Beltsville soils. The remaining 10 percent is minor soils.

Leonardtown soils are poorly drained, and Beltsville soils are moderately well drained. Both soils have a hard, dense fragipan in the lower part of the subsoil. This fragipan inhibits the downward growth of roots and the downward movement of water. In some seasons the soil above the fragipan commonly is saturated with water for long periods, but little or no free water is in the fragipan and immediately below. This free water is nearer the surface in Leonardtown soils than it is in Beltsville soils.

Minor soils are mainly the poorly drained Elkton and Fallsington soils and the moderately well drained Woodstown soils.

Leonardtown soils are seldom cultivated. If these soils are artificially drained, they are suited to corn, soybeans, and some kinds of hay and pasture. Beltsville soils are suited to crops and pasture. Both soils are poorly suited to deep-rooted perennial crops such as alfalfa.

The Leonardtown soils are severely limited for most nonfarm uses, including homesites and septic tank absorption fields. Beltsville soils are also severely limited for the disposal of effluent from septic tanks, but they are only moderately limited for most other nonfarm uses.

6. Magnolia Association

Level to moderately sloping, well-drained, loamy soils

This association is in five small areas, mainly in the western part of the county. The largest and most important areas are about 2 miles northwest of Doncaster and about the same distance southeast of Nanjemoy. These soils are mostly level to gently sloping and are somewhat dissected. Slopes are as much as 12 percent, and in places these soils are severely eroded.

This association makes up about 1 percent of the county. It is about 80 percent Magnolia soils and 20 percent minor soils.

Magnolia soils are deep and well drained. The surface layer is silt loam that grades to distinctly red clay loam in places where the original surface layer has been lost through erosion. Minor soils are the well drained Aura soils and the moderately well drained Beltsville and Exum soils.

Much of this association is farmed. Other parts are idle or have reverted to trees. These soils are well suited to the major crops of the area, and under good management yields are among the highest in the county.

Magnolia soils are suitable for dwellings with basements and for other structures with similar foundations.

7. Elkton-Othello-Keyport Association

Nearly level to moderately sloping, poorly drained and moderately well drained, loamy soils, some of which have a clayey subsoil

This association is mainly in nearly level areas, commonly less than 40 feet above sea level. It borders the rivers and some of the larger creeks of the county. The largest areas border the Potomac River, the Nanjemoy Creek, the Port Tobacco River, and the Wicomico River.

This association makes up about 14 percent of the county. It is about 25 percent Elkton soils, 25 percent Othello soils, and 15 percent Keyport soils (fig. 5). The remaining 35 percent is minor soils.

The Elkton and Othello soils are poorly drained. Elkton soils have a subsoil of clay or silty clay. Othello soils have a subsoil of silt loam or silty clay loam. Keyport soils are moderately well drained, and they have a subsoil mostly of clay or silty clay. Elkton and Othello soils are difficult to drain and need artificial drainage if they are intensively farmed. Keyport soils also need artificial drainage, particularly the more nearly level areas.

Many minor soils are in this association. Most extensive are the well-drained Matapeake and Sassafras soils, and the moderately well drained Mattapex and Woodstown soils. Also included in this association are areas of Tidal marsh.

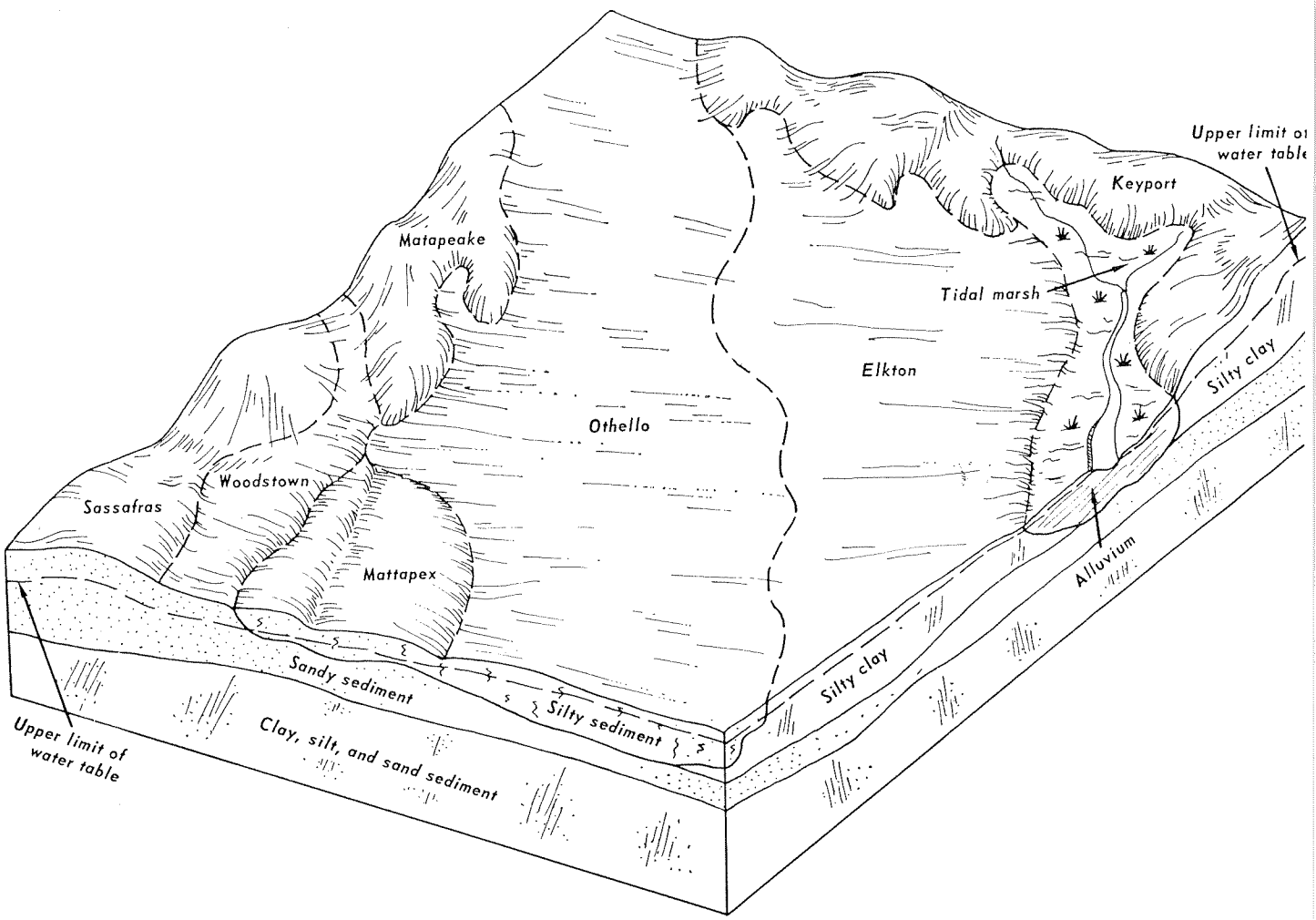


Figure 5.—**Cross section of association 7 showing relief, important soils, and underlying material.**

If the major soils are adequately drained, they are suited to general crops, hay, and pasture. Little tobacco or alfalfa is grown. Large areas, mainly of undrained Elkton and Othello soils, are wooded, and the stands consist of hardwoods and loblolly pine.

No extensive residential developments are in this association. Elkton and Othello soils are severely limited for the disposal of effluent from septic tanks. They are also severely limited for most other nonfarm uses. Keyport soils have only moderate limitations for other nonfarm uses.

8. Sassafras-Mattapex-Othello Association

Level to gently sloping, well drained, moderately well drained, and poorly drained, loamy soils

This association is in four small areas in Charles County. It borders Zekiah Swamp Run, Newport Run, Mattawoman Creek, Swanson Creek, and the Patuxent River. Elevations are less than 40 feet above sea level. Most soils in the association are gently sloping, but there are some poorly drained soils on the flats.

This association makes up about 2 percent of the coun It is about 55 percent Sassafras soils, 20 percent Mattap soils, and 10 percent Othello soils. The remaining 15 p cent is minor soils.

The dominant Sassafras soils are well drained and ha a sandy loam surface layer. The well-developed subsoil sandy clay loam. Mattapex soils are moderately w drained, and Othello soils are poorly drained. Mattap and Othello soils have a subsoil of silt loam or silty c loam.

The minor soils in this association are mainly the w drained Matapeake soils and the moderately well drair Keyport and Woodstown soils. Also included are sm areas of Eroded land and Tidal marsh.

Except for the well-drained Sassafras soils on wh some tobacco is grown, the other soils of the associat need additional drainage for the cultivation of crops.

Sassafras soils generally are only slightly limited nonfarm uses. Mattapex soils are severely limited for disposal of effluent from septic tanks. They are sligh to moderately limited for most other nonfarm uses. Oth soils are severely limited for nearly all nonfarm uses.

9. Evesboro-Keyport-Elkton Association

Level to moderately sloping, excessively drained, sandy soils and moderately well drained and poorly drained, level to gently sloping, loamy soils that have a clayey subsoil.

This association is in five distinct areas along the upper parts of the Potomac River. Elevations commonly are less than 40 feet above sea level. The largest area is in the extreme north of the county near Fenwick and Marshall Hall. Most soils in the association are gently sloping, others are nearly level, and still others have slopes as much as 15 percent.

This association makes up about 4 percent of the county. It is about 30 percent Evesboro soils and about 40 percent Keyport and Elkton soils in equal parts. The remaining 30 percent is minor soils.

The excessively drained Evesboro soils are droughty. They are very sandy to a depth of 5 feet or more. A few areas are gravelly, and contain as much as 30 percent fine, smooth, subangular quartz pebbles. The Keyport soils are moderately well drained and have a subsoil mainly of clay or silty clay. Elkton soils are poorly drained and nearly level and have a subsoil of clay or silty clay.

Many minor soils are in this association. Most extensive are the somewhat excessively drained Galestown and Rumford soils, the well-drained Croom and Sassafras soils, the moderately well drained Matawan and Mattapex soils, and the poorly drained Bibb soils that are on flood plains. Also included in this association are small areas of Tidal marsh.

In this association, farming comparatively is on a small scale. Some tobacco is grown on Evesboro soils. Keyport and Elkton soils require drainage for the cultivation of crops, including hay and pasture.

Because of its location, this association is mainly used for residential and industrial developments. The well-drained to excessively drained soils are mostly used for these developments. The Elkton soils are severely limited for the disposal of effluent from septic tanks and for building sites. Keyport soils are also severely limited for disposal of effluent from septic tanks, but are only slightly to moderately limited for residential and industrial developments.

10. Bibb-Tidal Marsh-Swamp Association

Level or nearly level, poorly drained soils on flood plains and miscellaneous unclassified wetland

This association is in areas along major flood plains and on nearby marshes and swamps. The most important of these areas are along Mattawoman Creek and Zekiah Swamp Run. Others are on the flood plains and estuaries of Chicamuxen Creek, Thorne Gut Marsh, Nanjemoy Creek, Wards Run, Mill Run, Port Tobacco Creek, and Gilbert Swamp Run.

This association makes up about 7 percent of the county. It is about 60 percent Bibb silt loam, 25 percent Tidal marsh, and 10 percent Swamp. The remaining 5 percent is minor soils.

Bibb soils are poorly drained and are subject to flooding. Tidal marsh consists of wet, unstable soil material that is subject to flooding by saline to brackish water. Swamp consists of wet, unclassified soil material that has fresh water above the surface for long periods.

Where flooding is not too frequent on Bibb soils, or where they are protected from flooding, these soils are suited to corn, soybeans, and pasture. Large areas of the soils in this association were once cultivated, but they have now reverted to hardwoods. Swamp generally is in wetland hardwoods. Tidal marsh and Swamp are not used for farming.

Most extensive minor soils are the moderately well drained Iuka soils and the poorly drained Othello soils.

This association is severely limited for most nonfarm uses. The soils are used mainly as habitat for some kinds of wildlife.

Descriptions of the Soils

This section describes the soil series and mapping units in Charles County. Each soil series is described in considerable detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second, detailed and in technical terms, is for scientists, engineers, and others who need to make thorough and precise studies of soils. Unless it is otherwise stated, the colors given in the descriptions are those of moist soil.

Following the name of each mapping units is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit and woodland subclass in which the mapping unit has been placed. The page for the description of each capability unit and woodland subclass can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 1. Some of the terms used in describing soils are defined in the section "How This Survey Was Made," and many can be found in the Glossary at the end of this survey. More detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*10*).[1]

Alluvial Land

Alluvial land (Ad) is nearly level and consists of soils formed in material recently washed from uplands and deposited on flood plains and in some draws and depressions. Most of the areas on flood plains are fairly narrow. The dominant soils of this land type are silty, but in places the soils are fairly sandy. These soils generally are somewhat poorly drained to very poorly drained, but some of the sandier soils are well drained. Alluvial land generally is flooded once or more each year, but where the watershed is mostly in woods and pasture, flooding may not occur every year.

[1] Italic numbers in parentheses refer to Literature Cited, p. 92.

478-272—74——2

TABLE 1.—*Approximate acreage and proportionate extent of soils*

Soil	Acres	Percent
Alluvial land	1,740	0.6
Aura gravelly sandy loam, 5 to 10 percent slopes, moderately eroded	1,150	.4
Aura gravelly sandy loam, 10 to 15 percent slopes, moderately eroded	4,390	1.5
Aura gravelly sandy loam, 5 to 15 percent slopes, severely eroded	8,560	2.9
Beltsville silt loam, 0 to 2 percent slopes	4,500	1.5
Beltsville silt loam, 2 to 5 percent slopes, moderately eroded	54,370	18.5
Beltsville silt loam, 5 to 10 percent slopes, moderately eroded	5,650	1.9
Beltsville silt loam, 5 to 10 percent slopes, severely eroded	7,660	2.6
Bibb silt loam	22,040	7.5
Bourne sandy loam, 2 to 5 percent slopes, moderately eroded	6,200	2.1
Bourne sandy loam, 5 to 10 percent slopes, moderately eroded	1,250	.4
Bourne sandy clay loam, 5 to 10 percent slopes, severely eroded	2,180	.7
Chillum silt loam, 2 to 6 percent slopes, moderately eroded	450	.2
Chillum silt loam, 6 to 12 percent slopes, moderately eroded	210	.1
Coastal beaches	60	(1)
Croom gravelly loam, 3 to 8 percent slopes, moderately eroded	1,490	.5
Croom gravelly loam, 8 to 15 percent slopes, moderately eroded	1,910	.7
Croom gravelly loam, 8 to 15 percent slopes, severely eroded	960	.3
Cut and fill land	270	.1
Elkton silt loam	12,810	4.4
Eroded land, steep	5,460	1.8
Evesboro loamy sand, 0 to 8 percent slopes	7,700	2.6
Evesboro loamy sand, 8 to 15 percent slopes	460	.2
Evesboro gravelly loamy sand, 0 to 8 percent slopes	1,960	.6
Evesboro gravelly loamy sand, 8 to 15 percent slopes	2,710	.9
Exum silt loam, 5 to 10 percent slopes, moderately eroded	4,540	1.5
Exum silt loam, 10 to 15 percent slopes, moderately eroded	1,050	.3
Exum clay loam, 5 to 10 percent slopes, severely eroded	7,080	2.4
Exum clay loam, 10 to 15 percent slopes, severely eroded	1,380	.5
Exum-Beltsville silt loams, 2 to 5 percent slopes, moderately eroded	2,250	.8
Fallsington sandy loam	2,200	.8
Galestown loamy sand, 0 to 8 percent slopes	2,130	.7
Gravel and borrow pits	320	.1
Gravelly land, steep	23,340	8.0
Iuka fine sandy loam	850	.3
Iuka sandy loam, local alluvium	850	.3
Iuka silt loam, local alluvium	1,800	.6
Keyport fine sandy loam, 0 to 2 percent slopes	420	.1
Keyport fine sandy loam, 2 to 5 percent slopes, moderately eroded	590	.2
Keyport silt loam, 0 to 2 percent slopes	5,470	1.8
Keyport silt loam, 2 to 5 percent slopes, moderately eroded	1,500	.5
Keyport silt loam, 5 to 12 percent slopes, moderately eroded	610	.2
Keyport silty clay loam, 5 to 12 percent slopes, severely eroded	300	0.1
Leonardtown silt loam	5,350	1.8
Magnolia silt loam, 0 to 2 percent slopes	670	.2
Magnolia silt loam, 2 to 5 percent slopes, moderately eroded	1,350	.5
Magnolia silt loam, 5 to 12 percent slopes, moderately eroded	410	.1
Magnolia clay loam, 5 to 12 percent slopes, severely eroded	420	.1
Marr fine sandy loam, 2 to 5 percent slopes, moderately eroded	130	(1)
Matapeake fine sandy loam, 0 to 2 percent slopes	350	.1
Matapeake fine sandy loam, 2 to 5 percent slopes, moderately eroded	490	.2
Matapeake silt loam, 0 to 2 percent slopes	510	.2
Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	1,500	.5
Matapeake silt loam, 5 to 10 percent slopes, moderately eroded	300	.1
Matapeake silt loam, 5 to 10 percent slopes, severely eroded	230	.1
Matawan loamy sand	430	.1
Mattapex fine sandy loam, 0 to 2 percent slopes	2,640	.9
Mattapex fine sandy loam, 2 to 5 percent slopes, moderately eroded	2,070	.7
Mattapex silt loam, 0 to 2 percent slopes	1,160	.4
Mattapex silt loam, 2 to 5 percent slopes, moderately eroded	700	.2
Mattapex soils, 5 to 12 percent slopes	840	.3
Ochlockonee fine sandy loam, local alluvium, 0 to 5 percent slopes	1,190	.4
Osier loamy sand	370	.1
Othello fine sandy loam	3,790	1.6
Othello silt loam	7,660	2.6
Rumford loamy sand, 0 to 5 percent slopes, moderately eroded	1,830	.6
Rumford loamy sand, 5 to 10 percent slopes, moderately eroded	740	.3
Rumford gravelly sandy loam, 0 to 5 percent slopes, moderately eroded	1,370	.5
Rumford gravelly sandy loam, 5 to 10 percent slopes, moderately eroded	470	.1
Sandy land, steep	2,610	.9
Sassafras sandy loam, 0 to 2 percent slopes	2,400	.8
Sassafras sandy loam, 2 to 5 percent slopes, moderately eroded	6,610	2.3
Sassafras sandy loam, 5 to 10 percent slopes, moderately eroded	2,480	.9
Sassafras sandy loam, 5 to 10 percent slopes, severely eroded	920	.3
Sassafras sandy loam, 10 to 15 percent slopes, moderately eroded	780	.3
Sassafras sandy loam, 10 to 15 percent slopes, severely eroded	800	.3
Swamp	3,810	1.3
Tidal marsh	6,380	2.2
Westphalia fine sandy loam, 2 to 6 percent slopes, moderately eroded	750	.3
Westphalia fine sandy loam, 6 to 12 percent slopes, moderately eroded	1,630	.6
Westphalia fine sandy loam, 6 to 12 percent slopes, severely eroded	180	.1
Westphalia fine sandy loam, 12 to 20 percent slopes, moderately eroded	690	.2

See footnote at end of table.

TABLE 1.—*Approximate acreage and proportionate extent of soils*—Continued

Soil	Acres	Percent	Soil	Acres	Percent
Westphalia fine sandy loam, 12 to 20 percent slopes, severely eroded	960	0. 3	Wickham fine sandy loam, 10 to 15 percent slopes, moderately eroded	580	0. 2
Westphalia-Evesboro complex, 2 to 6 percent slopes, moderately eroded	260	. 1	Wickham sandy clay loam, 5 to 10 percent slopes, severely eroded	2, 960	1. 0
Westphalia-Evesboro complex, 6 to 12 percent slopes, moderately eroded	600	. 2	Wickham sandy clay loam, 10 to 15 percent slopes, severely eroded	890	. 3
Westphalia-Evesboro complex, 6 to 12 percent slopes, severely eroded	190	. 1	Woodstown sandy loam, 0 to 2 percent slopes	2, 280	. 8
Wickham fine sandy loam, 2 to 5 percent slopes, moderately eroded	1, 100	. 4	Woodstown sandy loam, 2 to 5 percent slopes, moderately eroded	1, 640	. 6
Wickham fine sandy loam, 5 to 10 percent slopes, moderately eroded	1, 590	. 5	Woodstown sandy loam, 5 to 10 percent slopes, moderately eroded	240	. 1
			Total	293, 120	100. 0

[1] Less than 0.05 percent.

This land type is not cultivated. Most areas are idle or are wooded. They are suitable habitat for various kinds of wildlife. Capability unit VIw–1; woodland subclass 2w.

Aura Series

The Aura series consists of moderately sloping, deep, well-drained gravelly soils on uplands. These soils are deep, but a very hard, compact gravelly subsoil that limits root penetration by many plants is at a moderate depth. These soils formed in very old fluvial deposits of gravel, sand, and clay. The native vegetation is mixed upland hardwoods, mainly oak, and Virginia pine.

In a representative profile the surface layer, about 7 inches thick, is light olive-brown gravelly sandy loam. The upper part of the subsoil, about 17 inches thick, is light-brown to light yellowish-brown gravelly loam that is more compact as depth increases. The lower part is yellowish-red, gravelly sandy clay loam. It is very hard and compact and limits root penetration. The underlying material, below a depth of 54 inches, is yellowish-red gravelly sandy loam that is mixed with white.

The soils in this series are fairly easy to work, but the gravel is quite abrasive to farm implements. These soils are very strongly acid and have moderately slow permeability. They have a moderate available moisture capacity and dry out quickly in the rooting zone. For these reasons, they are not extensively farmed. Many areas have been exploited for gravel and road fill. Aura soils are suitable for use as foundations for buildings, but they have moderate to severe limitations for most other nonfarm uses.

Representative profile of Aura gravelly sandy loam, 5 to 10 percent slopes, moderately eroded, in a rewooded area about 2 miles east of Bel Alton:

Ap—0 to 7 inches, light olive-brown (2.5Y 5/4) gravelly sandy loam; very weak, medium, granular structure; very friable; many roots; very strongly acid; abrupt, smooth boundary.

B1—7 to 13 inches, light yellowish-brown (10YR 6/4) gravelly loam; weak, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; a few roots; very strongly acid; clear, smooth boundary.

B21t—13 to 24 inches, light-brown (7.5YR 6/4) gravelly heavy loam, variegated with yellowish red (5YR 5/6); weak, medium, subangular blocky structure; firm, slightly sticky and slightly plastic; a few roots; distinct reddish-brown (5YR 4/4) clay films; very strongly acid; clear, wavy boundary.

B22t—24 to 37 inches, yellowish-red (5YR 4/8) gravelly sandy clay loam, variegated with reddish yellow (7.5YR 6/6); weak, coarse, blocky, and massive structure; very hard, very firm, slightly sticky and slightly plastic; a few roots; yellowish-red (5YR 4/6) clay films, mostly on pebbles; inclusions of white, decomposed rock material; very strongly acid; clear, wavy boundary.

B23t—37 to 54 inches, yellowish-red (5YR 4/8) gravelly sandy clay loam, variegated with reddish yellow (7.5YR 6/6) and white; massive; very hard, firm, slightly sticky and slightly plastic; pebbles coated and sand grains bridged with yellowish-red (5YR 4/6) clay; very strongly acid; clear, wavy boundary.

C—54 to 66 inches, yellowish-red (5YR 5/6) gravelly sandy loam, variegated with white; massive; firm; friable when removed, slightly sticky; clay films on some pebbles; very strongly acid.

The solum ranges from about 4 to 8 feet in thickness. The subsoil is massive and very hard and extends to a depth of about 12 to 30 inches. The gravel content ranges from 15 to 35 percent in the solum, and is about 35 percent in the C horizon. The gravel is smooth and rounded and generally is ½ inch to 2 inches thick.

The A and B1 horizons are 10YR or 2.5Y in hue, 4 to 6 in value, and 3 to 6 in chroma. Undisturbed A1 horizons less than 6 inches thick are lowest in value and chroma.

The B2 horizon is 7.5YR to 2.5YR in hue, 4 to 6 in value, and 4 to 8 in chroma. The Bt horizon generally is gravelly sandy clay loam but ranges to gravelly loam and gravelly heavy sandy loam. The clay content is about 18 to 27 percent, and the silt content generally is less than 30 percent.

The color range in the C horizon is similar to that in the B horizon, but in some profiles the C horizon is variegated. The C horizon contains less clay and commonly more gravel than the B horizon, and it is less firm and crumbles readily when removed.

Aura soils resemble Croom soils, but they do not contain as much gravel and are redder in color. Commonly they are in association with Rumford and Sassafras soils. The subsoil in soils of the Aura series contains more clay and gravel and less sand than that of soils in the Rumford series. Aura soils contain more gravel than Sassafras soils, and the subsoil commonly is redder than that in Rumford and Sassafras soils. Aura soils are similar to Magnolia soils in color, but Magnolia soils have more clay in the subsoil, and they contain little, if any, gravel.

Aura gravelly sandy loam, 5 to 10 percent slopes, moderately eroded (AuC2).—This profile of this soil is the one described as representative of the series. This soil is mostly on upper slopes between ridgetops and ravines. Generally, at least half of the original surface soil has been washed away. Shallow gullies are fairly common.

This soil is suited to nearly all uses, but if it is cultivated, yields generally are only moderate, and the hazard of further erosion is severe. Capability unit IIIe–9; woodland subclass 3d.

Aura gravelly sandy loam, 10 to 15 percent slopes, moderately eroded (AuD2).—Most of this soil was formerly cultivated but now a large part is in woodland. In most places a part of the original surface soil has been lost through erosion. Shallow gullies are fairly common. Included with this soil in mapping are places where the surface layer has more silt or clay and less sand than that of this soil. The soil is suited to most farm uses, but if it is cultivated, the hazard of further erosion is severe. Capability unit IVe–7; woodland subclass 3d.

Aura gravelly sandy loam, 5 to 15 percent slopes, severely eroded (AuD3).—This soil is mostly on the sides of ravines. Most areas are idle or are in sparse woodland. The subsoil is exposed or is partly eroded in most places. Gullies are common to abundant, and many are filled with gravel that was left behind by erosion. The hazard of further erosion is extremely severe on this soil, unless a permanent protective cover of plants is kept on the areas. This soil is well suited to the production of trees for commercial purposes, watershed protection, wildlife habitat, and some kinds of recreation. Capability unit VIIe–2; woodland subclass 3d.

Beltsville Series

The Beltsville series consists of nearly level to moderately sloping, moderately deep, moderately well drained soils. These soils are strongly acid and slowly permeable, and they have a fragipan that generally is at a depth of less than 30 inches. Beltsville soils formed in silty and moderately sandy material containing moderate amounts of clay. They are in most upland areas and are the most extensive soils in the county. Many farms and communities are almost completely dominated by them. The native vegetation generally is hardwoods, mainly scrub-type oaks, and some Virginia pine and loblolly pine.

In a representative profile the surface layer, about 10 inches thick, is silt loam that generally is pale brown, brown, or yellowish brown. In wooded areas it is grayish brown in the thinner, upper part and pale yellow below. The upper part of the subsoil, about 18 inches thick, is yellowish-brown to brownish-yellow silt loam that is mixed with pale yellow. The lower part of the subsoil is fragipan through which water moves very slowly and roots do not penetrate readily. It is 26 inches thick and is brownish-yellow or yellowish-brown, mottled silt loam that is firm to very firm, dense, and brittle when moist. When dry it is very hard. Below the fragipan is mixed yellowish-brown and red loam.

Beltsville soils are fairly easy to work when the moisture content is favorable, but the moisture content is extremely variable during the year. Near the surface these soils are often saturated, but they are almost dry in and below the slowly permeable fragipan. During other seasons Beltsville soils are almost completely dry as far down as the fragipan, which prevents the upward movement of soil moisture. At such times the soil is droughty and irrigation is beneficial for some crops (fig. 6).

Large areas of Beltsville soils are farmed, others are idle or in woodland, and some areas have intensive nonfarm uses (fig. 7). These soils have moderate to severe limitations for many nonfarm purposes.

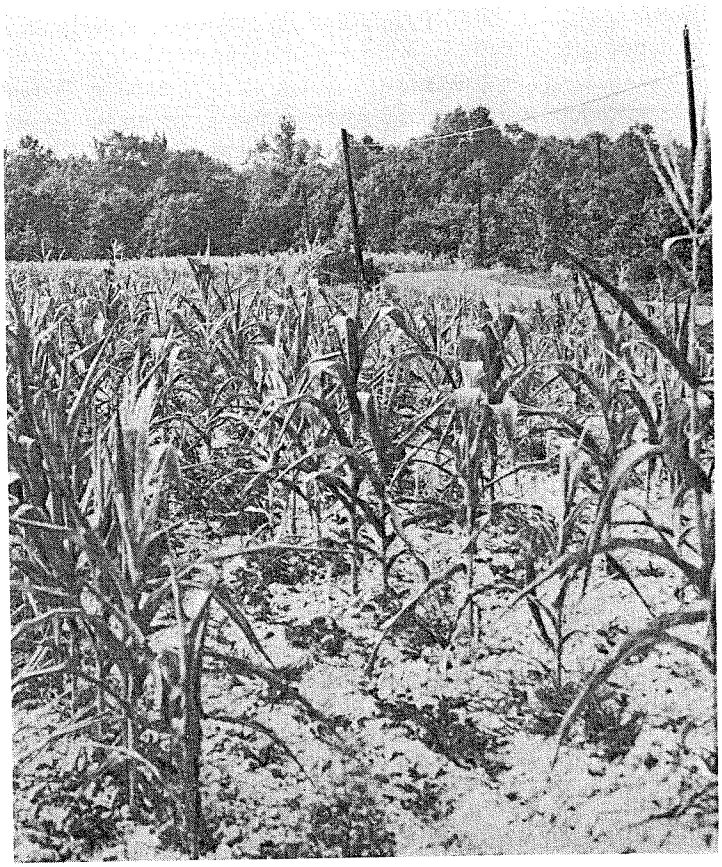


Figure 6.—**Corn showing effects of lack of moisture, on Beltsville silt loam near Nanjemoy.**

Representative profile of a Beltsville silt loam, in a gently sloping wooded area just off Popes Creek Road, about 1 mile southwest of Faulkner:

A1—0 to 2 inches, grayish-brown (2.5Y 5/2) silt loam; weak, fine and medium, granular structure; very friable, slightly sticky and slightly plastic; many roots; very strongly acid; abrupt, smooth boundary.

A2—2 to 10 inches, pale-yellow (2.5Y 7/4) silt loam; very weak, fine subangular blocky structure; friable, slightly sticky and slightly plastic; common roots; very strongly acid; clear, smooth boundary.

B1—10 to 16 inches, light yellowish-brown (10YR 6/4) heavy silt loam, variegated with pale yellow (2.5Y 7/4); weak, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; a few roots; very strongly acid; clear, smooth boundary.

B2t—16 to 28 inches, brownish-yellow (10YR 6/6) heavy silt loam, variegated with pale yellow (5Y 7/4); weak to moderate, medium, subangular blocky structure; friable to firm, slightly sticky and slightly plastic; a few roots; almost continuous pale brown (10YR 6/3) clay films; very strongly acid; clear, smooth boundary.

Bx1—28 to 45 inches, brownish-yellow (10YR 6/6) heavy silt loam; many, medium, faint mottles of very pale brown (10YR 7/3), and common, medium, distinct mottles of light gray (N 7/0) and strong brown (7.5YR 5/6); strong, coarse, prismatic and weak, thick, platy structure; dense; very hard, very firm, slightly sticky and slightly plastic; a few fine roots in upper part; continuous brown (10YR 5/3) clay films on upper surfaces of plates; very strongly acid; gradual, smooth boundary.

Bx2—45 to 54 inches, yellowish-brown (10YR 5/6) silt loam; many, medium, distinct mottles of light gray (2.5Y 7/2) and common, medium, faint mottles of strong brown (7.5YR 5/6); weak, medium, platy and fine, subangular blocky structure; firm, slightly sticky and slightly plastic; faint, discontinuous clay films; very strongly acid; clear, smooth boundary.

IIC—54 to 72 inches, yellowish-brown (10YR 5/6) loam, variegated with red (2.5YR 4/6), strong brown (7.5YR 5/6), and light gray (2.5Y 7/2); massive; firm, slightly sticky; very strongly acid.

The solum ranges from about 40 to 64 inches in thickness. Depth to the Bx horizon ranges from about 20 to 32 inches. The A horizon is 2.5Y or 10YR in hue, 2 to 7 in value, and 1 to 6 in chroma. Very thin A1 horizons are 3 in value and 1 and 2 in chroma. The A2 horizon can be 6 or 7 in value and 1 and 2 in chroma. The B1 and Bt horizons is 10YR in hue, 5 or 6 in value, and 4 or 6 in chroma. They may be variegated. These horizons are silt loam or silty clay loam in texture. The sand content is greater than 15 percent but less than 30 percent. The clay content of the Bt horizon is 18 to 30 percent. The Bx horizon is 2.5Y, 10YR, or 7.5YR in hue, 4 to 6 in value, and 3 to 6 in chroma. It is variegated or has mottles that are low or high in chroma, or both. This horizon is loam, silt loam, or silty clay loam, and characteristically is very dense, tough, and brittle. The IIC horizon has about the same range in color as the Bx horizon, but it is distinctly coarser in texture. Fine to medium smooth pebbles are common to many in the IIC horizon.

Beltsville soils are similar to Bourne soils in color and in natural drainage, but they are much more silty and less sandy throughout. They are better drained than Leonardtown soils, which are dominantly gray throughout. Beltsville soils are not so well drained as the Aura and Croom soils, which have hard, gravelly Bt horizons, and the Chillum soils, which have hard, dense C horizons.

Beltsville silt loam, 0 to 2 percent slopes (BlA).—This soil becomes saturated quickly when it rains or when snow melts. Generally, it is wet for a fairly long period because runoff and permeability are slow, and late planting is sometimes necessary. Artificial drainage is beneficial for some crops and for some nonfarm uses. The hazard of further erosion generally is slight, although a small amount of surface soil has been lost in some areas that have been cultivated for many years. Capability unit IIw–8; woodland subclass 3w.

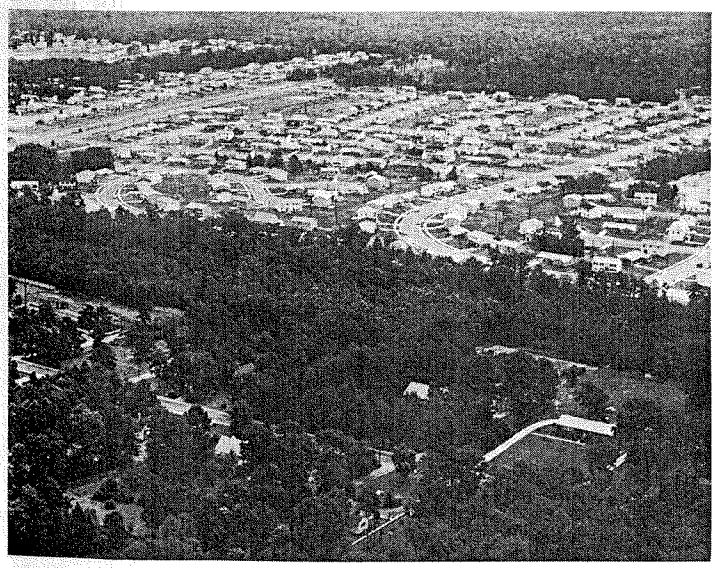


Figure 7.—St. Charles, a new residential development in the northern part of the county. The dominant soils in this area are those of the Beltsville series.

Beltsville silt loam, 2 to 5 percent slopes, moderately eroded (BlB2).—This soil has a profile similar to that described as representative for the series, except that in most places the surface layer is thinner. In practically all cleared areas, surface soil has been lost through erosion, and a few shallow gullies have formed. The hazard of further erosion is moderate, as water runs off readily, especially when the soil is wet. This hazard is a more serious limitation to use on these soils than is impeded drainage. The improvement of drainage is beneficial for some uses. Included with this soil in mapping are some areas where gray mottling is in the part of the subsoil above the fragipan. This Beltsville soil is the most extensive and widespread soil in the county, and its uses and limitations are extremely important. Capability unit IIe–13; woodland subclass 3w.

Beltsville silt loam, 5 to 10 percent slopes, moderately eroded (BlC2).—This soil has a profile similar to that described as representative of the series except that its surface layer and its subsoil generally are thinner. Further erosion is a hazard, and in places plowing usually exposes the subsoil, giving newly plowed areas a spotty appearance. Shallow gullies are present. Included with this soil in mapping are a few small areas that are mottled with gray in the subsoil above the fragipan. The hazard of further erosion is severe. This soil is suited to pasture or trees. Under good management that includes practices to control erosion, this soil is suited to cultivated crops. Capability unit IIIe–13; woodland subclass 3w.

Beltsville silt loam, 5 to 10 percent slopes, severely eroded (BlC3).—This soil has a profile similar to that described as representative of the series, except that it has lost most or all of its original surface layer and a part of its subsoil through erosion. Gullies are common to many, and some of them extend into the fragipan or through it. Included with this soil in mapping are small areas that are mottled with gray in the subsoil above the fragipan. Where gullies occur, this soil is marginal for cultivated crops. It is better suited to hay, pasture, or woodland. Capability unit IVe–9; woodland subclass 3w.

Bibb Series

The Bibb series consists of level or nearly level, poorly drained soils on flood plains. These soils are subject to flooding at irregular intervals (fig. 8). They formed in recently deposited alluvium that was washed mainly from soils on the uplands in the county. The native vegetation is wetland hardwoods, mainly red maple (commonly called swamp maple), blackgum, birch, willow, and oaks, but pond pine and loblolly pine grow in some places. Most of the acreage is woodland.

In a representative profile the surface layer is grayish-brown silt loam that is mottled with reddish brown and is about 14 inches thick. The underlying material, to a depth of about 60 inches, is gray or light gray and is mottled with various colors. It is silt loam mottled with light brownish gray in the upper part, loam mottled with reddish brown in the middle, and gravelly sandy loam mottled with yellowish red in the lower part.

Bibb soils are easy to work when the moisture content is favorable, but the water table is at or near the surface in winter and generally remains there until late in spring.

Figure 8.—**A flooded pasture on Bibb silt loam, on the flood plain of Port Tobacco Creek.**

The high water table delays planting where Bibb soils are farmed. These soils are moderately permeable. They are severely limited for most nonfarm uses because natural drainage is poor, the water table is seasonally high, and flooding is a hazard.

A representative profile of a level Bibb silt loam, in a wooded area on the flood plain of Port Tobacco Creek, about 2½ miles northwest of La Plata:

A1—0 to 14 inches, grayish-brown (10YR 5/2) silt loam; many, medium, prominent mottles of reddish brown (5YR 4/4); moderate, fine and medium, granular structure; friable, slightly sticky and slightly plastic; common roots; very strongly acid; clear, smooth boundary.

C1g—14 to 21 inches, gray and light-gray (5Y 6/1) silt loam; many, coarse, faint mottles of light brownish gray (2.5Y 6/2) and common, fine, prominent mottles of reddish brown (2.5YR 4/4); weak, fine, granular structure; friable, slightly sticky and slightly plastic; a few roots; very strongly acid; clear, smooth boundary.

C2g—21 to 28 inches, gray and light-gray (5Y 6/1) loam; common, medium, prominent mottles of reddish brown 5YR 4/4); stratified; friable, slightly sticky and slightly plastic; a few roots; very strongly acid; abrupt, wavy boundary.

C3g—28 to 60 inches, gray and light-gray (5Y 6/1) gravelly sandy loam; common, medium, prominent mottles of yellowish red (5YR 5/6) and a few, coarse, prominent mottles of dark red (2.5YR 3/6); stratified; very friable, slightly sticky; very strongly acid.

The A horizon is silt loam in texture. The matrix is 4 to 7 in value and 1 or 2 in chroma. Mottles occur in some places. The matrix of the C horizon is 10YR to 5Y in hue, 4 to 7 in value, and 0 to 2 in chroma. The C horizon is neutral in some places. It is mottled with red, brown, yellow, or gray, the C1g and C2g horizons are silt loam or loam. Depth to the C3g horizon ranges from about 20 to more than 40 inches. The C3g horizon is commonly coarser textured than the horizons above it, but in some places it is abruptly finer textured. Between depths of 10 and 40 inches the soil profile generally is less than 18 percent clay and more than 15 percent sand. The C horizon generally is stratified. Fine smooth pebbles occur at any place in the profile, but they are most common in the C horizon.

Bibb soils resemble Elkton, Fallsington, Othello, and Osier soils in color and in natural drainage, but none of those soils are on flood plains. Bibb soils lack the distinct to prominent Bt horizons that are in Elkton, Fallsington, and Othello soils. They are not so sandy as Osier soils. Associated with Bibb soils are Alluvial land and the moderately well drained soils of the Iuka series.

Bibb silt loam (Bo).—This is the only Bibb soil mapped in the county. It is nearly level and in only a few places are slopes more than 1 percent. Artificial drainage is needed for cultivated crops. Where flooding is not too frequent or too severe, the soil is suited to annual crops that are planted late and to seasonal pasture. Where flooding is very frequent or very severe, the soil is used mostly as woodland. The frequency and severity of flooding cannot be predicted from the soil map, but only from a knowledge of the flooding history of any particular tract or area. Capability unit IIIw–7; woodland subclass 2w.

Bourne Series

The Bourne series consists of gently sloping to moderately sloping, moderately well drained soils that have a dense, brittle fragipan in the lower part of the subsoil. These soils are on broad ridgetops at the higher elevations. They formed in thick sandy sediment containing moderate amounts of clay and some silt. The native vegetation is upland oaks and Virginia pine.

In a representative profile, the surface layer is sandy loam about 13 inches thick. It is dark grayish brown in the upper 2 inches and pale brown below. The upper part of the subsoil, about 10 inches thick, is yellowish-brown loam. The lower part of the subsoil is a fragipan about 28 inches thick. It consists of brownish-yellow to pale-brown fine sandy loam that is mottled with various colors. It is dense and is very firm and brittle when moist and very hard when dry. Water moves very slowly through this layer, and roots ordinarily do not penetrate it. Below the subsoil is stratified, massive fine sandy loam.

Bourne soils are easy to work, except where they are severely eroded. The available water capacity is low to moderate. Above the fragipan these soils are wet for short periods, but they tend to dry out thoroughly in summer and in fall. The fragipan is seldom wet, for it acts as a barrier for soil moisture. Bourne soils are slowly permeable. They have moderate to severe limitations for many nonfarm uses.

Representative profile of Bourne sandy loam, in a gently sloping wooded area on east side of State Route 232, about 3 miles east of Newport:

A1—0 to 2 inches, dark grayish-brown (10YR 4/2) sandy loam; weak, fine and medium, granular structure; friable; many roots; very strongly acid; abrupt, smooth boundary.

A2—2 to 13 inches, pale-brown (10YR 6/3) sandy loam; weak, fine and medium, granular structure; friable, slightly sticky; common roots; extremely acid; clear, smooth boundary.

B2t—13 to 23 inches, yellowish-brown (10YR 5/6) heavy loam; very weak, medium, subangular blocky structure; friable, sticky and slightly plastic; a few roots; thin, discontinuous clay films; very strongly acid; abrupt, smooth boundary.

Bx1—23 to 42 inches, brownish-yellow (10YR 6/6) fine sandy loam, faintly variegated or mottled with yellowish brown (10YR 5/8), strong brown (7.5YR 5/8), and light gray (5Y 7/2); weak, thick, platy structure; very hard, firm, slightly sticky and slightly plastic; patchy clay films; very strongly acid; clear, smooth boundary.

Bx2—42 to 51 inches, pale-brown (10YR 6/3) fine sandy loam, variegated with yellowish brown (10YR 5/6) and light olive brown (2.5Y 5/6); weak, thick, platy structure

and weak, medium, blocky structure; very hard, firm, slightly sticky and slightly plastic; strong-brown (7.5YR 5/6) patchy clay films; very strongly acid; clear, smooth boundary.

Cx—51 to 60 inches, variegated yellowish-brown (10YR 5/8), brownish-yellow (10YR 6/6), and yellowish-red (5YR 4/8) fine sandy loam; stratified, massive; firm, slightly sticky and slightly plastic; a few vertical cracks; very strongly acid.

The A horizon is 4 to 6 in value and 2 to 4 in chroma. In the Bt horizon hue is 10YR or 7.5YR, value is 5 or 6, and chroma is 4 to 8. This horizon is commonly sandy clay loam, but its range includes loam and clay loam. The clay content of the Bt horizon generally is between about 18 and 30 percent. The Bt horizon is 10 inches thick or more. The Bx horizon is at a depth of 18 to about 28 inches, and it ranges from about 16 to 30 inches in thickness. In the Bx horizon, the matrix is 10YR or 7.5YR in hue, 5 or 6 in value, and 3 to 8 in chroma. Mottles range from 5Y to 5YR in hue, and the range in value and chroma is wide. In some profiles, the Bx horizon is highly variegated and there is no dominant matrix color. The Bx horizon is loam or fine sandy loam. The solum ranges from about 40 to 70 inches in thickness. The Cx horizon generally is variegated. It is massive and stratified. Texture is sandy loam or fine sandy loam. Fine, smooth quartz pebbles may occur in any horizon.

Bourne soils resemble Beltsville soils but are less silty and more sandy in the A and B horizons, including the Bx horizon.

Bourne sandy loam, 2 to 5 percent slopes, moderately eroded (BrB2).—This soil has a profile similar to that described as representative of the series, except that in most places the surface layer is thinner. Included in mapping are a few small areas where slopes are less than 2 percent. Also included are some wooded areas that are similar to this soil, but they are only slightly affected by erosion. There are also a few areas of severely eroded soils. Water runs off this soil readily, especially when it is wet. The hazard of further erosion is moderate. Impeded drainage is a concern, and improved drainage is needed for some purposes. This soil is suited to cultivated crops, pasture, and trees, but it is seldom used for pasture. Capability unit IIe–36; woodland subclass 3w.

Bourne sandy loam, 5 to 10 percent slopes, moderately eroded (BrC2).—This soil is subject to further erosion when it is cultivated. Included in mapping are some wooded areas that are slightly eroded. Under good management that includes practices for controlling erosion, this soil can be cultivated regularly. The soil is seldom used for pasture. Capability unit IIIe–36; woodland subclass 3w.

Bourne sandy clay loam, 5 to 10 percent slopes, severely eroded (BuC3).—This soil has lost most or all of its original sandy loam surface layer, and the subsoil is exposed in many places. Gullies that extend into the lower part of the subsoil are common. Where plowed, the present surface layer is sticky and crusts when dry, and it generally is difficult to manage. This soil is marginal for cultivated crops. It is better suited to perennials, including trees. Capability unit IVe–7; woodland subclass 3w.

Chillum Series

The Chillum series consists of gently sloping to moderately sloping, well-drained soils on uplands. These soils are on ridgetops and their upper slopes. They formed in silty sediment over deposits of dense, compact gravelly material. The native vegetation is hardwoods, mainly oak, and Virginia pine.

In a representative profile the surface layer, about 6 inches thick, is silt loam that is dark grayish brown in the thinner upper part and brown below. The upper part of the subsoil, about 16 inches thick, is strong-brown heavy silt loam. Below it is about 6 inches of yellowish-brown loam that is also very silty. The underlying material is hard and compact gravelly sandy loam variegated with many colors.

Chillum soils are easy to work and have high available moisture capacity. They are moderately permeable. Slope and the hazard of further erosion limit the use of these soils for some purposes. Other uses are limited by the hard, compact underlying material that is sometimes exploited for gravel.

Representative profile of Chillum silt loam, in a gently sloping wooded area, on Forest Road within Cedarville State Forest, about 5 miles east of Waldorf:

A1—0 to 2 inches, dark grayish-brown (10YR 4/2) light silt loam; weak, medium, granular structure; very friable, slightly sticky and slightly plastic; many roots; extremely acid; abrupt, smooth boundary.

A2—2 to 6 inches, brown (10YR 5/3) light silt loam; weak, medium and coarse, granular structure; very friable, slightly sticky and slightly plastic; many roots; very strongly acid; clear, smooth boundary.

B2t—6 to 22 inches, strong-brown (7.5YR 5/6) heavy silt loam; weak, fine and medium, subangular blocky structure; friable, sticky and slightly plastic; a few roots; thin, discontinuous clay films; very strongly acid; clear, wavy boundary.

B3—22 to 28 inches, yellowish-brown (10YR 5/6) loan; weak, fine and medium, subangular blocky structure; friable, slightly sticky and slightly plastic; a few roots; traces of clay films; very strongly acid; abrupt, smooth boundary.

IIC1—28 to 45 inches, yellowish-brown (10YR 5/6) gravelly sandy loam, variegated with strong brown (7.5YR 5/8), light yellowish brown (10YR 6/4), and light gray (2.5Y 7/2); massive; very hard, very firm and brittle; some pebbles coated with clay or silt; strongly acid; gradual, smooth boundary.

IIC2—45 to 60 inches, light yellowish-brown (10YR 6/4) gravelly light sandy loam, variegated with strong brown (7.5YR 5/8) and very pale brown (10YR 8/3); massive; firm in place; some pebbles coated; strongly acid.

The solum ranges from about 24 to 30 inches in thickness. It is 10YR or 7.5YR in hue. A few pebbles are present, but they are commonly only in the IIC horizon. The A horizon is 3 to 5 in value and 2 to 4 in chroma. Undisturbed A1 horizons less than 6 inches thick are 3 in value. The B horizon is 4 or 5 in value and 4 or 6 in chroma. The Bt horizon is silt loam or silty clay loam. Where present, the B3 horizon is loam or silt loam. The IIC horizon is variable in color, and commonly variegated. It is hard, firm, and generally quite gravelly.

Chillum soils resemble Marr, Matapeake, and Sassafras soils in color and natural drainage. The solum of Chillum soils is similar to that of Matapeake soils, but Matapeake soils have a friable loamy C horizon in contrast to the very hard gravelly C horizon of the Chillum soils. Chillum soils have more silt and less sand than Marr and Sassafras soils. They formed in the same kind of silty material as the Matapeake soils, the moderately well drained Beltsville and Mattapex soils, and the poorly drained Leonardtown and Othello soils.

Chillum silt loam, 2 to 6 percent slopes, moderately eroded (ChB2).—This soil has a profile similar to that described as representative of the series, except that in most places the surface layer is thinner. Included in mapping are a few small, nearly level areas. The soil is suited to cultivated crops, pasture, and trees. The gravelly substratum, at a moderate depth, restricts deep root development, and it is the principal limitation to use. The hazard

of further erosion is moderate. Capability unit IIs–7; woodland subclass 3o.

Chillum silt loam, 6 to 12 percent slopes, moderately eroded (ChC2).—The profile of this soil is similar to that described as representative of the series except the surface layer is thinner. Also included in mapping are small areas in which most of the silty surface layer has been washed away. In places plowing exposes a part of the strong-brown subsoil. The hazard of further erosion is a greater concern of management than the gravelly substratum, which limits the development of roots. Capability unit IIIe–7; woodland subclass 3o.

Coastal Beaches

Coastal beaches (Co) consist of strips of land along some shores of the tidal part of the Potomac River and a few of its major tributaries. Typically, they consist mainly of loose sand that has been worked and reworked by tides and wave action. Some areas are shelly, and others are clayey or muddy sand. The beaches are mostly smooth and nearly level. Others are hummocky and have short slopes. The sand shows no soil development, and little or no vegetation exists. This land is well suited to recreation, and is used as habitat for selected wildlife. Capability unit VIIIs–2; woodland subclass not assigned.

Croom Series

The Croom series consists of gently sloping to moderately sloping, shallow, well-drained gravelly soils on uplands. These soils formed in very old fluvial deposits of gravel containing sand and clay. The native vegetation is upland hardwood, mainly oak, and some Virginia pine.

In a representative profile the surface layer is gravelly loam about 11 inches thick. It is light brownish gray in the thinner upper part and yellowish brown below. The upper part of the subsoil, about 24 inches thick, is strong-brown, very gravelly sandy clay loam. It is extremely hard and compact and limits root penetration. The lower part is brown, very gravelly sandy loam about 14 inches thick. It is somewhat less hard and compact than the upper part of the subsoil. The underlying material to a depth of about 72 inches is strong-brown, stratified, very gravelly loamy coarse sand.

Croom soils are not difficult to work in places suitable for plowing. The gravel, however, is quite abrasive to farm implements. These soils seldom are used for farming. They have a low available moisture capacity, and the rooting zone dries quickly. Permeability in these soils is moderately slow. Many areas have been exploited for gravel and road fill. Although these soils provide stable foundations for buildings, they have moderate to severe limitations for most other nonfarm uses.

Representative profile of Croom gravelly loam, in a gently sloping wooded area, south of Durham Church Road, about 1 mile northeast of old Durham Church:

A1—0 to 2 inches, light brownish gray (2.5Y 6/2) gravelly loam; very weak, fine and medium, granular structure; friable, slightly sticky; many roots; extremely acid; abrupt, smooth boundary.

A2—2 to 11 inches, yellowish-brown (10YR 5/4) gravelly loam; very weak, fine and medium, granular structure; friable, slightly sticky; many roots; extremely acid; clear, smooth boundary.

B2t—11 to 35 inches, strong-brown (7.5YR 5/6) very gravelly sandy clay loam; massive; extremely hard, very firm, slightly sticky and slightly plastic; a few roots; distinct reddish-brown (5YR 4/4) clay films on pebbles; extremely acid; gradual, smooth boundary.

B3—35 to 49 inches, brown (7.5YR 5/4) very gravelly sandy loam; massive; very hard, very firm, slightly sticky; no roots; some thin clay films on pebbles in upper part; very strongly acid; clear, wavy boundary.

C—49 to 72 inches, strong-brown (7.5YR 5/6) very gravelly loamy coarse sand; stratified; friable to firm; very strongly acid.

The solum ranges from about 40 to more than 100 inches in thickness. This wide range is influenced by the thickness of the B3 horizon, which is as much as 8 feet. The depth to the extremely hard B2t horizon is no more than 15 inches in uneroded areas. Structure is weak or it is lacking throughout the soil. The A horizon is 10YR or 2.5Y in hue, 5 to 7 in value, and 2 to 4 in chroma. The B horizon is 10YR or 7.5YR in hue, 5 or 6 in value, and 4 to 8 in chroma. The B2t horizon contains 50 to 75 percent rounded or subangular gravel, mostly less than 2 inches thick. The fine material in this horizon generally is sandy clay loam, but may be heavy loam or clay loam that is low in silt. The clay content of this fine material generally is more than 18 percent but less than 30 percent. The C horizon resembles the B horizon in color and in gravel content, but the fine material in the C horizon is less than 18 percent clay. It is stratified and generally is less hard and less compact than the B horizon.

Croom soils resemble Aura soils, but have more gravel in the B and C horizons than those soils, and they are not so reddish. Commonly, Croom soils are in association with Aura Chillum, and Beltsville soils. They have a very gravelly solum, but the Chillum and Beltsville soils have little or no gravel in the solum. Chillum soils are friable in the solum but have hard C horizons, whereas Beltsville soils have a dense fragipan in the lower part of the subsoil and are only moderately well drained.

Croom gravelly loam, 3 to 8 percent slopes, moderately eroded (CrB2).—This soil has a profile similar to that described as representative of the series, except that in most places the surface layer is thinner. Most of the surface layer of this soil has been washed away and in a few areas the subsoil is exposed or almost exposed. This soil has rills and shallow and deep gullies in which gravel has accumulated. Included in mapping are small areas where the surface layer is a little sandier and the subsoil is less hard than that described. Low available moisture capacity and the hazard of erosion mostly limit farming. The soil is suited to corn and tobacco. These crops will benefit from irrigation. The soil is seldom used for hay or pasture. Some areas are in woodland. Capability unit IIs–7; woodland subclass 4d.

Croom gravelly loam, 8 to 15 percent slopes, moderately eroded (CrC2).—A profile of this soil is similar to that described as representative of the series except that the surface layer is only 5 to 8 inches thick. Plowing is difficult in the upper subsoil. A few shallow gullies are present. Included in mapping are small areas where the surface layer is somewhat sandier than that described and others where it has comparatively little gravel. The hazard of further erosion is severe in places where the soil is tilled. Under good management, the soil is suited to crops such as corn and tobacco. Uncultivated areas are mostly in woodland. Capability unit IIIe–7; woodland subclass 4d.

Croom gravelly loam, 8 to 15 percent slopes, severely eroded (CrC3).—This soil is so severely eroded that it is seldom used for cultivated crops or pasture. Most of it is idle or in second-growth woodland. Most of the surface layer has eroded, exposing most of the subsoil. Many gullies

are present. Included in mapping are areas where the exposed subsoil is not so dense and hard as described in the representative profile. Even under very good management, crops are seldom grown. Woodland improvement is economical, and will provide important watershed protection. Capability unit IVe–7; woodland subclass 4d.

Cut and Fill Land

Cut and fill land (Cu) consists, in part, of land areas where the soil has been cut away by grading and similar operations. Most of the remaining areas generally are filled with soil and other materials to a depth of many feet, but others are filled only to a depth of 1 or 2 feet. Included in mapping are small areas where the fill is garbage or other solid wastes. Also included are a few shopping plazas and other paved areas.

Cut and fill land is never farmed. Where used, it is chiefly for commercial or residential purposes. It is so variable in nature that the suitability of any area for a specific use must be determined by onsite investigation. Capability unit and woodland subclass not assigned.

Elkton Series

The Elkton series consists of nearly level, poorly drained soils in areas bordering major rivers and on higher upland flats. These soils have a fine subsoil that is slowly permeable to very slowly permeable. They formed in old deposits of very clayey marine and alluvial sediment. The native vegetation is wetland hardwoods, mainly red or swamp maple, willow oak, and birch. In other areas are stands of loblolly and other pines.

In a representative profile the surface layer, about 6 inches thick, is gray silt loam. The upper part of the subsoil, about 6 inches thick, is light-gray, friable heavy silt loam mottled with pale brown and yellowish brown. The lower part of the subsoil, about 28 inches, is gray or light-gray silty clay that is firm, sticky and plastic and mottled with brighter colors. The underlying material, to a depth of about 70 inches, is light-gray, mottled fine sandy loam.

If cultivated, Elkton soils must be worked when the moisture content is favorable. When dry, these soils are rough and hard and when wet, they do not support heavy machinery. These soils have high available moisture capacity. They have a high water table and are wet for long periods. Permeability in these soils generally is slow, but it is slow to very slow in the lower part of the subsoil. Artificial drainage is necessary if these soils are farmed. Poor drainage and the high water table are severe limitations for most nonfarm uses.

Representative profile of Elkton silt loam, in a level rewooded area about 1½ miles west of Riverside:

Ap—0 to 6 inches, gray (5Y 5/1) silt loam; very weak, fine, granular structure; friable, slightly sticky; many roots; extremely acid; abrupt, smooth boundary.

B1g—6 to 12 inches, light-gray (5Y 7/1) heavy silt loam; common, medium, distinct mottles of pale brown (10YR 6/3) and a few fine, prominent mottles of yellowish brown (10YR 5/8); weak, fine, granular structure; friable, sticky and slightly plastic; a few roots; extremely acid; clear, wavy boundary.

B21tg—12 to 21 inches, gray or light-gray (5Y 6/1) silty clay; common, medium, prominent mottles of brownish yellow (10YR 6/6); moderate, coarse, blocky structure; very firm, plastic and sticky; a few roots; distinct, almost continuous, gray (5Y 5/1) clay films; very strongly acid; gradual, smooth boundary.

B22tg—21 to 40 inches, light-gray (5Y 7/2) silty clay; many, medium, prominent mottles of brownish yellow (10YR 6/6) and a few, medium, prominent mottles of strong brown (7.5YR 5/8); moderate, medium and coarse, blocky structure; firm, plastic and sticky; a few roots; faint, almost continuous, gray or light gray (5Y 6/1) clay films; very strongly acid; clear, smooth boundary.

IICg—40 to 70 inches, light-gray (5Y 7/1) fine sandy loam; many, medium, faint mottles of light olive gray (5Y 6/2) and common, medium, prominent mottles of reddish yellow (7.5YR 6/8); massive; friable; medium to strongly acid.

The solum ranges from about 30 to 40 inches in thickness. Fine, smooth gravel is likely to occur anywhere in the profile, but is common only in the IICg horizon. Hue throughout the profile is 10YR to 5Y, or the colors are neutral. The A horizon is 3 to 5 in hue and 1 or 2 in chroma. Very thin A1 horizons are 3 in value. In the B horizon the matrix is 5 to 7 in value, and 0 to 2 in chroma. Mottles are 7.5YR in hue or yellower, 4 in value and 2 to 8 in chroma. The Bt horizon is clay, silty clay, or silty clay loam in places. Generally, the clay content is 35 to 50 percent. The color range of the C horizon is the same as that of the B horizon. In texture the C horizon ranges from loamy sand to clay.

Elkton soils are similar to Bibb, Fallsington, Leonardtown, Othello, and Osier soils in drainage and in color. They are more clayey than Fallsington and Osier soils. They have a Bt horizon that is not present in Bibb, Osier, and Elkton soils. This horizon has more clay and less silt than similar horizons in Leonardtown and Othello soils. Although they formed in similar clayey sediment, Elkton soils are more poorly drained than Keyport soils.

Elkton silt loam (Ek).—This is the only Elkton soil mapped in the county. Included in mapping are small areas where the surface layer has a little more sand or clay and is more sticky than that of this soil. Also included are scattered small areas where the surface layer, to a depth of about 4 inches, is very dark gray or black. If this soil is artificially drained, it is well suited to corn and soybeans. It is not suitable for tobacco. Most undrained areas are wooded. Capability unit IIIw–9; woodland subclass 3w.

Eroded Land

This land type is represented by one mapping unit, Eroded land, steep (ErE). It consists of steep areas that have been so severely eroded that the soil profile largely has been destroyed. Slopes range from about 15 to more than 40 percent. Adjacent soils commonly are of the Sassafras and Westphalia series, but included with this unit in mapping are areas of Woodstown, Beltsville, Bourne, Exum, Wickham, Marr, Keyport, Matapeake, Mattapex, and Chillum soils. In most places the surface layer and the subsoil have been lost, have been severely gullied, or both. In some places, soil has been left between the gullies. These gullies, however, are either very close together or very deep, or both.

This unit is not suitable for crops or grazing. Many areas are in woodland that has been regenerated on what was once open cropland or pasture. Erosion caused by runoff on this land results in damage to surrounding areas. The soil lost from this land can clog ditches and drainageways and cause silting-in of ponds or other bodies of water. Keeping the areas of this land under a cover of protective vegetation helps to control erosion. The vegetation

can also be used for woodland products, for watershed protection, and as wildlife habitat. Capability unit VIIe–2; woodland subclass 3r.

Evesboro Series

The Evesboro series consists of very deep, excessively drained, level to moderately sloping soils. In places these soils resemble low dunes. They formed in old marine deposits of sand that have been at least partly reworked by wind and water. The native vegetation primarily is hardwoods, mainly oak, and some Virginia pine.

In a representative profile the surface layer is about 11 inches thick. The underlying material is yellowish brown and it extends to a depth of about 60 inches. The upper 34 inches is loamy sand, and the lower 15 inches is gravelly loamy sand that has about 40 percent fine, smooth, quartz pebbles.

Evesboro soils are easy to work, and they warm quickly in spring. These soils and the Galestown soils are the first soils in the county to be ready for farming. The available moisture capacity is low, and the sand is loose. These features chiefly limit soil use. Loose dry surfaces are subject to soil blowing. Erosion by water generally is a minor problem. Permeability is rapid in these soils.

Representative profile of Evesboro loamy sand, 0 to 8 percent slopes, in a cultivated area on Burnt Store Road, about 2 miles southwest of Hughesville:

Ap—0 to 11 inches, brown (10YR 5/3) loamy sand; very weak, fine, granular structure; loose to very friable; common roots; strongly acid; abrupt, smooth boundary.

C1—11 to 36 inches, yellowish-brown (10YR 5/6) loamy sand; single grain; loose to very friable; a few roots; strongly acid; clear, smooth boundary.

C2—36 to 45 inches, yellowish-brown (10YR 5/8) light loamy sand; single grain; loose to very friable; sand grains coated; some fragments of iron-cemented sand; very strongly acid; abrupt, smooth boundary.

IIC3—45 to 60 inches, yellowish-brown (10YR 5/4) gravelly loamy sand; single grain; loose; about 40 percent smooth, subangular, quartz pebbles as much as 1 inch thick; very strongly acid.

The depth to the IIC horizon is 40 inches or more. At a depth of about 36 inches is sand or loamy sand. The entire profile is nearly free of coarse fragments, but all horizons may contain up to 30 percent fine, subangular, quartz pebbles. The A horizon is 3 to 5 in value and 1 to 3 in chroma. A1 horizons less than 6 inches thick are 3 in value and 1 in chroma. The C horizon is 5 to 7 in value and 4 to 8 in chroma. The lower part of the C horizon generally is lowest in chroma, but in places thin strata or bands are high in chroma.

Evesboro soils resemble Galestown soils, but they do not have the strong-brown to reddish-brown, weakly developed Bt horizon of those soils. Osier soils are poorly drained and formed in similar very sandy deposits as Evesboro soils.

In some of these soils, the percent of gravel is higher than the range defined for the series, but this difference does not alter their usefulness or behavior.

Evesboro loamy sand, 0 to 8 percent slopes (EvB).—This soil has the profile described as representative of the series. Included with this soil in mapping are some depressional areas where loose loamy sand has recently accumulated. Also included are a few areas in the eastern part of the county where the soil is reddish and somewhat finer at depths below 40 inches. Low available moisture capacity is the main limitation to farming. This soil is used mainly for tobacco, but corn and soybeans are also grown. Under good management that includes supplemental irrigation, yields are favorable. Capability unit IVs–1; woodland subclass 3s.

Evesboro loamy sand, 8 to 15 percent slopes (EvC).—This soil has an irregular surface. It occurs as dunelike ridges on the sides of sandy hills and depressions. Included with this soil in mapping are small areas of reddish, somewhat finer textured material at depths below 40 inches. The soil is very poorly suited to crops or pasture. It is better suited to woodland and to some nonfarm uses. Capability unit VIIs–1; woodland subclass 3s.

Evesboro gravelly loamy sand, 0 to 8 percent slopes (EwB).—This soil has a profile similar to that of the soil described as representative of the series, except that all horizons contain 15 to 30 percent fine, smooth, subangular quartz pebbles. The soil is seldom used except for tobacco, but it is suited to other crops. Under good management practices that include supplemental irrigation, plant growth is favorable. Some areas of this soil have been exploited for gravel. Capability unit IVs–1; woodland subclass 3s.

Evesboro gravelly loamy sand, 8 to 15 percent slopes (EwC).—This soil has an irregular surface and is chiefly on the sides of sandy and gravelly hills and ridges. It is poorly suited to crops or pasture. The soil is better suited to woodland and to some nonfarm uses. Several areas have been exploited for gravel. Capability unit VIIs–1; woodland subclass 3s.

Exum Series

The Exum series consists of gently sloping to moderately sloping, deep, moderately well drained soils on uplands. These soils formed in old silty deposits containing moderate amounts of clay and small amounts of sand. The native vegetation mostly is mixed hardwoods and Virginia pine.

In a representative profile the surface layer, about 5 inches thick, is dark yellowish-brown silt loam. The upper part of the subsoil, about 38 inches thick, is yellowish-brown clay loam. It is sticky and plastic and mottled with red and light brownish gray. The lower part of the subsoil about 25 inches thick, is yellowish-brown loam. This material is underlain by friable, mixed colored loam that extends to a depth of about 8 feet.

Exum silt loams are moderately easy to work at a favorable moisture content. The severely eroded clay loams are difficult to work when too wet or dry. These soils have a high available moisture capacity, but are low in natural content of plant nutrients. Permeability is moderate to moderately slow. Wetness, slope, and the hazard of erosion chiefly limit use of these soils.

Representative profile of Exum silt loam, 5 to 10 percent slopes, moderately eroded, in an idle area in Woodhaven Park, about 2 miles southeast of La Plata:

Ap—0 to 5 inches, dark yellowish-brown (10YR 4/4) silt loam; weak, medium, granular structure; friable, slightly sticky; a few roots; very strongly acid; clear, smooth boundary.

B1—5 to 8 inches, yellowish-brown (10YR 5/6) clay loam, a few variegations of yellowish red (5YR 4/6); moderate, fine, subangular blocky structure; friable, slightly sticky and slightly plastic; a few roots; strongly acid; abrupt, smooth boundary.

B21t—8 to 16 inches, yellowish-brown (10YR 5/6) heavy clay loam; common, medium, prominent mottles of red (2.5YR 4/8) and a few, medium, faint mottles of light brownish-gray (10YR 6/2); very weak, thick platy

and moderate, fine, subangular blocky structure; friable to firm, sticky and plastic; a few roots; continuous brown or dark-brown (7.5YR 4/4) clay films; strongly acid; clear, smooth boundary.

B22t—16 to 43 inches, yellowish-brown (10YR 5/6) clay loam; common, fine to coarse, prominent mottles of red (2.5YR 4/8), and a few, fine and medium, faint mottles of light brownish-gray (10YR 6/2); weak, very thick platy and moderate to strong, medium, subangular blocky structure; friable to firm, sticky and plastic; a few roots; continuous reddish-brown (5YR 4/4) and brown to dark-brown (7.5YR 4/4) clay films; very strongly acid; gradual, smooth boundary.

B23t—43 to 68 inches, yellowish-brown (10YR 5/6) heavy loam; common, fine and medium, prominent mottles of red (2.5YR 4/8), and common, fine and medium, faint mottles of light brownish-gray (10YR 6/2); weak, thick platy and weak to moderate, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; a few roots; yellowish-red (5YR 4/6) and brown or dark-brown (7.5YR 4/4) clay films; very strongly acid; gradual, smooth boundary.

C—68 to 96 inches, variegated yellowish-brown (10YR 5/6), red (2.5YR 4/8), and light brownish-gray (10YR 6/2) loam; massive; friable, slightly sticky; very strongly acid.

The solum is more than 60 inches in thickness. Fine, smooth pebbles are in the lower part of the solum and in the C horizon of a few profiles. In the subsoil are red mottles and a few soft nodules of incipient plinthite. The A horizon is 10YR or 2.5Y in hue, 4 or 5 in value, and 2 to 4 in chroma. The A2 or Ap horizon is as much as 4 in chroma. The A horizon generally is silt loam, but in severely eroded areas the surface is clay loam. The B horizon is 10YR in hue, but hue is 2.5Y or 7.5YR in some subhorizons. The matrix of the B horizon is 5 or 6 in color and 4 to 8 in chroma. Mottles range from red to gray, but in the B horizon some are less than 2 in chroma. The Bt horizon is commonly clay loam that is high in silt and low in sand. This horizon is 27 to 35 percent clay, and 30 to 50 percent silt. Most of the sand is very fine. The C horizon is mixed colored loam that is stratified in places.

Exum soils resemble Beltsville, Bourne, Iuka, Keyport, Matawan, Mattapex, and Woodstown soils in natural drainage. They lack the fragipan of Beltsville and Bourne soils. The subsoil of Exum soils is thicker and more clayey than that of Iuka, Matawan, Mattapex, and Woodstown soils. In places Exum and Beltsville soils are in a complex pattern, and they tend to intergrade toward each other.

Exum silt loam, 5 to 10 percent slopes, moderately eroded (ExC2).—The profile of this soil is the one described as representative of the series. The surface layer is fairly thin as most of it has been lost through erosion. Included with this soil in mapping are some areas where the lower subsoil is much redder than normal. Also included are areas where the subsoil is firmer and more brittle than that described. The soil is cut by some shallow gullies. It is suited to crops, pasture, and woodland. The hazard of further erosion is severe in places where the soil is tilled. Capability unit IIIe–16; woodland subclass 3o.

Exum silt loam, 10 to 15 percent slopes, moderately eroded (ExD2).—A large part of this soil is in woodland, most of which is second or third growth. In most places the surface layer is thin, and in many places plowing exposes a part of the subsoil. Shallow gullies are common in some places. The hazard of further erosion is severe, so only occasional cultivated crops can be grown safely. This soil is better suited to hay, pasture, woodland, and as wildlife habitat. Wooded areas are suitable for watershed protection. Capability unit IVe–9; woodland subclass 3o.

Exum clay loam, 5 to 10 percent slopes, severely eroded (EyC3).—This soil has lost the original surface layer and part of the subsoil in many places. The new surface layer is yellowish-brown clay loam. It commonly is sticky and difficult to work properly when too wet or too dry. The soil has shallow and deep gullies. Included with this soil in mapping are many small areas where the lower part of the subsoil is redder than normal. Where the soil is protected against the severe hazard of further erosion, it is suited to hay, pasture, and woodland. Capability unit IVe–9; woodland subclass 4o.

Exum clay loam, 10 to 15 percent slopes, severely eroded (EyD3).—This soil is severely gullied in nearly all areas. Between the gullies, the soil has been washed away, exposing subsoil. Included with this soil in mapping are small areas that have a reddish subsoil. In many places the exposed subsoil is so dense and compact that runoff is rapid. The soil is not suited to crop cultivation. A permanent protective cover of grasses, shrubs, vines, or trees would make it suitable for pasture, woodland, watershed protection, and as a wildlife habitat. Capability unit VIe–2; woodland subclass 4o.

Exum-Beltsville silt loams, 2 to 5 percent slopes, moderately eroded (EzB2).—This mapping unit consists of a complex of Exum and Beltsville soils. Of this, 65 to 75 percent is Exum silt loam. The rest is the Beltsville soil. In mapping, it was impractical to separate these two soils because the Beltsville soil is mostly in small, irregularly shaped areas. Included with this unit in mapping are small areas that are more level, and a number of severely eroded areas (fig. 9). The soils are suited to most uses. They have a moderate limitation in farming chiefly because of a moderate hazard of further erosion. Capability unit IIe–16; woodland subclass 3o.

Fallsington Series

The Fallsington series consists of nearly level, deep, poorly drained soils on upland flats and on terraces above major streams. These soils formed in marine and old alluvial deposits of sandy material containing low to moderate amounts of silt and clay. The native vegetation chiefly is wetland oaks and maples, holly, sweetgum, and blackgum. There are also a few Virginia and loblolly pines.

In a representative profile the surface layer, about 8 inches thick, is sandy loam. It is dark grayish brown in the thinner upper part, and grayish brown mottled with yellowish brown below. The subsoil, about 20 inches thick, is light brownish-gray, heavy sandy loam in the upper part and sandy clay loam mottled with strong brown below. The underlying material to a depth of about 60 inches is light-gray gravelly and very gravelly sandy loam mottled with various shades of brown.

Fallsington soils are easy to work when they are not too wet. In spring farm operations are delayed until the water table has lowered. Because water moves readily through these soils, they are not very difficult to drain in places where outlets are adequate. Poor drainage and the high water table are the chief limitations to use. These soils have a moderate available moisture capacity.

Representative profile of Fallsington sandy loam, in a level wooded area one-fourth mile south of Burnt Store Road, about 2 miles southwest of Hughesville:

A1—0 to 3 inches, dark grayish-brown (10YR 4/2) sandy loam; weak, medium, granular structure; friable; many roots; very strongly acid; abrupt, wavy boundary.

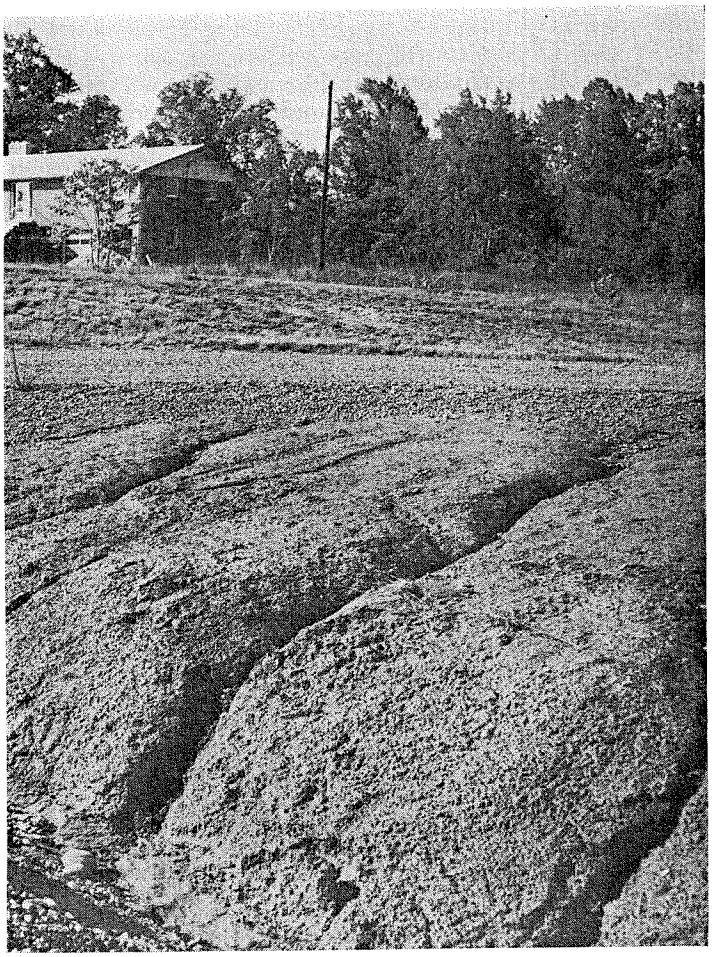


Figure 9.—**Unprotected, severely eroded spot on Exum-Beltsville silt loams, 2 to 5 percent slopes, moderately eroded, in Woodhaven Park.**

A2g—3 to 8 inches, grayish-brown (2.5Y 5/2) sandy loam; common, medium, distinct mottles of yellowish-brown (10YR 5/6); weak, fine and medium, subangular blocky structure; friable, slightly sticky; a few roots; very strongly acid; clear, smooth boundary.

B21tg—8 to 16 inches, light brownish-gray (2.5Y 6/2) heavy sandy loam; many, medium, prominent mottles of strong brown (7.5YR 5/8); weak, medium, subangular blocky structure; friable, slightly sticky; a few roots; faint, discontinuous, yellowish-brown (10YR 5/4) clay films; very strongly acid; clear, smooth boundary.

B22tg—16 to 28 inches, light brownish-gray (2.5Y 6/2) sandy clay loam; many medium, prominent mottles of strong brown (7.5YR 5/8); weak, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; a few roots; distinct, continuous, pale-brown (10YR 6/3) clay films; very strongly acid; abrupt, wavy boundary.

IIC1g—28 to 35 inches, light-gray (5Y 6/1) gravelly sandy loam; common, medium, prominent mottles of strong brown (7.5YR 5/8) and a few fine, prominent mottles of dark brown (7.5YR 4/4); single grain; very friable, slightly sticky; a few roots; very strongly acid; gradual, smooth boundary.

IIC2g—35 to 60 inches, light-gray (N 7/0) very gravelly sandy loam; a few, coarse, prominent mottles of yellowish brown (10YR 5/6); single grain; very friable; strongly acid.

The solum ranges from about 24 to 38 inches in thickness. In places smooth quartz pebbles, about 1 inch thick, occur in the B horizon, and in places they are common to abundant in the C horizon. The hue throughout the profile is about 2.5Y, but includes 10YR and 5Y. Some subhorizons are neutral in color. The A horizon is 2 to 5 in hue and 0 to 2 in chroma. Where the A1 horizon is thin, value is 2 and 3. In the B horizon, the matrix of 4 to 6 in hue and 0 to 2 in chroma. The B horizon generally is mottled with colors high in chroma. The Bt horizon is sandy clay loam, heavy loam, or heavy sandy loam. Generally, the clay content of this horizon is 18 to 25 percent. The C horizon is coarser in texture than the B horizon, and generally is coarser than the A horizon. In color, the C horizon is similar to the B horizon, but in places the matrix is higher in value. Some profiles have few or no pebbles in the C horizon.

Fallsington soils resemble Bibb, Elkton, Leonardtown, Osier, and Othello soils in color and in natural drainage. They are sandier in the Bt horizon than Elkton, Leonardtown, and Othello soils. They have less sand than Osier soils, which do not have a Bt horizon. The Bt horizon is lacking in Bibb soils. Closely associated with Fallsington soils are the somewhat excessively drained Rumford soils, the well drained Sassafras soils, and the moderately well drained Woodstown soils.

Fallsington sandy loam (Fs).—This is the only Fallsington soil mapped in the county. Included in mapping are a few small areas where slope is slightly greater than 2 percent and a few areas that contain more silt and less sand in the surface layer. Also included with this soil are small areas where the soil is extremely wet, and the surface layer is black. These areas are shown on the detailed map by the conventional symbol for wet spot. Drained areas are used mainly for corn, but they are also suited to soybeans, truck crops, hay, and pasture. Most undrained areas are in woodland. Seasonal wetness and the presence of a high water table severely limit the soil for most nonfarm uses. Capability unit IIIw–6; woodland subclass 2w.

Galestown Series

The Galestown series consists of very deep, somewhat excessively drained, nearly level to gently sloping soils. These soils are chiefly in areas bordering major rivers of the county. Others are on higher elevations. These soils formed in old marine and alluvial deposits of sandy material, and some of them have been reworked by water. The native vegetation is hardwoods, mainly oak, but Virginia and loblolly pine grow in some places.

In a representative profile the surface layer, about 11 inches thick, is dark grayish-brown loamy sand. The upper part of the subsoil, about 9 inches thick, is yellowish-brown loamy sand. The lower part of the subsoil, about 21 inches thick, is strong-brown loamy fine sand. It contains a little more clay than the layers above and below it. The underlying material is light yellowish-brown, loose fine sand, extending to a depth of at least 5 feet.

Galestown soils are very easy to work. They warm very quickly in spring and are among the earliest soils in the county to be ready for planting. The available moisture capacity is low, and the sand is loose. These factors chiefly limit most soil uses. Loose dry surfaces are subject to wind blowing. Erosion by water is a minor problem. Permeability is rapid on these soils.

Representative profile of Galestown loamy sand, 0 to 8 percent slopes, in a cultivated area about 2 miles southwest of Newport:

Ap—0 to 11 inches, dark grayish-brown (10YR 4/2) loamy sand; very weak, medium, granular structure; very friable; many roots; strongly acid; abrupt, smooth boundary.

B1—11 to 20 inches, yellowish-brown (10YR 5/6) loamy sand; single grain; loose to very friable; many roots; strongly acid; clear, smooth boundary.

B2t—20 to 41 inches, strong-brown (7.5YR 5/8) loamy fine sand; very weak, medium, blocky structure; very friable; roots are common in upper portion; sand grains are strongly coated; distinct clay bridging; very strongly acid; abrupt, wavy boundary.

C—41 to 60 inches, light yellowish-brown (10YR 6/4) fine sand, with a few thick bands of strong brown (7.5YR 5/6); single grain; loose; very few roots; very strongly acid.

The solum is about 27 to 45 inches in thickness. The profile generally is free of gravel. In the A horizon, the matrix is 10YR or 7.5YR in hue, 2 to 5 in value, and 1 to 4 in chroma. The A1 horizons less than 6 inches thick are 2 and 3 in value and 1 in chroma. In the B horizon, the matrix most commonly is 7.5YR in hue. The B1 horizon is about 10YR in hue, and the Bt horizon is 5YR. These horizons are 4 to 6 in value, and the chroma is 4 to 8. The B horizon generally is loamy sand, but in places it is sand or fine sand. In some profiles, a B3 horizon is between the B2t and C horizons. The C horizon is commonly yellower in hue, and is higher in value and lower in chroma than the B horizon. In the C horizon of some profiles, are very thin bands that resemble material in the B horizon.

Galestown soils resemble Evesboro soils, but Evesboro soils generally are yellower in color and do not have Bt horizons. Also, Galestown soils are not so excessively drained and droughty as Evesboro soils.

Galestown loamy sand, 0 to 8 percent slopes (GaB).—This is the only Galestown soil mapped in the county. The low available moisture capacity is the chief concern of management. This soil is used mostly for tobacco, corn, and soybeans. Without good management that includes supplemental irrigation during dry seasons, crop yields are low. Capability unit IVs–1; woodland subclass 3s.

Gravel and Borrow Pits

Gravel and borrow pits (Gp) consist of excavations from which gravel and other materials have been or are being removed. These materials are used mainly for road fill or for other kinds of construction. Most pits are exploited for gravel, others for sand, and still others for both gravel and sand. In some pits soil material is removed. The total area of these pits is increasing. Possible uses of these pits must be determined after onsite investigation. Capability unit VIIIs–4; woodland subclass not assigned.

Gravelly Land

Gravelly land, steep, (GvE) consists of gravelly deposits of soil material. Some of these represent areas that may have once been profiles of the Aura and Croom soils, but if so the profiles have been so severely eroded that they cannot be identified. Other areas are mostly relatively unaltered deposits of gravelly materials that have some similarity to the underlying material of various soils in the county.

The gravel content of this mapping unit ranges from about 20 to 80 percent, by volume. Most of the gravel is quartz pebbles that are smooth, rounded to subangular, and mostly less than 2 inches in diameter. Slopes range from about 15 to 50 percent.

Gravelly land is not suitable for crops or for grazing. Many areas are idle or in woodland. It is best suited to woodland, watershed protection, wildlife habitat, and a source of gravel. Capability unit VIIe–2; woodland subclass 4f.

Iuka Series

The Iuka series consists of nearly level to gently sloping, deep, moderately well drained soils on flood plains and in upland depressions. These soils formed in recently deposited alluvium that was washed mainly from soils on the uplands in the county. Where these soils occur on flood plains, they are subject to flooding from streams. Where they occur in upland depressions, they are saturated with water for short periods. The native vegetation consists of mixed wetland hardwoods.

In a representative profile, the surface layer is about 18 inches thick. It is dark yellowish-brown fine sandy loam in the upper part and is yellowish-brown fine sandy loam in the lower part. The upper part of the underlying material, about 10 inches thick, is pale-brown loam that is mottled with light gray and dark brown. Below is grayish-brown silt loam, about 8 inches thick, that is mottled with brown or dark brown. Below this layer, to a depth of 60 inches, is gray or light-gray fine sandy loam that is mottled with yellowish-brown in places.

Iuka soils are easy to work at a favorable moisture content. They have a high water table late in spring and are fairly slow to warm. Seasonal wetness, impeded drainage, and the hazard of flooding are moderate to severe limitations on these soils for nearly all purposes. They have high available moisture capacity. Permeability on these soils is moderate to moderately slow.

Representative profile of Iuka fine sandy loam, in a level cultivated area on the flood plain of Port Tobacco Creek, about 2½ miles northwest of La Plata:

Ap—0 to 9 inches, dark yellowish-brown (10YR 4/4) fine sandy loam; weak, medium, granular structure; friable; many roots; medium acid (limed); abrupt, smooth boundary.

A1—9 to 18 inches, yellowish-brown (10YR 5/4) fine sandy loam; weak, fine, granular structure; friable, slightly sticky; many roots; medium acid; clear, smooth boundary.

C1—18 to 28 inches, pale-brown (10YR 6/3) loam; many fine, distinct mottles of light gray (10YR 7/2) and dark brown (10YR 3/3); massive; friable, slightly sticky; a few roots; strongly acid; clear, smooth boundary.

C2g—28 to 36 inches, grayish-brown (2.5Y 5/2) light silt loam; common, fine, distinct mottles of brown or dark brown (7.5YR 4/4); massive; friable, slightly sticky and slightly plastic; a few roots; strongly acid; clear, smooth boundary.

C3g—36 to 42 inches, gray (5Y 5/1), variegated with light-gray (5Y 6/1) fine sandy loam; massive, very friable, slightly sticky; a few roots; very strongly acid; abrupt, smooth boundary.

C4g—42 to 60 inches, light-gray (2.5Y 7/2) fine sandy loam; common, medium, distinct mottles of yellowish brown (10YR 5/8); massive; very friable; extremely acid.

Iuka soils do not have a B horizon. The C horizon has mottles and variegations less than 2 in chroma. In the A horizon the matrix is 10YR or 7.5YR in hue, 3 to 6 in value, and 2 to 4 in chroma. The surface subhorizons, less than 6 inches thick, are 3 in value. The A horizon is sandy loam, fine sandy loam, or silt loam. In the C1 horizon, the matrix color is 7.5YR to 2.5Y in hue, 4 to 6 in value, and 3 to 6 in chroma. Mottles are similar in hue and are 4 to 7 in value. Mottles are 2 or less than 2 in chroma. Within 20 inches of the soil surface, mottles higher in chroma may or may not be present. The matrix of the C2 and C3 horizons differ from the C1 in having chromas as low as 1 or 2. The C4 horizon is highly variable in color. The

C horizon is stratified and ranges from sandy loam to silt loam or silty clay loam.

Iuka soils resemble Beltsville, Bourne, Exum, Keyport, Mattapex, and Woodstown soils in color and in natural drainage, but those soils are not in flood plains, and all of them have a Bt horizon. Beltsville and Bourne soils have a fragipan. Associated with Iuka soils on flood plains are poorly drained Bibb soils and Alluvial land. Associated with Iuka soils in upland depressions are the well-drained Ochlockonee soils.

Iuka fine sandy loam (Ik).—This soil has the profile described as representative of the series. It is dominantly level (fig. 10), but in a few places slopes are more than 2 percent. The soil is on flood plains where traces of old stream channels frequently are evident. Included with this soil in mapping are small, better drained areas, and spots where the surface layer is more silty and less sandy than that of this soil.

Where flooding is not too frequent or too severe, this soil is suited to some cultivated crops, but for other crops improved drainage is needed. Areas that are subject to severe or frequent flooding are suitable for seasonal grazing or for woodland. Frequency and severity of flooding can only be predicted from a knowledge of the flooding history of a particular tract. Capability unit IIw–7; woodland subclass 1o.

Iuka sandy loam, local alluvium (Im).—The profile of this soil is similar to the one described as representative of the series, except that the surface layer is sandy loam. Also, this soil is in upland depressions and at the base of some upland slopes. This soil is level to gently sloping, but in places slopes are as much as 4 percent. It is not subject to flooding, but it is seasonally wet, and seepage spots are common (fig. 11). The soil is suited to cultivated crops, pasture, and woodland. Capability unit IIw–7; woodland subclass 1o.

Iuka silt loam, local alluvium (In).—The surface layer of this soil is silt loam but the profile otherwise is similar to the one described as representative of the series. This soil is dominantly nearly level, but in a few places slopes are as great as 5 percent. The soil is seasonally wet, and seepage spots are common. It does not dry as quickly and is not so easy to work as Iuka sandy loam, local alluvium. On this soil, planting generally is delayed. The soil is suited to cultivated crops, pasture, and woodland. Capability unit IIw–7; woodland subclass 1o.

Keyport Series

The Keyport series consists of moderately well drained, nearly level to moderately sloping soils. These soils are chiefly at low elevations near major rivers (fig. 12), but some are at higher elevations on uplands. They formed in old marine and alluvial deposits dominated by clay. The

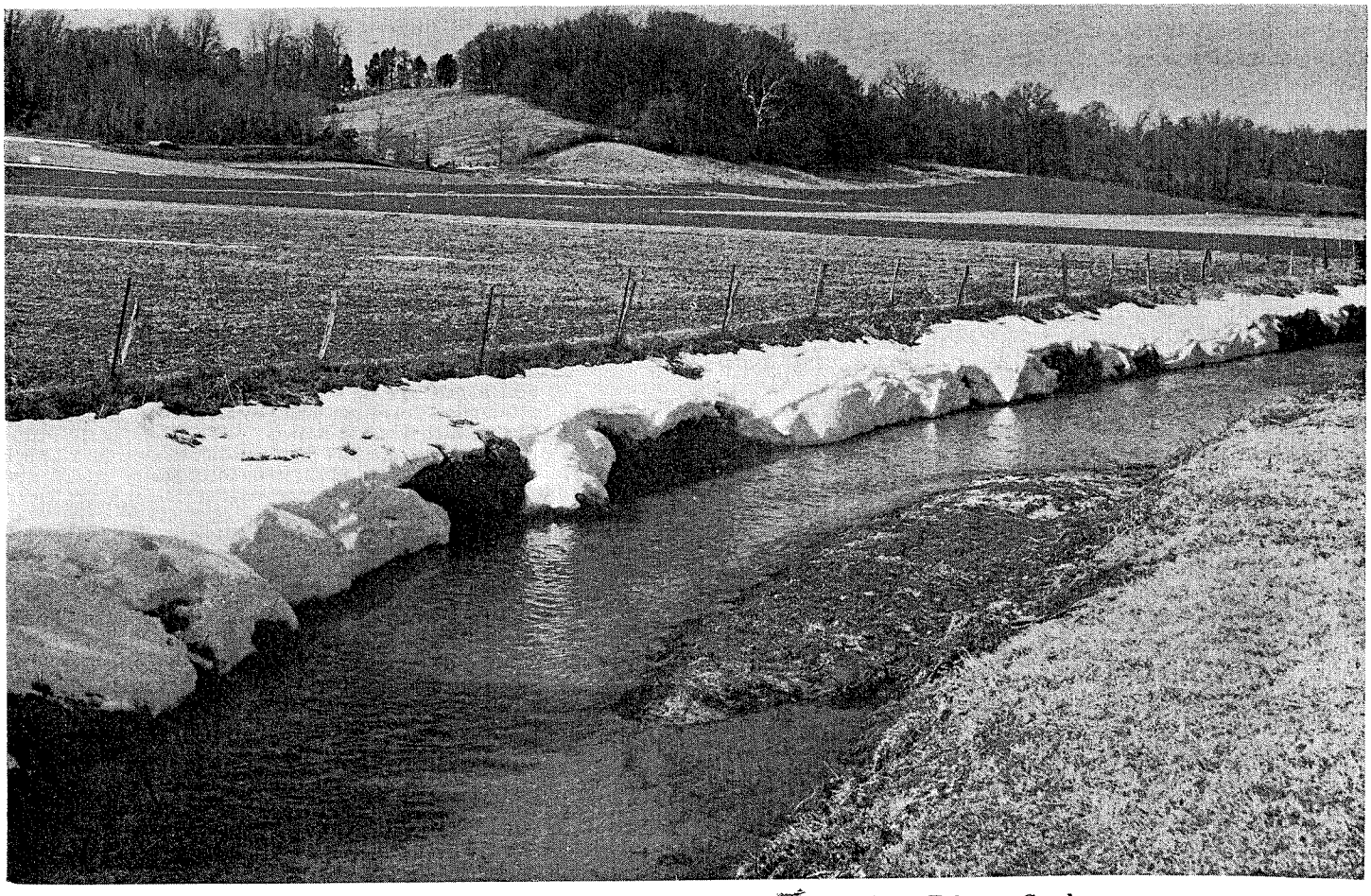


Figure 10.—Iuka fine sandy loam, on the flood plain of Port Tobacco Creek.

Figure 11.—**Damage to tobacco by temporary wetness in Iuka sandy loam, local alluvium, after an unusually heavy rain.**

native vegetation consists of mixed and wetland hardwoods but Virginia pine grows in some places.

In a representative profile the surface layer is silt loam about 11 inches thick. It is dark grayish brown in the thinner upper part and light yellowish brown below. The upper part of the subsoil, about 5 inches thick, is yellowish-brown heavy silt loam. The middle part, about 23 inches thick, is yellowish-brown silty clay or heavy silty clay loam mottled with light gray. The lower part of the subsoil, about 17 inches thick, is light-gray fine sandy loam mottled with yellowish brown. The underlying material, to a depth of 66 inches, is gravelly sandy loam of various colors.

Keyport soils are easy to work when the moisture content is favorable and where erosion is not severe. They have high available moisture capacity, and permeability is slow. These soils are limited by impeded drainage, slow movement of water through the subsoil, and the hazard of further erosion. They are not well suited to deep-rooted crops that require good drainage and soil aeration, or to perennial crops that are likely to be damaged by frost heave in winter. These soils have severe limitations to use for septic tank sewage disposal fields because of slow permeability.

Representative profile of Keyport silt loam, 0 to 2 percent slopes, in a wooded area, about 1½ miles west of Riverside:

A1—0 to 4 inches, dark grayish-brown (2.5Y 4/2) silt loam; weak, fine and medium, granular structure; friable, slightly sticky; many roots; strongly acid; abrupt, smooth boundary.

A2—4 to 11 inches, light yellowish-brown (2.5Y 6/4) silt loam; very weak, very fine, subangular blocky structure; friable, slightly sticky; a few roots; strongly acid; clear, smooth boundary.

B1—11 to 16 inches, yellowish-brown (10YR 5/6) heavy silt loam; weak, fine, subangular blocky structure; firm, slightly sticky and slightly plastic; a few roots; strongly acid; clear, smooth boundary.

B21t—16 to 27 inches, yellowish-brown (10YR 5/8) silty clay; moderate, fine and medium, blocky structure; firm, sticky and slightly plastic; a few roots; thin, continuous, yellowish-brown (10YR 5/4) clay films; strongly acid; gradual, smooth boundary.

B22t—27 to 39 inches, yellowish-brown (10YR 5/8) heavy silty clay loam; a few, fine, prominent mottles of light gray (5Y 7/1); moderate, fine, blocky structure; firm, slightly sticky and slightly plastic; very few roots; distinct, yellowish-brown (10YR 5/4) clay films; strongly acid; clear, smooth boundary.

IIB3g—39 to 56 inches, light-gray (5Y 7/1) fine sandy loam; many, medium, prominent mottles of yellowish-brown (10YR 5/6); massive, firm, slightly sticky; a few roots; faint clay films in a few vertical fractures; very strongly acid; abrupt, wavy boundary.

IIIC—56 to 66 inches, yellowish-brown (10YR 5/6) gravelly sandy loam, variegated with very pale brown (10YR 8/3); massive; very friable; very strongly acid.

The solum ranges from about 36 to more than 50 inches in thickness. Fine smooth pebbles are in the profile, but they are common only in the C horizon. In the A horizon, the matrix is 10YR or 2.5Y in hue, 3 to 6 in value, and 1 to 4 in chroma. The lower value and chroma are confined to undisturbed A1 horizons less than 6 inches thick. The A horizon generally is silt loam or fine sandy loam. In severely eroded profiles, the Ap horizon is commonly silty clay loam. In the B horizon, the matrix is 10YR or 2.5Y in hue and 4 to 6 in value. In the lower part it is 5Y in hue or 7 in value. The B1 and B2 horizons are 4 or more in chroma, but in places chroma is as low as 1 in the B3 horizon. Mottles with chroma of 2 or less are in the Bt horizon but not in its upper 10 inches. Mottles that are high in chroma may occur in the lower part of the B horizon. The Bt horizon is clay, silty clay, heavy silty clay loam, or heavy clay loam. Structure is moderate and strong, and is dominantly blocky. The C horizon is highly variable, but in most places it is coarser in texture than the Bt horizon.

Keyport soils resemble Exum, Mattapex, and Woodstown soils in most major features, but they have a finer, more slowly permeable subsoil. They are not so poorly drained as the Elkton soils that formed in a similar clayey sediment.

Keyport fine sandy loam, 0 to 2 percent slopes (KeA).—The profile of this soil is similar to the one described as representative of the series, except that the surface layer is fine sandy loam. The subsoil contains fine sand. This soil is easier to work earlier in spring than the Keyport silt loams. The soil is suited to cultivated crops, pasture, and woodland. Drainage improvement is of benefit to some crops. The hazard of further erosion is slight. Capability unit IIw–9; woodland subclass 3w.

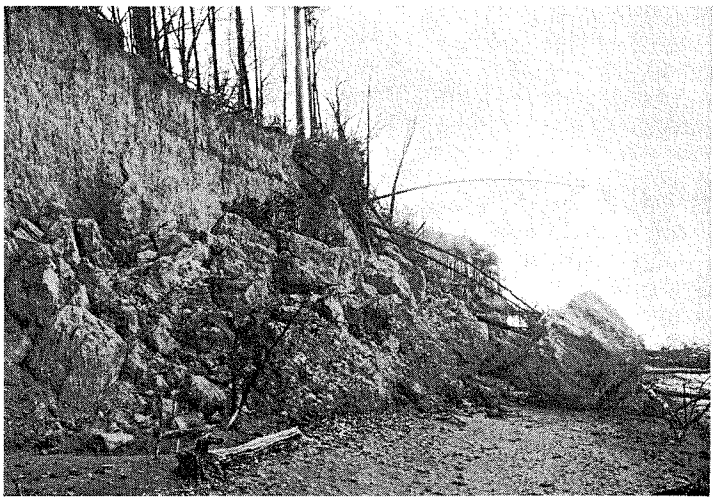


Figure 12.—**Erosion on Keyport silt loam on shore of the Potomac River.**

Keyport fine sandy loam, 2 to 5 percent slopes, moderately eroded (KeB2).—This soil has only 6 to 8 inches or less of the original surface layer. Shallow gullies are present. In places, the subsoil is exposed. The moderate hazard of further erosion is the major concern of management. Impeded drainage and moisture movement also limit use. The soil is suited to crops, pasture, and trees. Capability unit IIe–36; woodland subclass 3w.

Keyport silt loam, 0 to 2 percent slopes (KpA).—This soil has the profile described as representative of the series. Included in mapping are small areas where the surface layer is thinner than that of this soil. Also included are areas where silty material that was washed from other soils has accumulated. The surface layer is not so easy to work or to drain as in Keyport fine sandy loams. The soil is suited to cultivated crops, pasture, and trees. Drainage improvement will benefit some uses. Capability unit IIw–8; woodland subclass 3w.

Keyport silt loam, 2 to 5 percent slopes, moderately eroded (KpB2).—This soil is similar to the one described as representative of the series, except that the remaining silt loam surface layer is thinner. In small areas the subsoil is exposed. A few gullies are present. The soil is suited to cultivated crops, pasture, and trees. The hazard of further erosion is moderate, and it is a major concern of management. Other concerns of management are impeded drainage and moisture movement. Capability unit IIe–13; woodland subclass 3w.

Keyport silt loam, 5 to 12 percent slopes, moderately eroded (KpC2).—In most places this soil has lost much of the original surface layer. Plowing will expose the brighter colored subsoil in these places, giving newly plowed areas a spotty appearance. Included with this soil in mapping are a few areas where the surface layer is less silty and more sandy than that described. Shallow gullies are present. Although the hazard of further erosion is severe, with careful management, the soil is suited to crops, pasture, and trees. Capability unit IIIe–13; woodland subclass 3w.

Keyport silty clay loam, 5 to 12 percent slopes, severely eroded (KrC3).—The original surface layer of this soil has been lost through erosion. The subsoil is exposed so plowing and other soil manipulation is difficult. The surface layer is sticky and will crust over when drying, thus making it very difficult to prevent clodding. The hazard of further erosion is severe. With these limitations, the soil is suited to pasture and trees. It generally is not suited to tilled crops. Capability unit VIe–2; woodland subclass 3w.

Kitchen Midden

On the soil map, a number of places are marked by a special symbol that indicates a *kitchen midden.* As used in this survey, a kitchen midden is an abandoned area formerly used by American Indians. Prolonged use of these middens have drastically altered the original soils.

In Charles County, these kitchen middens are almost entirely on low bluff areas adjacent to the Potomac River, but a few areas are along the shores of the Nanjemoy and Piccowaxen Creeks. Oyster shells on the surface of and in the upper part of the soil help to identify these areas. Arrowheads and other Indian artifacts are in places, but they are difficult to find and to identify among the shells.

In many places the shells are in soil material as much as 2 feet thick. The fine soil that is mixed with the shells is black or almost black. Lime from the shell deposits has changed the reaction of the subsoil and the underlying material in most of these areas from strongly acid or very strongly acid to moderately alkaline. The alkalinity of the soil is so intensive that it limits the growth of some plants.

These kitchen middens have affected a number of the soils in the county, mainly those of the Mattapex, Woodstown, Keyport, and Elkton series. Also affected are small areas of the Matapeake (fig. 13), Sassafras, Othello, and Beltsville soils. In the county there are about 800 acres of kitchen middens distributed over several miles near river shorelines. Although these areas have little value for crops, limitations are likely to be few for most nonfarm uses.

Leonardtown Series

The Leonardtown series consists of shallow or moderately deep, poorly drained, nearly level soils that have a fragipan. These soils are on upland flats that commonly lack channeled drainageways. They formed in old silty marine deposits. The native vegetation consists of wetland hardwoods, including oaks, holly, maples, and gums.

In a representative profile the surface layer is silt loam about 8 inches thick. The thinner upper part is grayish brown, and the lower part is light olive gray. The upper part of the subsoil, about 8 inches thick, is light olive gray, firm silt loam mottled with brownish yellow. The lower

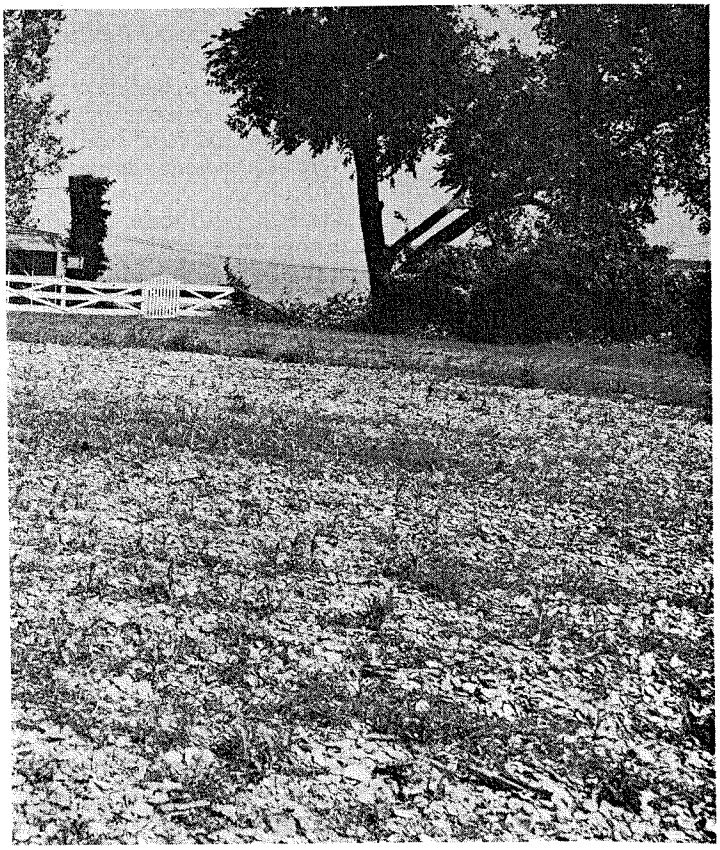


Figure 13.—Kitchen midden deposit of oyster and other shells, on Cedar Point Neck, within an area of Matapeake fine sandy loam, 0 to 2 percent slopes.

part of the subsoil, about 24 inches thick, is olive gray to light gray mottled with yellowish red and yellowish brown. It is a fragipan that is very firm, brittle, and very slowly permeable. The underlying material, to a depth of about 72 inches, is light-gray silty clay loam mottled with strong brown.

Leonardtown soils have moderate available moisture capacity. Generally, they are low in natural fertility. These soils are severely limited for farming because natural drainage is poor, the water table is seasonally high (fig. 14), and the rooting zone is limited. These soils also have severe limitations for most nonfarm uses.

Representative profile of Leonardtown silt loam, in a level wooded area west of Popes Creek Road, about 1 mile southwest of Faulkner:

A1—0 to 1 inch, grayish-brown (2.5Y 5/2) silt loam; weak, fine and medium, granular structure; friable, slightly sticky and slightly plastic; many roots; very strongly acid to extremely acid; abrupt, smooth boundary.

A2g—1 to 8 inches, light olive-gray (5Y 6/2) silt loam; common, medium, distinct mottles of yellowish brown (10YR 5/6); very weak, fine, subangular blocky structure; friable, slightly sticky and slightly plastic; a few roots; very strongly acid; abrupt, smooth boundary.

B2tg—8 to 16 inches, light olive-gray (5Y 6/2) heavy silt loam, many, medium, distinct mottles of brownish yellow (10YR 6/6); weak, medium, subangular blocky structure; firm, slightly sticky and slightly plastic; a few roots; thin, pale-olive (5Y 6/3) clay films; very strongly acid to extremely acid; clear, smooth boundary.

Bx1—16 to 24 inches, olive-gray (5Y 5/2) heavy silt loam, common, medium, prominent mottles of yellowish red (5YR 5/6) and dark brown (7.5YR 4/4), common, medium, faint mottles of light gray (5Y 7/1); weak, coarse, prismatic structure and medium, platy structure; hard, very firm, brittle, slightly sticky and slightly plastic; a few roots; continuous, pale olive (5Y 6/3) clay films; extremely acid; abrupt, smooth boundary.

Bx2—24 to 40 inches, gray or light-gray (5Y 6/1) heavy silt loam, common, medium, distinct mottles of yellowish brown (10YR 5/6) and common, medium, faint mottles of light gray (5Y 7/1); weak, thick, platy structure and moderate, fine and medium, blocky structure; hard, very firm, brittle, slightly sticky and slightly plastic; distinct, gray (5Y 5/1) clay films; very strongly acid to extremely acid; gradual, smooth boundary.

Cg—40 to 72 inches, gray or light-gray (5Y 6/1) silty clay loam, common, medium, prominent mottles of strong brown (7.5YR 5/8) and common, medium, faint mottles of gray (5Y 5/1); massive; firm, sticky and plastic; some vertical cracks lined with gray silt; extremely acid.

The solum ranges from about 28 to 40 inches in thickness. The fragipan ranges from about 24 to 30 inches. The matrix commonly is 2.5Y or 5Y in hue, but may be 10YR or neutral in some subhorizons. Any horizon may be mottled. In places smooth pebbles are in the C horizon. In the A horizon, the matrix is 3 to 6 in value and 1 or 2 in chroma. Undisturbed A1 horizons less than 6 inches thick are 3 in value. In the B and C horizons, the matrix color generally is 5 or 6 or sometimes 4 in value and 0 to 2 in chroma. Mottles are variable in hue, in value, and in chroma. The B horizon is silt loam or silty clay loam. The C horizon ranges from sandy loam to silty clay loam.

Leonardtown soils resemble Bibb, Elkton, Fallsington, Othello, and Osier soils in color and in natural drainage. Those soils, however, do not have a fragipan. Leonardtown soils are more poorly drained than the closely associated Beltsville soils. The well-drained Chillum and Matapeake soils, the moderately well drained Beltsville soils, and the poorly drained Othello soils formed in the same kind of silty material as Leonardtown soils.

Figure 14.—**Ponded area of Leonardtown silt loam. Water table almost at the surface of this soil severely limits its use for homesites and other nonfarm purposes.**

Leonardtown silt loam (Le).—This is the only Leonardtown soil mapped in the county. Included in mapping are areas where the upper part of the subsoil is pale yellow to olive. These areas are better drained than Leonardtown soils. In most areas the hazard of further erosion is slight. If this soil is drained, it is suited to some annual crops, mainly corn. Undrained areas are suited to woodland and seasonal pastures. Capability unit IVw–3; woodland subclass 3w.

Magnolia Series

The Magnolia series consists of very deep, well-drained, level to moderately sloping soils. These soils are chiefly on very old alluvial terraces along the Potomac River and other major rivers and streams of the county. They formed mostly on old flood plains in sediment deposited by these rivers and streams. The native vegetation is mixed hardwoods and some Virginia and loblolly pine.

In a representative profile the surface layer is silt loam about 16 inches thick. It is brown in the thinner upper part and strong brown below. The upper part of the subsoil, about 49 inches thick, is red to weak-red, heavy sticky and plastic clay loam. The lower part of the subsoil, about 11 inches thick, is weak-red, sticky, heavy sandy clay loam. The underlying material, to a depth of 90 inches, is weak-red, stratified gravelly sandy loam.

Magnolia soils are easy to work except when wet and are well suited to farming. Slope and the hazard of further erosion are the major limitations on these soils. These soils have high available moisture capacity and are moderately permeable. Almost all areas are cleared.

Representative profile of Magnolia silt loam, 2 to 5 percent slopes, moderately eroded, in an idle area near Grayton Post Office, about 2½ miles southeast of Nanjemoy:

Ap—0 to 6 inches, brown (10YR 5/3) silt loam; weak, fine, granular structure; friable; many roots; strongly acid; abrupt, smooth boundary.

A2—6 to 16 inches, strong-brown (7.5YR 5/6) silt loam; weak, medium and coarse, granular structure; friable; many roots; very strongly acid; clear, wavy boundary.

B21t—16 to 43 inches, red (2.5YR 4/6) heavy clay loam, faintly variegated with pale red (2.5YR 6/2); moderate, fine, subangular blocky structure; firm, sticky and plastic; a few roots; distinct, dark reddish-brown (2.5YR 3/4) continuous clay films; very strongly acid; gradual, smooth boundary.

B22t—43 to 65 inches, weak-red (10R 4/4) heavy clay loam, variegated with red (2.5YR 4/6); moderate, fine, and medium, subangular blocky structure; firm, sticky and plastic; a few roots; faint, discontinuous clay films; some fine, strongly weathered, yellowish pebbles; very strongly acid; gradual, smooth boundary.

B23t—65 to 76 inches, weak-red (10R 4/4) heavy sandy clay loam; weak, fine and medium, subangular blocky structure; firm, sticky and slightly plastic; faint, patchy clay films; some fine, strongly weathered, yellowish pebbles; very strongly acid; abrupt, wavy boundary.

IIC—76 to 90 inches, weak-red (10R 4/4) gravelly sandy loam; stratified; friable, slightly sticky and slightly plastic; some whitish, mostly decomposed cobblestones; very strongly acid.

In the A horizon, the matrix is 10YR or 7.5YR in hue, 4 to 6 in value, and 2 to 6 in chroma. The A2 horizon is 4 and 6 in chroma. The B horizon is 2.5YR or 10R in hue, and commonly is 4 in value or 3 in some subhorizons. This horizon is 4 or 6 in chroma. The Bt horizon is clay loam to clay. The subhorizons are clay, sandy clay, or heavy sandy clay loam. The B23t horizon is at least 30 percent clay. The C horizon has about the same color range as the B horizon. Observations indicate that the C horizon is unconforming and gravelly.

Magnolia soils resemble Aura soils somewhat in color, but Aura soils have less than 35 percent clay in the Bt horizon and are gravelly throughout. In Charles County, Magnolia soils are lighter in color and have less clay and more silt in the profile than the defined range for the series. However, these differences do not alter their usefulness and behavior.

Magnolia silt loam, 0 to 2 percent slopes (MgA).—This soil has a profile similar to that described as representative of the series, except that it has a thicker surface layer and generally is dark grayish brown in color. Included in mapping are a few areas where the surface layer is less silty and more sandy than this soil. This soil is well suited to most uses, and it has few or no limitations. It is among the most productive soils in the county. Capability unit I–4; woodland subclass 2o.

Magnolia silt loam, 2 to 5 percent slopes, moderately eroded (MgB2).—This soil has the profile described as representative of the series. A part of the original surface layer has been lost in most places, and in places the subsoil is almost exposed. Also included in mapping are areas where the surface layer has less silt and more sand than that of the soil described as representative of the series. The hazard of further erosion is moderate if this soil is tilled. The soil is well suited to crops, pasture, trees, and most nonfarm uses. Capability unit IIe–4; woodland subclass 2o.

Magnolia silt loam, 5 to 12 percent slopes, moderately eroded (MgC2).—This soil has a profile similar to that described as representative of the series, except that its subsoil is not so thick. Included in mapping are a few areas where the surface layer is more sandy and less silty than this soil. The hazard of further erosion is severe in places where the soil is tilled. Under good management, the soil is suited to crops, pasture, and trees. Capability unit IIIe–4; woodland subclass 2o.

Magnolia clay loam, 5 to 12 percent slopes, severely eroded (MkC3).—Most of the original silty surface layer and parts of the subsoil have been lost through erosion. The new surface layer is sticky and plastic clay loam that is difficult to work. Where this soil is tilled, it is difficult to prevent clodding and to control further erosion. For these reasons, this soil is marginal for crops. It is better suited to pasture and trees. Capability unit IVe–3; woodland subclass 2o.

Marr Series

The Marr series consists of deep, well-drained, gently sloping soils on uplands. These soils formed in old deposits of fine sandy sediment containing moderate amounts of silt and clay. The sand particles in Marr soils are uniform in size. The native vegetation is mixed hardwoods and some Virginia pine.

In a representative profile, the surface layer, about 11 inches thick, is brown fine sandy loam. The subsoil, about 27 inches thick, is brown to strong-brown sandy clay loam or very fine sandy loam. The underlying material, to a depth of at least 60 inches, is fine sandy loam of various colors that indicates stratification.

Marr soils are easy to work, but they are limited by slope and the hazard of further erosion for most uses. Most areas are cultivated, and the soils are especially productive for tobacco. They have high available moisture capacity and are moderately permeable.

Representative profile of Marr fine sandy loam, in a gently sloping wooded area that was formerly cultivated near the end of Swanson Creek Road, about 1½ miles northwest of Benedict:

Ap—0 to 11 inches, brown (7.5YR 5/4) fine sandy loam; weak, medium, granular structure; friable, slightly sticky; many roots; very strongly acid; abrupt, smooth boundary.

B1—11 to 17 inches, brown (7.5YR 5/4) very fine sandy loam, variegated with yellowish-red (5YR 5/6); weak, medium, subangular blocky structure; friable to firm; slightly sticky and slightly plastic; a few roots; very strongly acid; clear, smooth boundary.

B21t—17 to 26 inches, strong-brown (7.5YR 5/8) heavy sandy clay loam; moderate, fine and medium, subangular blocky structure; firm, sticky and slightly plastic; a few roots; distinct, continuous, yellowish-red (5YR 4/8) clay films; very strongly acid; clear, smooth boundary.

B22t—26 to 38 inches, strong-brown (7.5YR 5/8) sandy clay loam; moderate, fine and medium, subangular blocky structure; friable to firm, slightly sticky and slightly plastic; a few roots; discontinuous, yellowish-red (5YR 4/6) clay films; very strongly acid; clear, smooth boundary.

C—38 to 60 inches, variegated reddish-yellow (7.5YR 6/6), strong-brown (7.5YR 5/8), and yellowish-red (5YR 5/8) fine sandy loam, with pockets or inclusions of brown (7.5YR 5/4); massive to weakly stratified; friable to firm, slightly sticky; a few roots; very strongly acid to extremely acid.

The A horizon is 10YR or 7.5YR in hue, 3 to 5 in value, and 2 to 4 in chroma. Value of 3 generally is confined to undisturbed A1 horizons less than 6 inches thick. The B horizon generally is 7.5YR in hue, but hue is 10YR in subhorizons. It is 5 or 6 in value and 6 or 8 in chroma. Where present, B1 and B3 horizons are 4 in chroma. The Bt horizon is sandy clay loam, heavy fine sandy loam, or heavy very fine sandy loam. This horizon is 18 to 30 percent clay. The sand is uniform in size and commonly is near the boundary of fine sand and very fine sand, as it is in any of the profiles. The C horizon is mixed with colors. It is 4 to 8 both in value and in chroma and 10YR to 5YR in hue. The C horizon is loamy fine sand to very fine sandy loam.

Marr soils resemble Westphalia soils but the Bt horizon of Westphalia soils is no more than 10 inches thick and contains less than 18 percent clay. Marr soils do not contain as much medium and coarse sand as Sassafras soils. They are one unit higher in value and in chroma in the Bt horizon. Marr soils may have less weatherable minerals than Sassafras soils.

Marr fine sandy loam, 2 to 5 percent slopes, moderately eroded (MlB2).—This soil has a profile similar to that described as representative of the series, except that in most places the surface layer is thinner. Included with this soil in mapping are a few areas that are nearly level. This soil is suitable for all crops of the area, especially for tobacco. It is also suited to most other uses. On this soil the hazard of further erosion is moderate. Capability unit IIe–5; woodland subclass 3o.

Matapeake Series

The Matapeake series consists of deep, well drained, level to moderately sloping soils. These soils are mostly on terraces above major rivers and streams and also on uplands. They formed in loamy deposits (fig. 15) over older and coarser sediment. The native vegetation is mixed upland hardwoods, mainly oaks.

In a representative profile, the surface layer, about 14 inches thick, is brown to yellowish-brown fine sandy loam. The subsoil, about 26 inches thick, is brown or dark-brown silty clay loam that is sticky. The underlying material, to a depth of 60 inches, is stratified silt loam and fine sandy loam of mixed colors.

Matapeake soils are easy to work when the moisture content is favorable, and they warm readily in spring. They have high available moisture capacity and are among the most suitable soils for farming in the county. These soils are suited to most uses. Slope and the hazard of further erosion are the main limitations to use.

Representative profile of Matapeake fine sandy loam, 0 to 2 percent slopes, in a cultivated area, one-half mile northwest of Wicomico Beach.

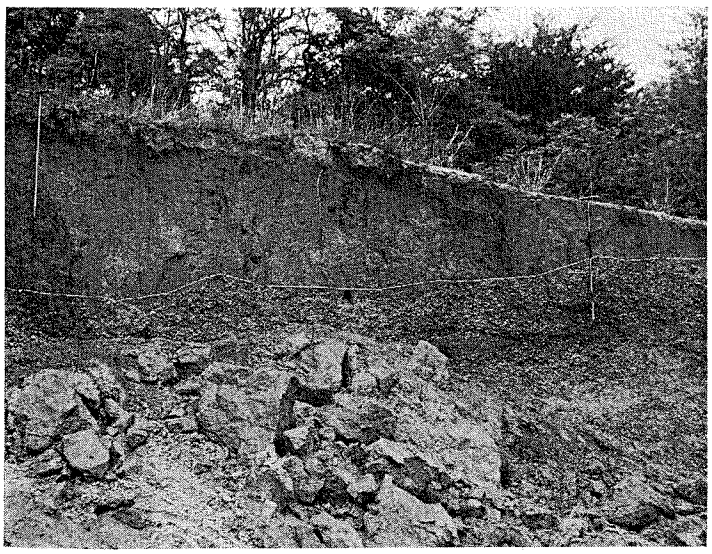


Figure 15.—Matapeake silt loam on the left, grading to Chillum silt loam on the right. The Chillum soil is only about 2 feet deep over hard gravel. The Matapeake soil is entirely silty material to a depth of at least 5 feet.

Ap—0 to 10 inches, brown (10YR 5/3) fine sandy loam; weak, fine, granular structure; friable; many roots; strongly acid; clear, smooth boundary.

A2—10 to 14 inches, yellowish-brown (10YR 5/4) fine sandy loam; weak, fine, granular structure; friable; common roots; strongly acid; clear, wavy boundary.

B21t—14 to 34 inches, brown or dark-brown (7.5YR 4/4) light silty clay loam; moderate, medium, subangular blocky structure; slightly firm, sticky and slightly plastic; common roots in upper part and a few in lower part; distinct, almost continuous clay films; a few fine, smooth pebbles; very strongly acid; gradual, wavy boundary.

B22t—34 to 40 inches, brown or dark-brown (7.5YR 4/4) silty clay loam; moderate, coarse, subangular blocky structure; firm, sticky and plastic, a few roots; patchy clay films; a few pinkish-gray (7.5YR 6/2) variegations or mottles; very strongly acid; clear, wavy boundary.

IIC—40 to 60 inches, variegated gray (10YR 5/1) and brownish-yellow (10YR 6/6) thinly stratified silt loam and fine sandy loam; friable to firm; very strongly acid.

The solum generally ranges from 24 to 40 inches in thickness. In places fine smooth pebbles occur in the profile, but they generally are only in the C horizon. The A horizon is 10YR or 2.5Y in hue, 3 to 6 in value, and 1 to 4 in chroma. Undisturbed A1 horizons less than 6 inches thick are 3 in value and 1 in chroma. The A horizon is either fine sandy loam or silt loam in texture. The B horizon is 10YR or 7.5YR in hue, 4 or 5 in value, and 4, 6, or 8 in chroma, but chroma is seldom 8. The Bt horizon is silt loam or silty clay loam. The clay content of this horizon is about 18 to 30 percent. The IIC horizon varies in color, and it is stratified in places. Where it is not stratified, texture ranges from loam to loamy sand.

Matapeake soils resemble Wickham, Chillum, Marr, and Sassafras soils in color and in natural drainage. The C horizon of Matapeake soils is more friable and contains less gravel than that of Chillum soils. Matapeake soils contain much more silt and less sand in the solum than Marr, Wickham, and Sassafras soils. They formed in the same kind of material as the well-drained Chillum soils, the moderately well drained Beltsville and Mattapex soils, and the poorly drained Leonardtown and Othello soils.

Matapeake fine sandy loam, 0 to 2 percent slopes (MmA).—The profile of this soil is the one described as representative of the series. This soil is somewhat easier to work and can be worked over a wider range of moisture than Matapeake silt loam. Under good management, this soil has few limitations that affect farming or other uses. This soil is one of the most productive in the county for tobacco. Capability unit I–5; woodland subclass 3o.

Matapeake fine sandy loam, 2 to 5 percent slopes, moderately eroded (MmB2).—The fine sandy loam surface layer of this soil is only about 6 to 9 inches thick. Most of the original surface has been lost through erosion. If erosion is controlled, this soil is well suited to farming and other uses. Capability unit IIe–5; woodland subclass 3o.

Matapeake silt loam, 0 to 2 percent slopes (MnA).—This soil has a profile similar to that described as representative of the series except that the surface layer has considerably more silt and less fine sand than Matapeake fine sandy loam. For this reason, it is somewhat harder to work but retains more moisture for plants than fine sandy loam. Under good management, this soil has few limitations that affect use. Capability unit I–4; woodland subclass 3o.

Matapeake silt loam, 2 to 5 percent slopes, moderately eroded (MnB2).—The silt loam surface layer of this soil is only about 6 to 9 inches thick. Included in mapping are a few areas that are more severely eroded. Under good management, the soil is suited to most uses. The hazard of

further erosion is moderate in places where the soil is tilled. Capability unit IIe–4; woodland subclass 3o.

Matapeake silt loam, 5 to 10 percent slopes, moderately eroded (MnC2).—Much of the surface layer of this soil has been lost and in places plowing turns up a part of the subsoil which gives cultivated areas a spotty appearance. Included in mapping are small areas where the remaining surface layer is sandier than that described. The hazard of further erosion is severe in places where the soil is tilled. Under good management, this soil can be safely and regularly cultivated. It is also suited to pasture and trees. Capability unit IIIe–4; woodland subclass 3o.

Matapeake silt loam, 5 to 10 percent slopes, severely eroded (MnC3).—Most of the original surface layer of this soil has been washed away. In places where the soil is plowed, the new surface layer is sticky, and runs together when wet and crusts over when dry. The soil is not suited to cultivated crops. If carefully managed, it could be used for pasture or trees. Capability unit IVe–3; woodland subclass 3o.

Matawan Series

The Matawan series consists of soils that are nearly level to gently sloping, moderately well drained to well drained, and deep. They have a thick sandy surface layer and a clayey subsoil through which water moves slowly. These soils formed on uplands in a sandy mantle over loamy sediment. The native vegetation consists of hardwood, mainly oak, sweetgum, and red maple. Some Virginia pine also grows.

In a representative profile the surface layer, about 19 inches thick, is loamy sand. The upper 10 inches is light brownish gray, and the lower 9 inches is light yellowish brown. The upper layer of the subsoil, about 8 inches thick, is light yellowish-brown, firm sandy clay loam. The middle part of the subsoil, about 13 inches thick, is light olive-brown, very firm clay loam mottled with gray and other colors. The lower part of the subsoil, about 10 inches thick, is brownish-yellow sandy clay loam that is also mottled. The underlying material, to a depth of about 60 inches, is light brownish-gray, mottled, stratified silt loam.

Matawan soils are easy to work. For short periods in winter and spring, however, the water table is within 2 to 3 feet of the surface, so planting is delayed. Limitations for some nonfarm uses are moderate to severe because of seasonal wetness. Permeability is slow. These soils have a moderate available moisture capacity.

Representative profile of Matawan loamy sand, in a level cultivated area about 1 mile northwest of La Plata:

Ap—0 to 10 inches, light brownish-gray (2.5Y 6/2) loamy sand; weak, medium, granular structure; very friable; many roots; very strongly acid; abrupt, smooth boundary.

A2—10 to 19 inches, light yellowish-brown (2.5Y 6/4) heavy loamy sand; very weak, medium, subangular blocky structure; friable; many roots; about 5 percent fine smooth pebbles; very strongly acid; clear, smooth boundary.

B21t—19 to 27 inches, light yellowish-brown (10YR 6/4) sandy clay loam, variegated with yellowish-brown (10YR 5/8); weak, medium and coarse, subangular blocky structure; firm, sticky and slightly plastic; a few roots; thin, pale-brown (10YR 6/3) clay films; very strongly to extremely acid; clear, smooth boundary.

IIB22t—27 to 40 inches, light olive-brown (2.5Y 5/4) clay loam, many, medium, distinct mottles of gray or light gray (5Y 6/1), and a few, medium, distinct mottles of reddish brown (5YR 5/4); very weak, medium, platy structure and weak, medium, blocky structure; dense, very firm, sticky and plastic; a very few roots; light yellowish-brown (2.5Y 6/4) clay films; extremely acid; abrupt, wavy boundary.

IIB23t—40 to 50 inches, brownish-yellow (10YR 6/6) sandy clay loam; common, medium, distinct mottles of gray or light gray (5Y 6/1) and a few, medium, distinct mottles of strong brown (7.5YR 5/8); very weak, thick, platy structure; firm, sticky and slightly plastic; a few roots; thin patchy clay films; about 5 percent fine smooth gravel and some soft, white skeletans: extremely acid; clear, wavy boundary.

IIICg—50 to 60 inches, light brownish-gray (10YR 6/2) silt loam, common, fine, distinct mottles of brown (7.5 YR 5/2) and yellowish brown (10YR 5/8); stratified; firm, slightly sticky and slightly plastic; no roots; a few, soft, white skeletans; extremely acid.

The solum ranges from 30 to 50 inches in thickness. Depth to the first unconforming material is 22 to 34 inches. The A horizon is 10YR or 2.5Y in hue, 4 to 6 in value, and 2 to 6 in chroma. The A2 horizon is higher in chroma. The B21t horizon generally is 10YR in hue, but in places it is variegated with redder hues. It is 5 or 6 in value and 4 or 6 in chroma. The B22t horizon is 2.5Y or 5Y in hue, 5 or 6 in value, and 3 to 6 in chroma. The B22t horizon is clay loam to sandy clay. The B23t horizon, which is variable in color and in texture, is absent in places. The C horizon is 1 or 2 units higher in value and 2 or more units lower in chroma than in the B22t horizon. This horizon consists of unconforming stratified material of almost any texture or mixture of textures.

Matawan soils resemble Woodstown soils, but the A horizon of Matawan soils is thicker and coarser. They are also more slowly permeable in the B22t horizon. Matawan soils are somewhat better drained than Woodstown soils.

Matawan loamy sand (Ms).—This is the only Matawan soil mapped in the county. Included in mapping are a few small areas where the surface layer is fine sandy loam and also a few areas where the surface layer is somewhat gravelly. This soil is suited to common crops, but seasonal wetness and sandiness of the surface layer are limitations. It is also suited to pasture and trees, but it is seldom used for pasture. Capability unit IIw–10; woodland subclass 2o.

Mattapex Series

The Mattapex series consists of level to moderately sloping, deep, moderately well drained soils. These soils are chiefly in low-lying areas bordering major rivers of the county. They formed in loamy deposits underlain by older, coarser sediment. The native vegetation is mixed wetland hardwoods.

In a representative profile the surface layer, about 13 inches thick, is silt loam. It is grayish brown in the upper 7 inches and yellowish brown below. The subsoil, about 23 inches thick, is yellowish-brown silty clay loam or silt loam that is mottled with gray in the lower part. Underlying the subsoil, fine sandy loam mottled with yellowish brown and gravelly loamy sand extend to a depth of 72 inches.

Mattapex soils are easy to work, but in winter and in spring they are limited by the presence of a high water table. Available moisture capacity is high. Permeability is moderately slow on these soils. These soils generally are intensively farmed. Seasonal wetness and impeded drainage are limitations for nonfarm uses.

Representative profile of Mattapex silt loam, 0 to 2 percent slopes, in an idle area on Taylors Neck Road, about 3½ miles north of Riverside:

Ap—0 to 7 inches, grayish-brown (10YR 5/2) silt loam; weak, fine, granular structure; friable, slightly sticky; many roots; medium acid (limed); abrupt, smooth boundary.

A2—7 to 13 inches, yellowish-brown (10YR 5/4) silt loam; weak, medium, granular structure; friable, slightly sticky and slightly plastic; many roots; strongly acid; clear, smooth boundary.

B21t—13 to 26 inches, yellowish-brown (10YR 5/8) heavy silt loam; weak, fine, subangular blocky structure; friable to firm, slightly sticky and slightly plastic; a few roots; faint, almost continuous clay films; very strongly acid; gradual, smooth boundary.

B22t—26 to 36 inches, yellowish-brown (10YR 5/6) silty clay loam; a few, medium, prominent mottles of light gray (2.5Y 7/2); weak, fine, blocky structure; firm, slightly sticky and slightly plastic; distinct continuous, pale-brown (10YR 6/3) clay films; strongly acid; clear, wavy boundary.

IIC1g—36 to 58 inches, light brownish-gray (2.5Y 6/2) fine sandy loam, variegated with pale olive (5Y 6/3); common, medium, prominent mottles of yellowish brown (10YR 5/8); massive, slightly sticky; a few roots; very strongly acid; abrupt, smooth boundary.

IIIC2—58 to 72 inches, brown or dark-brown (7.5YR 4/4) gravelly loamy sand; single grain; loose; pebbles mostly less than one-half inch in diameter; extremely acid.

The solum ranges from about 24 to 40 inches in thickness. It is either 10YR or 2.5Y in hue. The A horizon is fine sandy loam or silt loam. It is 3 to 5 in value and 1 to 4 in chroma. Where the A1 horizon less than 6 inches thick occurs in undisturbed areas, it is lowest in chroma, and the A2 horizon is highest in chroma. In the B horizon, the matrix is 5 or 6 in value, and 4 to 8 in chroma. The B22t horizon always has mottles of 2 or less in chroma. The Bt horizon is silt loam or silty clay loam that is 18 to 30 percent clay.

The IIC horizon commonly is variegated, and the material in this horizon is older and sandier than that in the solum. The IIIC horizon, whenever it is in the profile, is vastly different from the IIC horizon. The C horizon is gravelly in places.

Mattapex soils resemble Beltsville, Bourne, Exum, Iuka, Keyport, and Woodstown soils in color and in natural drainage. Iuka soils do not have a Bt horizon. Mattapex soils have a Bt horizon that is less clayey than that in Keyport soils. Beltsville and Bourne soils have a fragipan in the lower part of the subsoil. The Bt horizon of Mattapex soils contains more silt and less sand than that of Woodstown and Exum soils.

Mattapex fine sandy loam, 0 to 2 percent slopes (MtA).—This soil has a profile similar to that described as representative of the series, except that its surface layer has less silt and more fine sand. It is thus easier to work and is ready for planting earlier than Mattapex silt loam, 0 to 2 percent slopes. Improved drainage makes this soil well suited to crops and pasture. Undrained areas are limited to selected crops. Capability unit IIw–5; woodland subclass 3o.

Mattapex fine sandy loam, 2 to 5 percent slopes, moderately eroded (MtB2).—This soil has lost most of its original surface layer and in many areas the subsoil is almost exposed, and shallow to deep gullies have formed. The profile otherwise is similar to that of the profile representative of the series. This soil is limited by seasonal wetness, and further erosion is moderate if it is tilled. Under good management, the soil is suited to crops, pasture, and trees. Capability unit IIe–36; woodland subclass 3o.

Mattapex silt loam, 0 to 2 percent slopes (MuA).—This soil has the profile described as representative of the series. Impeded drainage is the principal limitation to use. Improved drainage makes this soil well suited to crops. The choice of crops that can be grown on undrained areas is limited. Capability unit IIw–1; woodland subclass 3o.

Mattapex silt loam, 2 to 5 percent slopes, moderately eroded (MuB2).—The profile of this soil is like the one described as representative of the series, except that mottling in the lower subsoil is not so light and so prominent. This soil has good surface drainage and does not need improved drainage for some crops. The hazard of further erosion is moderate, and controlling erosion is the chief concern of management. Capability unit IIe–16; woodland subclass 3o.

Mattapex soils, 5 to 12 percent slopes (MxC).—The surface layer of this soil is fine sandy loam or silt loam. Included in mapping are many small, severely eroded areas where shallow gullies have cut into the soil. Also included are areas where the subsoil is more grayish than that of the soil described as representative of the series. The hazard of erosion is severe wherever crop residue is removed. Capability unit IIIe–16; woodland subclass 3o.

Ochlockonee Series

The Ochlockonee series consists of nearly level to gently sloping, deep, well-drained soils in upland depressions and on foot slopes. These soils formed in recently deposited material that was washed from soils on adjacent uplands. The native vegetation is mixed hardwoods, and the stands consist mainly of oaks.

In a representative profile the surface layer, about 17 inches thick, is brown or dark-brown fine sandy loam. The underlying material, to a depth of 60 inches, is yellowish brown and light yellowish brown. It is silt loam in the upper 22 inches and very gravelly fine sandy loam in the lower 21 inches, where it is mottled with strong brown and light gray.

Ochlockonee soils are easy to work. Seasonally, the water table may be within 40 inches of the surface, but most of the time it is much lower. The soils have moderate available moisture capacity and are moderately permeable. Limitations are slight to moderate for most nonfarm uses.

Representative profile of Ochlockonee fine sandy loam, local alluvium, 0 to 5 percent slopes, in a cultivated area about 2½ miles northwest of La Plata:

A1p—0 to 9 inches, brown or dark-brown (10YR 4/3) fine sandy loam; weak, medium and coarse, granular structure; friable, slightly sticky; many roots; medium acid (limed); abrupt, smooth boundary.

A12—9 to 17 inches, brown (10YR 5/3) fine sandy loam; weak, coarse, granular structure; friable, slightly sticky; common roots; strongly acid; clear, wavy boundary.

C1—17 to 39 inches, yellowish-brown (10YR 5/6) light silt loam; massive; friable, slightly sticky and slightly plastic; a few roots; very strongly acid; abrupt, smooth boundary.

C2—39 to 60 inches, light yellowish-brown (2.5Y 6/4) very gravelly fine sandy loam, many, medium, distinct mottles of light gray (5Y 7/1) and common, medium, prominent mottles of strong brown (7.5YR 5/6); single grain; very friable, slightly sticky; a few roots; about 50 percent, by volume, is pebbles as much as about 1 inch thick; extremely acid.

Above, the material is 10YR or 7.5YR in hue and about 40 inches below it commonly is 2.5Y. The A horizon is 4 or 5 in value and 2 to 4 in chroma. The C1 horizon is 4 to 6 in value and 3 to 6 in chroma. It ranges from sandy loam to silt loam in texture, or is stratified with two or more textures. The C2 horizon is about 3 feet deep or more and is commonly gravelly. This horizon generally is higher in value and lower in chroma than the C1 horizon and in places mottles are absent. Mottles with 2 or less than 2 in chroma generally are at least

40 inches below the soil surface. The texture of this horizon is highly variable. Clay in the C horizon is less than 18 percent.

Ochlockonee soils resemble Evesboro, Marr, Matapeake, Sassafras, Westphalia, and Wickham soils in color. Ochlockonee soils lack the Bt horizon of those soils. They are not so sandy as the excessively drained Evesboro soils. Associated with Ochlockonee soils are local alluvium phases of the moderately well drained Iuka soils.

Ochlockonee fine sandy loam, local alluvium, 0 to 5 percent slopes (OcB).—This is the only Ochlockonee soil mapped in the county. This soil is in and around slight upland depressions and at the bases of slopes of other upland soils. Included in mapping are a few areas where the soil is siltier than this soil. Also included are small areas where slopes are more than 5 percent. The hazard of erosion is moderate on the more sloping areas. This soil is well suited to most crops, but where it occurs in depressions, late planting is sometimes necessary because of frost pockets in spring. This soil is also suited to pasture and trees. Capability unit IIe–6; woodland subclass 1o.

Osier Series

The Osier series consists of nearly level, deep, poorly drained soils that formed in old deposits of loamy sand. These soils are wet, and most of them are near areas of very sandy soils that are better drained. The native vegetation is mainly wetland hardwoods, but pond pine grows in places.

In a representative profile the surface layer, about 12 inches thick, is light brownish gray loamy sand that is mottled with yellowish brown in the lower part. The underlying material, to a depth of about 60 inches, is loose loamy sand that is light gray to grayish brown and is mottled with yellowish brown and pale brown.

Osier soils are easy to work if they are artificially drained. Seasonal wetness and extreme sandiness are severe limitations to most uses. These soils have low available moisture capacity.

Representative profile of Osier loamy sand, in a level wooded area on the west side of River Road, about 1¾ miles south of Marshall Hall:

A11—0 to 5 inches, light brownish-gray (10YR 6/2) loamy sand; very weak, coarse, granular structure; very friable; many roots; very strongly acid; clear, smooth boundary.

A12—5 to 12 inches, light brownish-gray (10YR 6/2) loamy sand; common, medium, faint mottles of yellowish brown (10YR 5/6); very weak, medium, granular structure; very friable; many roots; very strongly acid; clear, smooth boundary.

C1—12 to 20 inches, light-gray (10YR 7/1) loamy sand; common, medium, faint mottles of light yellowish brown (2.5Y 6/4); single grain; loose; a few roots; very strongly acid; gradual, smooth boundary.

C2—20 to 48 inches, light brownish-gray (2.5Y 6/2) loamy sand; common, fine to medium, prominent mottles of yellowish brown (10YR 5/6) and strong brown (7.5YR 5/8), and common, medium, faint mottles of pale brown (10YR 6/3); single grain; loose; a few roots in upper part; very strongly acid to extremely acid; clear, smooth boundary.

C3—48 to 60 inches, grayish-brown (10YR 5/2) loamy sand; single grain; loose; spherical inclusions of brown (10YR 5/3), heavy, loamy sand; very strongly to extremely acid.

The entire profile is 10YR or 2.5Y in hue. A few fine quartz pebbles are likely in all horizons. The A1 horizon is 3 to 6 in value and 1 or 2 in chroma. Very thin A11 horizons are 3 in value. The C horizon is 4 to 7 in value and 1 or 2 in chroma. Where present, mottles are 7.5YR to 2.5Y in hue and are as much as 8 in chroma. The C1 horizon is loamy sand, and the C2 and C3 horizons are either loamy sand, sand, or fine sand.

Osier soils resemble several soils of the county in color and in natural drainage, but they are looser and sandier throughout than those soils. The excessively drained Evesboro soils, the somewhat excessively drained Galestown soils, and Osier soils formed in similar material.

Osier loamy sand (Or).—This is the only Osier soil mapped in the county. It is nearly level, but in a few places slopes are as great as 3 percent. Included in mapping are small areas where the surface layer and the subsoil are browner than that described. These areas commonly are not so wet as this soil. Osier loamy sand is poorly suited to most crops and to pasture, but some corn and soybeans are grown, though yields generally are low. Most areas of this soil are idle or are in woodland. Capability unit IVw–6; woodland subclass 2w.

Othello Series

The Othello series consists of nearly level, deep, poorly drained soils on upland flats and on low terraces adjacent to some major streams. These soils formed in old loamy deposits that are underlain by older sandy sediments. The native vegetation is wetland hardwoods, but some loblolly pine and pond pine also grows.

In a representative profile the surface layer is silt loam about 11 inches thick. It is dark gray in the thinner upper part and light brownish gray mottled with yellowish brown in the lower part. The subsoil, about 18 inches thick, is gray or light-gray silt loam or silty clay loam. It is mottled with strong brown or yellowish brown. The underlying material, to a depth of 60 inches, is gray loamy sand streaked with grayish brown.

Othello soils are easy to work at a favorable moisture content. The seasonal water table, however, is high and these soils are wet for long periods. They have high available moisture capacity. Permeability is moderately slow. Artificial drainage is needed for most crops. Poor internal drainage and the high water table are severe limitations to nonfarm uses.

Representative profile of Othello silt loam, in a level wooded area about one-half mile southwest of Woodberry Beach:

A1—0 to 2 inches, dark-gray (5Y 4/1) silt loam; moderate, medium, granular structure; friable, slightly sticky and slightly plastic; many roots; very strongly acid; abrupt, smooth boundary.

A2g—2 to 11 inches, light brownish-gray (2.5Y 6/2) silt loam; common, fine, distinct mottles of yellowish brown (10YR 5/4); weak, medium, granular structure; friable, slightly sticky and slightly plastic; many roots; extremely acid; clear, smooth boundary.

B21tg—11 to 20 inches, gray or light-gray (5Y 6/1) heavy silt loam; common, medium, distinct mottles of yellowish brown (10YR 5/6); weak, medium, subangular blocky structure; friable to firm, sticky and plastic; a few roots; distinct gray (5Y 5/1) clay films; extremely acid; gradual, smooth boundary.

B22tg—20 to 29 inches, gray or light-gray (5Y 6/1) light silty clay loam; common, coarse, prominent mottles of strong brown (7.5YR 5/6); weak, coarse, blocky structure; firm, sticky and plastic; a few roots; distinct, gray (5Y 5/1) clay films; extremely acid; abrupt, smooth boundary.

IICg—29 to 60 inches, gray (N 5/0) loamy sand, streaked with grayish brown (2.5Y 5/2); single grain; very friable; a few, fine, smooth pebbles; very strongly acid.

The thickness of the solum ranges from about 24 to 40 inches, but it generally is within the thinner part of this range. The matrix is 10YR in hue or yellower, and neutral in some horizons. The A horizon is 4 to 6 in value and 0 to 2 in chroma. It is either fine sandy loam or silt loam in texture. Undisturbed A2 horizons are highest in value. In the B horizon, the matrix is 5 to 7 in value and 0 or 1 in chroma. Mottles are 10YR or 7.5YR in hue, 5 or 6 in value and 3 to 8 in chroma. The Bt horizon is silt loam or silty clay loam in texture. It has an average clay content of 18 to 30 percent. In places, the lower part of this horizon is weak and platy. In texture, the C horizon is sandy loam or coarser and is similar to the B horizon in color. In some profiles it is gravelly.

Othello soils resemble the Bibb, Elkton, Fallsington, Leonardtown, and Osier soils in color and in natural drainage. They have a Bt horizon that is not present in Osier soils and Bibb soils on flood plains. The Bt horizons of Elkton soils are more clayey than those of Othello soils. Leonardtown soils have a dense fragipan in the lower part of the subsoil.

Othello fine sandy loam (Os).—This soil has a profile similar to that described as representative of the series, except that its surface layer contains less silt and more fine or very fine sand. Also, the subsoil is more clayey than in Othello silt loam. This soil is nearly level, but in a few places slopes are as great as 3 percent. Artificial drainage is needed for cultivated crops, pasture, and trees. The chief crops are corn and soybeans. Capability unit IIIw–6; woodland subclass 3w.

Othello silt loam (Ot).—This is the soil described as representative of the series. It is nearly level, but in a few places slopes are as great as 3 percent. It is not so easy to work and to drain as Othello fine sandy loam. Artificial drainage is needed for cultivated crops, pasture, and trees. The chief crops are corn and soybeans. Capability unit IIIw–7; woodland subclass 3w.

Rumford Series

The Rumford series consists of level to moderately sloping, deep, somewhat excessively drained soils on uplands. These soils formed in stratified, sandy marine deposits that contain small amounts of silt and clay and variable amounts of fine gravel. The native vegetation is chiefly mixed hardwoods and Virginia pine.

In a representative profile the surface layer, about 12 inches thick, is loamy sand. It is dark grayish brown in the thinner upper part and pale brown in the lower part. The subsoil, about 20 inches thick, is brown to strong-brown sandy loam or sandy clay loam. The underlying material, to a depth of 52 inches, is strong-brown light sandy loam that is stratified.

Rumford soils are easy to work. Permeability is rapid, and available moisture capacity is low to moderate. These soils warm quickly in spring and are among the first soils in the county to be ready for planting. They are well suited to tobacco. Sandiness and the hazard of further erosion are the chief limitations to use.

Representative profile of Rumford loamy sand, in a gently sloping wooded area on the north side of Taylors Neck Road, about 3 miles north of Riverside:

A1—0 to 2 inches, dark grayish-brown (10YR 4/2) loamy sand; very weak, medium, granular structure; very friable; many roots; a few clean, coarse sand grains; strongly acid; abrupt, smooth boundary.

A2—2 to 12 inches, pale-brown (10YR 6/3) loamy sand; very weak, fine, granular structure; very friable; common roots; strongly acid; clear, wavy boundary.

B2t—12 to 22 inches, brown (7.5YR 5/4) light sandy clay loam; weak, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; few roots; thin discontinuous clay films; very strongly acid; clear, smooth boundary.

B3—22 to 32 inches, strong-brown (7.5YR 5/6) sandy loam; weak, medium, subangular blocky structure; friable, slightly sticky; a few roots; a few faint clay films; sand grains coated; very strongly acid; clear, smooth boundary.

C—32 to 52 inches, strong-brown (7.5YR 5/6) light sandy loam; stratified; very friable; very strongly acid.

The solum ranges from about 28 to 40 inches in thickness. These soils generally are free of gravel, but in places they are as much as 20 percent fine quartz gravel. The A horizon ranges from loamy sand to sandy loam in texture and is less than 20 inches thick. This horizon is 10YR or 2.5Y in hue, 4 to 6 in value, and 2 to 4 in chroma. The value of 6 is confined to the A2 horizon. The B horizon is 10YR to 5YR in hue. In the transitional B1 and B3 horizons, hue is 10YR. The Bt horizon is 4 or 5 in value and 4 to 8 in chroma. It generally is sandy loam or light sandy clay loam. The clay content is less than 18 percent, and it is 10 inches or less in thickness. The C horizon generally is coarser than the B horizon. It is variegated and commonly is stratified.

Rumford soils resemble Westphalia soils, but they have a thicker and coarser A horizon, and the sand in Rumford soils is not so fine and uniform in size as in Westphalia soils. In Charles County some of the Rumford soils contain more gravel than the defined range for the series, but this difference does not alter the usefulness or behavior of these soils.

Rumford loamy sand, 0 to 5 percent slopes, moderately eroded (RdB2).—This soil has a profile similar to that described as representative of the series except that in most places its surface layer is thinner. In places it is somewhat gravelly below 3 feet from the surface. Included in mapping are small areas, mainly in the northwestern part of the county, where the subsoil is yellower than that of this soil. This soil is suited to cultivated crops, mainly tobacco, and also to pasture and trees. Available moisture capacity is low to moderate, which is the chief limitation to farming. Further erosion is a moderate hazard on sloping areas. Capability unit IIs–4; woodland subclass 3o.

Rumford loamy sand, 5 to 10 percent slopes, moderately eroded (RdC2).—This soil has a profile similar to that of the soil described as representative of the series except that its surface layer is 8 to 10 inches thick. This soil is nearly free of gravel. Included in mapping are areas where the surface layer is thinner than that of this soil and where plowing exposes the subsoil in places. This soil is suited to crops, pasture, and trees. Available moisture capacity is low to moderate. The hazard of further erosion is severe in places where the soil is tilled. The low to moderate available moisture capacity and the hazard of further erosion are chief limitations to use. Capability unit IIIe–33; woodland subclass 3o.

Rumford gravelly sandy loam, 0 to 5 percent slopes, moderately eroded (RgB2).—This soil has a profile similar to that described as representative of the series except that the surface layer is light sandy loam that is 15 to 20 percent fine quartz pebbles. Below the surface layer, the gravel content varies, but it generally is higher in the underlying material. The soil is suited to cultivated crops and is used mostly for tobacco. It is also suited to pasture and trees. Available moisture capacity is low to moderate and is the chief concern of management. The hazard of further erosion is moderate. Capability unit IIs–4; woodland subclass 3o.

Rumford gravelly sandy loam, 5 to 10 percent slopes, moderately eroded (RgC2).—This soil has lost a part of its original surface layer through erosion, and in most

places the remaining surface layer is 6 to 10 inches thick. Also, in places pebbles left behind by erosion are on the surface and in shallow gullies that have cut through the soil. This soil otherwise has a profile similar to that of the soil described as representative of the series. It generally is more gravelly than similar soils that are more gently sloping. The hazard of further erosion is severe in places where the soil is tilled. Under careful management, however, this soil is suited to cultivated crops, pasture, and trees. Capability unit IIIe–33; woodland subclass 3o.

Sandy Land

Sandy land consists of exposures of very sandy soils along the steep ravines and stream valleys, mainly in the eastern part of the county. Most of the sediment is similar to the sandy material that underlies the Evesboro, Galestown, and Westphalia soils.

The only mapping unit is Sandy land, steep (SaE). It is mostly sand or fine sand containing gravel that is pale yellow to yellowish brown. In places finer material extends to a moderate depth. Slopes range from about 12 percent to more than 40 percent. Some areas are severely eroded but are still in use. Most areas are rewooded, but others are idle, and still others are in brush. Sandy land, steep, is not well suited to farming. Limitations are severe for most nonfarm uses. Capability unit VIIs–1; woodland subclass 3s.

Sassafras Series

The Sassafras series consists of nearly level to moderately sloping, deep, well-drained soils on uplands. These soils formed in loose deposits of loamy and sandy sediment of marine and alluvial origin. The native vegetation is mixed hardwoods, mainly oaks, but Virginia pine and loblolly pine grow in some places.

In a representative profile the surface layer is sandy loam about 8 inches thick. This layer is grayish brown in the thinner upper part and brown in the lower part. The upper part of the subsoil, about 4 inches thick, is yellowish-brown fine sandy loam. The lower part, about 26 inches thick, is strong-brown sandy clay loam that is friable. The underlying material to a depth of 60 inches is loose loamy sand of various colors.

Sassafras soils are easy to work. They have moderate available moisture capacity and are moderately permeable. Slope and the hazard of further erosion are the chief limitations to farming and nonfarm uses.

Representative profile of Sassafras sandy loam, 0 to 2 percent slopes, in a wooded area about one-half mile west of Malcolm:

A1—0 to 3 inches, grayish-brown (10YR 5/2) sandy loam; weak, fine, granular structure; friable, many roots; strongly acid; clear, wavy boundary.

A2—3 to 8 inches, brown (10YR 5/3) sandy loam; weak, fine, granular structure; friable; many roots; strongly acid; clear, wavy boundary.

B1—8 to 12 inches, yellowish-brown (10YR 5/4) heavy fine sandy loam; weak, medium, subangular blocky structure; friable, slightly sticky; common roots; strongly acid; gradual, wavy boundary.

B21t—12 to 28 inches, strong-brown (7.5YR 5/6) sandy clay loam; moderate, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; common roots; thin, almost continuous clay films; strongly acid; gradual, wavy boundary.

B22t—28 to 38 inches, strong-brown (7.5YR 5/6) light sandy clay loam; weak, medium and coarse, subangular blocky structure; friable, slightly sticky; a few roots; thin, discontinuous clay films; strongly acid; gradual, wavy boundary.

C—38 to 60 inches, variegated yellowish-brown (10YR 5/6), strong-brown (7.5YR 5/6), and grayish-brown (10YR 5/2) loamy sand; single grain; loose; very strongly acid.

The solum ranges from about 30 to 40 inches in thickness. The profile contains fine, smooth quartz pebbles, but these pebbles are abundant only in the C horizon. The A horizon is 10YR in hue, 3 to 5 in value, and 1 to 4 in chroma. The lowest value and chroma are confined to some A1 horizons less than 6 inches thick. The B horizon is 10YR to 5YR in hue, 5 or 6 in value, and 4 to 8 in chroma. The Bt horizon generally is sandy clay loam, but it ranges to heavy sandy loam and heavy loam. The clay content is 18 to 27 percent and the silt content is 20 to 35 percent. The C horizon is similar to the B horizon in color, but it is variegated in places and is coarser textured. The C horizon is as coarse or coarser than the A horizon. In some places the C horizon is moderately hard and brittle when dry.

Sassafras soils resemble Chillum, Marr, Matapeake, Rumford, and Wickham soils, but they contain less silt and more sand in the solum than Chillum and Matapeake soils. Sassafras soils have more clay in the Bt horizons than Rumford soils, and they contain more medium and coarse sand and weatherable minerals than Marr soils. Sassafras soils have a thinner solum than Wickham soils and commonly have less clay and more sand in the Bt horizon than those soils.

Sassafras sandy loam, 0 to 2 percent slopes (ShA).—The profile of this soil is the one described as representative of the series. Included with this soil in mapping are small areas where the surface layer is siltier than that of this soil. Also included are areas where the surface layer and the subsoil are redder than those of this soil. Under good management, this soil is suited to farming and to many nonfarm uses, and limitations to use are few. Capability unit I–5; woodland subclass 3o.

Sassafras sandy loam, 2 to 5 percent slopes, moderately eroded (ShB2).—This soil has a thinner surface layer than that of the soil described as representative of the series but the two profiles otherwise are similar. In places this soil is severely eroded or is cut by shallow gullies. Included with this soil in mapping are silty areas where the surface layer and subsoil are redder than those of this soil. Also included are spots where the underlying material is hard and brittle. This soil is suited to cultivated crops, pasture, trees, and most other uses. The hazard of further erosion is moderate. Capability unit IIe–5; woodland subclass 3o.

Sassafras sandy loam, 5 to 10 percent slopes, moderately eroded (ShC2).—This soil has lost most of its original surface layer through erosion, and in many places plowing exposes small amounts of subsoil, which gives the areas a spotty appearance. Under good management the soil is suited to most uses. The hazard of further erosion is severe in places where the soil is tilled. Capability unit IIIe–5; woodland subclass 3o.

Sassafras sandy loam, 5 to 10 percent slopes, severely eroded (ShC3).—This soil has lost most of its original surface layer, and in places some of its subsoil. The present surface layer is yellowish brown to strong brown and somewhat sticky. It is difficult to cultivate. This soil is marginal for tillage and should seldom be cultivated. It is better suited to pasture, hay crops, or trees. Capability unit IVe–5; woodland subclass 3o.

Sassafras sandy loam, 10 to 15 percent slopes, moderately eroded (ShD2).—Most of this soil is in woodland. Where it has been cleared, moderate amounts of surface soil have been lost through erosion, and plowing exposes some of the subsoil. Included with this soil in mapping are areas where the surface layer contains more silt and less sand than this soil. Also included are a few areas where the surface layer is thicker and sandier than this soil. Spots where the lower part of the subsoil is mottled with gray are also included. The soil is suited to pasture, orchards, trees, and a few cultivated crops. Capability unit IVe–5, woodland subclass 3o.

Sassafras sandy loam, 10 to 15 percent slopes, severely eroded (ShD3).—The present surface layer of this soil consists mostly of material formerly in the subsoil. It is sticky and crusts when dry. The areas are cut by many gullies. Included with this soil in mapping are places where the subsoil is mottled with gray. Also included are areas where the underlying material is hard and brittle. The hazard of further erosion is severe. This soil is not suited to crops. Capability unit VIe–2; woodland subclass 3o.

Swamp

Swamp (Sx) consists of areas of very wet land that is covered by fresh water most of the time. These areas are mostly in depressions on flood plains or in former estuaries that are almost filled with silt, sand, gravel, and organic material. Swamp is not used for farming. It generally is wooded with such trees as red maple, swamp magnolia, ash, and pond pine. A few trees are suitable for wood products, but the trees generally have little value for commercial purposes. Cattails, sedges, and various herbs are in open areas. Included in mapping are a few brackish areas near the heads of tidal estuaries. Wetness is a severe limitation. The areas of Swamp are suited to some wetland wildlife habitat. Capability unit VIIw–1; woodland subclass not assigned.

Tidal Marsh

Tidal marsh (Tm) is in estuaries along the lower sides of streams and in low areas that border the major rivers (fig. 16). Some areas are flooded daily by tidal waters, and others are flooded less frequently. The tidal waters vary in salinity from almost fresh to strongly brackish. The soil material generally ranges from sand to clay, but in places it is peaty or mucky. The vegetation is marsh grasses and sedges that contain some salt-tolerant herbs and low shrubs. Tidal marsh is not suited to crops, pasture, or trees. It is suitable for use as habitat for wetland wildlife and for recreation. Capability unit VIIIw–1; woodland subclass not assigned.

Westphalia Series

The Westphalia series consists of gently sloping to strongly sloping, very deep, well-drained soils on uplands. These soils are mostly in the northeastern part of the county where they formed in old deposits containing sands that are uniform in size. The native vegetation is mixed upland hardwoods, but some Virginia pine and redcedar are in rewooded areas.

In a representative profile the surface layer, about 9 inches thick, is yellowish-brown fine sandy loam. The upper part of the subsoil, about 9 inches thick, is strong-brown heavy fine sandy loam that is friable and slightly sticky. The lower part, about 7 inches thick, is brownish-yellow, very friable fine sandy loam. The underlying material, to a depth of 72 inches, is pale-yellow and light yellowish-brown loamy fine sand that is loose to very friable.

Westphalia soils are easy to work and they warm early in spring. Available moisture capacity is moderate to high. These soils are not very fertile, but they are well suited to tobacco and to early truck crops. Permeability is moderate to moderately rapid. Slope and the hazard of further erosion are chief limitations to nonfarm uses.

Representative profile of Westphalia fine sandy loam, 2 to 6 percent slopes, moderately eroded, in a cultivated area near the end of Swanson Creek Road, 1¼ miles northwest of Benedict:

Ap—0 to 9 inches, yellowish-brown (10YR 5/4) fine sandy loam; very weak, coarse, granular structure; friable, slightly sticky; a few roots; very strongly acid; abrupt, smooth boundary.

B2t—9 to 18 inches, strong-brown (7.5YR 5/6) heavy fine sandy loam, that contains less silt and more clay than the Ap horizon; weak, medium, subangular blocky structure; friable, slightly sticky; a few roots; a few thin, dark-brown (7.5YR 4/4) clay films; very strongly acid; clear, smooth boundary.

B3—18 to 25 inches, variegated brownish-yellow (10YR 6/6) and yellow (10YR 7/6) light fine sandy loam; very weak, medium, subangular blocky structure; very friable; a few roots; very strongly to extremely acid; clear, smooth boundary.

C—25 to 72 inches, variegated pale-yellow (2.5Y 7/1) and light yellowish-brown (2.5Y 6/4) loamy fine sand; single grain; loose to very friable; a few roots in upper part; extremely acid.

The solum ranges from about 20 to 36 inches in thickness. The A horizon is 3 to 5 in hue and 2 to 4 in chroma. Undisturbed A1 horizons less than 6 inches thick are 3 in value. The B horizon is 10YR or 7.5YR in hue, 4 to 6 in value, and 6 or 8 in chroma. The Bt horizon is as much as 10 inches thick and is fine sandy loam or very fine sandy loam. It is low in silt and is about 10 to 18 percent clay. The C horizon is paler in hue than the solum. It is higher in value, and in places it is variegated. The C horizon is fine sand, loamy fine sand, or loamy very fine sand that is as much as 10 percent clay.

Westphalia soils resemble Marr and Rumford soils. The Bt horizon in Westphalia soils are thinner and contain less clay than that in Marr soils. They have a thinner and finer A horizon than Rumford soils and the sand throughout their profile is finer and more uniform in size.

Westphalia fine sandy loam, 2 to 6 percent slopes, moderately eroded (WaB2).—This soil has the profile described as repersentative of the series. Included in mapping are areas that are little affected by erosion, and the surface layer is much thicker than that of this soil. Also included are areas where most of the surface layer has been washed away. This soil is well suited to tobacco. It is also suited to other crops, pasture, and trees. The hazard of further erosion is moderate in places where the soil is tilled. Capability unit IIe–5; woodland subclass 3o.

Westphalia fine sandy loam, 6 to 12 percent slopes, moderately eroded (WaC2).—This soil is cut by shallow gullies that extend into the subsoil. Included in mapping are a few areas where the upper part of the subsoil is much thicker than that of the soil described as representative of

478-272—74——3

the series. This soil is well suited to tobacco. The hazard of further erosion is severe in places where the soil is tilled. Under good management, this soil is suited to crops, pasture, and trees. Capability unit IIIe–5; woodland subclass 3o.

Westphalia fine sandy loam, 6 to 12 percent slopes, severely eroded (WaC3).—Most of the surface layer of this soil has been washed away and in many places a part of the subsoil has been lost through erosion. Gullies are common, and a few have cut into the loose underlying material. Under good management, this soil is marginal for cultivated crops. It is better suited to pasture, orchards, or trees. Capability unit IVe–5; woodland subclass 3o.

Westphalia fine sandy loam, 12 to 20 percent slopes, moderately eroded (WaD2).—Slope and the severe hazard of further erosion are the main limitations on this soil. Under the best management, this soil is marginal for farming. Tobacco or other row crops are grown, but most of the time the soil should have a cover of protective vegetation; for example, pasture, sodded orchards, or trees. Capability unit IVe–5; woodland subclass 3r.

Westphalia fine sandy loam, 12 to 20 percent slopes, severely eroded (WaD3).—The surface layer of this soil has been lost through erosion, and gullies are fairly common. Slope and the erosion hazard limit cultivation. This soil is suited to pasture or trees. Capability unit VIe–2; woodland subclass 3r.

Westphalia-Evesboro complex, 2 to 6 percent slopes, moderately eroded (WeB2).—About 67 percent of this mapping unit is Westphalia soils and about 33 percent is

Figure 16.—Tidal marsh at the mouth of Mattawoman Creek. Indian Head is in the background.

Evesboro soils. The Evesboro soils are more sandy and droughty than Westphalia soils, and they are less productive. Capability unit IIe–5; woodland subclass 3o.

Westphalia-Evesboro complex, 6 to 12 percent slopes, moderately eroded (WeC2).—Westphalia soils make up 50 percent of this mapping unit, and Evesboro soils make up 50 percent. A large part of the surface layer of the Westphalia soils has been washed away, and shallow gullies occur in places. A part of the Evesboro soils has been lost through erosion caused by runoff and also by soil blowing. Where these soils are cultivated, tobacco is the chief crop. These soils are seldom used for pasture. Capability unit IIIe–5; woodland subclass 3o.

Westphalia-Evesboro complex, 6 to 12 percent slopes, severely eroded (WeC3).—Westphalia soils make up 50 percent of this mapping unit, and Evesboro soils make up 50 percent. The Westphalia soils have lost most of their original surface layer. The Evesboro soils consist of loamy sand or gravelly loamy sand that has been severely washed. Gullies are common in all areas, and some gullies are deep. Under good management, these soils are suited to a few cultivated crops, but they are little used for this purpose. Most areas are idle or are rewooded. Capability unit IVe–5; woodland subclass 3o.

Wickham Series

The Wickham series consists of gently sloping to moderately sloping, deep, well-drained soils on ancient terraces of the Potomac River. These soils formed in old loamy deposits that contain mica and other weatherable minerals and a small amount of silt. The native vegetation is mixed upland hardwoods and Virginia pine.

In a representative profile the surface layer, about 9 inches thick, is yellowish-brown fine sandy loam. The subsoil, about 46 inches thick, is yellowish red, and the lower part is variegated. The upper 11 inches is firm sandy clay loam, the next 16 inches is firm clay loam, and the lower 19 inches is friable fine sandy loam. The underlying material, to a depth of 64 inches, is a dominantly red, stratified sandy loam.

Wickham soils are easy to work except in places where they are severely eroded. They have high available moisture capacity and are moderately permeable. Slope and the hazard of further erosion are chief limitations to use.

Representative profile of Wickham fine sandy loam, 2 to 5 percent slopes, moderately eroded, in a rewooded area, on the east side of Maryland Point Road, about one-half mile south of Route 6:

Ap—0 to 9 inches, yellowish-brown (10YR 5/4) fine sandy loam; weak, coarse, granular structure; friable, slightly sticky; many roots; very strongly acid; abrupt, smooth boundary.

B21t—9 to 20 inches, yellowish-red (5YR 5/6) sandy clay loam; strong, fine and medium, subangular blocky structure; firm, sticky and slightly plastic; a few roots; thin, continuous clay films; strongly acid; clear, smooth boundary.

B22t—20 to 36 inches, yellowish-red (5YR 4/6) clay loam, faintly variegated with higher chroma in lower portion; moderate, fine, blocky structure; very weakly stratified; firm, sticky and slightly plastic; a few roots; thin, continuous clay films; very strongly acid; abrupt, smooth boundary.

F23t—36 to 55 inches, yellowish-red (5YR 5/6) fine sandy loam, variegated strong brown (7.5YR 5/6), with a few fine, light-gray (5Y 7/1) mottles in lower portion; weakly and thinly stratified; friable, slightly sticky; a few roots; thin, patchy clay films; very strongly acid; gradual, smooth boundary.

C—55 to 64 inches, variegated red (2.5YR 4/8 to 2.5YR 5/6) sandy loam; thinly stratified; friable, slightly sticky; extremely acid.

The solum ranges from about 40 to 60 inches in thickness. Fine smooth quartz pebbles are throughout the profile, but they are more common in the C horizon. The A horizon is 10YR or 7.5YR in hue, 4 to 6 in value, and 2 to 4 in chroma. It is fine sandy loam in texture, but in severely eroded soils the surface layer (Ap horizon) generally is sandy clay loam. The B horizon is 5YR in hue, but in some subhorizons hue is 2.5YR. It is 4 to 6 in value and 4 to 8 in chroma. It is variegated with high chroma in any part and mottled with low chroma in the extreme lower part. The upper 20 inches of the Bt horizon is sandy clay loam to clay loam in texture and is about 25 to 30 percent clay. The lower part of the Bt horizon commonly is less clayey. The C horizon is variable in color but it mainly is red. It generally is sandy loam or sandy clay loam, but in places it consists of stratified material of various textures. Mica is in this horizon in places.

Wickham soils resemble Sassafras soils, but they are thicker and contain more clay and less sand in the Bt horizon than Sassafras soils, and they are somewhat redder.

Wickham fine sandy loam, 2 to 5 percent slopes, moderately eroded (WkB2).—The profile of this soil is the one described as representative of the series. Included with this soil in mapping are small areas that are more nearly level and a few severely eroded areas that are cut by shallow gullies. This soil is suited to cultivated crops, pasture, and trees. The hazard of further erosion is moderate. Capability unit IIe–5; woodland subclass 2o.

Wickham fine sandy loam, 5 to 10 percent slopes, moderately eroded (WkC2).—A few areas of this soil are cut by shallow gullies. This soil is suited to cultivated crops, pasture, and trees. The hazard of further erosion is severe in places where the soil is tilled. Capability unit IIIe–5; woodland subclass 2o.

Wickham fine sandy loam, 10 to 15 percent slopes, moderately eroded (WkD2).—Included with this soil in mapping are some areas where the subsoil is yellower and less red than this soil. In these areas, the lower part of the subsoil is somewhat firm and brittle and has many grayish spots and streaks. Also included are areas that are cut by shallow gullies. This soil is marginal for cultivated crops because of the severe hazard of further erosion on sloping areas. It is better suited to pasture or trees than to other uses. Capability unit IVe–5; woodland subclass 2o.

Wickham sandy clay loam, 5 to 10 percent slopes, severely eroded (WmC3).—This soil has lost most or all of its original surface layer of fine sandy loam through erosion. In many places part of the subsoil has been lost, and shallow to deep gullies are fairly common. In places where the soil is cultivated, the surface layer is sticky sandy clay loam that crusts over when it is dry. Under good management, this soil is suited to pasture and trees and to a few cultivated crops. Capability unit IVe–5; woodland subclass 2o.

Wickham sandy clay loam, 10 to 15 percent slopes, severely eroded (WmD3).—The surface layer of this soil is sticky sandy clay loam that is difficult to work, even under good conditions. Gullies are common to abundant. Included with this soil in mapping are a few areas where the lower part of the subsoil is hard and brittle. The hazard of further erosion is severe. This soil is not suited

to cultivated crops and is little used for farming. Most areas are rewooded or are in weeds and brush. Capability unit VIe–2; woodland subclass 2o.

Woodstown Series

The Woodstown series consists of level to moderately sloping, deep, moderately well drained soils on uplands and on low terraces bordering major rivers. These soils formed in loamy sediment containing moderate amounts of silt and clay. The native vegetation is mainly mixed hardwoods that can tolerate some wetness, but some loblolly pine grows in places.

In a representative profile the surface layer, about 15 inches thick, is sandy loam. This layer is grayish brown in the upper part and yellowish brown in the lower part. The subsoil, about 19 inches thick, is heavy fine sandy loam. It is yellowish brown, and the lower part is mottled with gray and strong brown. The underlying material to a depth of 60 inches is light-gray, mottled loamy sand that has a few pebbles.

Woodstown soils are easy to work, but they have a seasonal water table that is within 2 feet of the surface, and plowing and planting of crops is sometimes delayed. Wetness is a moderate to severe limitation to some nonfarm uses. These soils have moderate available moisture capacity. Permeability is moderate.

Representative profile of Woodstown sandy loam, 0 to 2 percent slopes, in a cultivated area south of Budds Creek Road, about 1¾ miles southwest of Newport:

Ap—0 to 9 inches, grayish-brown (2.5Y 5/2) sandy loam; weak, coarse, granular structure; very friable; many roots; strongly acid; abrupt, smooth boundary.

A2—9 to 15 inches, yellowish-brown (10YR 5/4) sandy loam; weak, medium, subangular blocky structure; friable, slightly sticky; common roots; very strongly acid; clear, smooth boundary.

B21t—15 to 25 inches, yellowish-brown (10YR 5/6) heavy fine sandy loam; weak, medium and coarse, subangular blocky structure; friable, slightly sticky and slightly plastic; common roots; thin, continuous clay films; very strongly acid; clear, smooth boundary.

B22t—25 to 34 inches, yellowish-brown (10YR 5/6) heavy fine sandy loam; common, medium, prominent mottles of gray or light gray (5Y 6/1), and a few, medium, distinct mottles of strong brown (7.5YR 5/8); weak, medium, subangular blocky structure; friable, slightly sticky and slightly plastic; a few roots; thin patchy clay films; very strongly acid; abrupt, wavy boundary.

C—34 to 60 inches, light-gray (2.5Y 7/2) loamy sand; many, coarse, prominent mottles of yellowish brown (10YR 5/6) and strong brown (7.5YR 5/8); single grain; very friable; about 3 percent smooth pebbles as much as 2 inches thick and some fine iron concretions; strongly acid.

The solum ranges from about 24 to 42 inches in thickness. In some places as much as 10 percent fine smooth pebbles is in the solum, about 20 percent in the C horizon, or both. Hue generally is 10YR or 2.5Y throughout the profile, but in places it is as much as 5Y in the C horizon. The A horizon is 3 to 6 in value and 1 to 4 in chroma. Undisturbed A1 horizons less than 6 inches thick are 3 in value. The matrix of the B horizon is 5 or 6 in value and 4 to 8 in chroma. This horizon is always mottled with chroma of 2 or less in the lower part of the B horizon. Mottles high in chroma are likely anywhere in the horizon. The texture of the Bt horizon is either loam, sandy loam, fine sandy loam, or more commonly sandy clay loam. This horizon is 18 to 27 percent clay and 20 to 35 percent silt. The C horizon generally is higher in value and lower in chroma than the B horizon, and in some profiles it is not mottled. The C horizon ranges from sandy loam to sand.

Woodstown soils resemble Matawan soils, but they have a thinner, finer textured A horizon than those soils, and their B22t horizon is coarser and more permeable. Seasonally, Woodstown soils generally are a little wetter than Matawan soils. These soils also resemble Beltsville, Bourne, Exum, Iuka, Keyport, and Mattapex soils in color and in natural drainage. The Bt horizon of Woodstown soils is lacking in Iuka soils. A fragipan that is in the lower part of the subsoil of Beltsville and Bourne soils is not present in Woodstown soils. These soils have less clay in the Bt horizons than Keyport soils. The solum in Woodstown soils is thinner than that of Exum soils, and it is less silty and more sandy than that of Mattapex soils.

Woodstown sandy loam, 0 to 2 percent slopes (WoA).—The profile of this soil is the one described as representative of the series. Included with this soil in mapping are small areas where the surface layer is more silty and less sandy than that of this soil. Also included are areas where the surface layer is somewhat gravelly. This soil is suited to cultivated crops, pasture, and trees. Artificial drainage is of benefit to most crops except those that are planted late. Capability unit IIw–5; woodland subclass 2o.

Woodstown sandy loam, 2 to 5 percent slopes, moderately eroded (WoB2).—In this soil the surface layer is about 6 to 8 inches thick, but the profile otherwise is similar to that described as representative of the series. In a few areas, the soil is severely eroded and is cut by shallow gullies. Included in mapping are small areas where the surface layer is more silty and less sandy than that of this soil. Also included are areas where the surface layer is slightly gravelly. This soil is suited to cultivated crops, pasture, and trees. When cultivated regularly, protective measures are needed to help control further erosion. Drainage is of benefit to some crops. Capability unit IIe–36; woodland subclass 2o.

Woodstown sandy loam, 5 to 10 percent slopes, moderately eroded (WoC2).—This soil has lost some of its original surface layer through erosion, and in places plowing exposes small amounts of subsoil, which gives the areas a spotty appearance. This soil is severely eroded in places and is also cut by gullies. Included in mapping are some areas that are more silty and gravelly than this soil. This soil is suited to cultivated crops, pasture, and trees, but the erosion hazard is severe in places where the soil is tilled. Drainage improvement is not needed for some crops. Capability unit IIIe–36; woodland subclass 2o.

Use and Management of the Soils

This section briefly explains the system of capability classification used by the Soil Conservation Service. Table 2 gives estimated yields of principal crops grown in the county. This section then discusses the use and management of the soils as woodland and as wildlife habitat and explains engineering uses of the soils. It also discusses use of the soils in town and country planning and for recreational purposes.

Capability Grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The groups are made according to the limitations of the soils when used for field crops, the risk of damage when they are used, and

TABLE 11.—*Terminology used in naming major taxonomic categories of the soils of Charles County* [1]

ORDER NAMES

Names of soil orders end in "sol" (solum,[2] soil) and contain a formative element used in the final syllable in the names of the suborder, great group, and subgroup classes.

Entisols	Soils that have no pedogenic horizons. Formative element: ent, which has the connotation of "recent."
Ultisols	Soils with horizons of clay accumulation and low base supply. Formative element ult, which has the connotation of "last."

STEMS USED IN SUBORDER NAMES

These stems are placed before the formative element of the order names to form suborder names.

Fluv	Fluvius,[2] river; soils formed in alluvium.
Aqu	Aqua,[2] water; soils that are wet for long periods.
Ud	Udus,[2] humid; of humid climates.
Psam	Psammos,[3] sand; excessively sandy.

STEMS USED IN GREAT GROUP NAMES

Ud	Udus,[2] humid; of humid climates.
Hapl	Haplous,[3] simple; the least advanced horizons, generally typifies the suborder.
Fluv	Fluvius,[2] river; soils formed in alluvium.
Ochr	Base of ochros,[3] pale; soils with little organic matter.
Quartzi	Quarz, quartz;[4] dominated by the mineral quartz.
Fragi	Modified from fragilis,[2] brittle; a dense brittle horizon.
Pale	Paleos,[3] old; old soils of advanced degree of development.

SUBGROUP TERMINOLOGY

Typic	Typus [2] and typos,[3] type; this subgroup typifies the central concept of the great group.
Aquic	Aqua,[2] water; the soil has some characteristics of poor natural drainage though not sufficient for its placement in an Aqu suborder.
Ochreptic	Base of ochros,[3] pale; Hapludults with a very thin argillic horizon, thus with a solum dominantly pale in color.
Psammentic	Psammos,[3] sand; intergrading toward Psamments, which are a suborder of sandy Entisols.
Rhodic	Rhodon,[3] rose; soils that are unusually dark-red in color.

[1] Terminology in this table follows, and the explanations have been adapted from the USDA comprehensive system of soil classification (*11*).
[2] From the Latin.
[3] From the Greek.
[4] From the German.

Skeletal soils have a control section with more than 35 percent, by volume, of coarse fragments greater than 2 millimeters thick. Loamy soils are divided into coarse-loamy (less than 18 percent clay) and fine-loamy (18 to 35 percent clay), and more than 15 percent is coarser than very fine sand. On the same basis of clay content, silty soils are divided into coarse-silty and fine-silty, but less than 15 percent is coarser than very fine sand. Clayey soils have a control section containing more than 35 percent clay.

Mineralogy classes are based on the dominant minerals in the control section. For clayey families, this means the dominant clay mineral. For others it means the dominant minerals in the silt and sand. Most of the soils of Charles County are either siliceous (dominated by silica or quartz) or of mixed mineralogy (no dominant single mineral). One series (Magnolia) is dominated by kaolinitic clay. Mineralogy does not appear in the family name of the Evesboro series, because quartz, which is silicon dioxide, appears in the names used to designate both the great group and subgroup to which this series belongs.

Soil families are also separated on the basis of temperature. *Mesic* families have an average annual temperature at a depth of 20 inches between 47° and 59° F., with a difference of at least 9° F. between the average summer and winter temperatures. *Thermic* families have an average annual temperature that is greater than 59° at a depth of 20 inches.

The soil isotherm of 59° F. passes through Charles County. This line is fairly broad and indefinite. The soils of this county are classified as thermic families if they most commonly occur southward in the warmer regions. They are classified as mesic families if they most commonly occur northward in the cooler regions. It must be emphasized that the 59° isotherm is not only broad and indefinite but also quite irregular. Limited information on exact soil temperatures makes it impossible to trace this isotherm on any map of the landscape.

It will be noted in table 10 that most soil families have only one representative. Most of these families have other members that are elsewhere in Maryland or in adjacent states. Three families listed in table 10 have two members in the county. Differences between the Marr and Sassafras series, between Chillum and Matapeake series (see fig. 15), and between Matawan and Woodstown series, are based on color, thickness of solum or major horizons, or other factors, and are pointed out in the section "Descriptions of the Soils."

General Nature of the County

This section gives background information about the history, population, and climate of the county. It also gives some facts about transportation and markets, farming, surface features, and water supply.

Charles County is the fifth county in Maryland and was founded by the Governor and his Council on May 10, 1658. It was named in honor of Charles Calvert, the third Lord Baltimore. Port Tobacco, then called Chandler's Town, was designated the county seat. Previously it was a village called "Potobac" that was occupied by the Indians when Captain John Smith visited the area in 1608. Port Tobacco soon became the center of activity, shipping tobacco and other products of Southern Maryland to European ports. It was on the stagecoach and Potomac Ferry route from Philadelphia to the south.

La Plata, the present county seat, was founded as a town about 1870, on the newly built Popes Creek Railroad. By 1895, Port Tobacco had lost much of its importance because soil debris from eroded farms in the watershed

blocked the river below the port and prevented access by larger ships. In 1895 the courthouse burned, and the county seat moved to La Plata.

Benedict, the second oldest town in the county, is on the Patuxent River. Benedict was the landing site of the British Army that burned Washington, D.C., during the War of 1812. Indian Head, Waldorf, and Hughesville were founded during the 19th century. Most of the smaller communities in the county date from colonial times.

The early settlers of Charles County were English, or of English descent. Many of the settlers did not come directly from England, but from other colonial settlements. Growth of the county was slow until about 1940. It was semi-isolated until the bridge over the Potomac River at Morgantown was constructed, making possible north-south traffic on U.S. Highway 301.

In 1950 the population of Charles County was 23,415, and by 1970, it was 47,678. The highest density of population is in the Pomonkey-Indian Head area, and the second highest is in the Waldorf area.

Transportation for the earliest settlers in the county was mainly by water. Several towns, including the county seat, were established at points served by ocean-going ships. The Potomac River, which borders the county for about 75 miles, with its tributaries served the families who lived far from the towns.

The building of good roads was accelerated just before World War I, when automobiles became the common mode of transportation. U.S. Highway 301 runs through the center of the county and is the principal north-south highway.

The Popes Creek Railroad was completed around 1868 to provide rail transportation.

Today, rail service is supplied by the Pennsylvania Central Railroad. Air service is supplied by National Airport in Washington, D.C., and by Friendship International Airport near Baltimore, Maryland. Motor freight service is from terminals in Washington, Baltimore, and Richmond and Norfolk, Virginia.

Markets are easily available. Within overnight trucking distance from La Plata is 28 percent of the U.S. population and 29 percent of the Nation's effective buying power.

Climate [7]

Charles County's position in the middle latitudes, where the general atmospheric flow is from west to east, favors a continental type of climate with its well-defined seasons. However, the Chesapeake Bay and the Potomac River have a modifying influence on the climate, especially in moderating extreme temperatures of the areas nearby.

Data in table 12 are based on the climatic record of the National Weather Service cooperative station in La Plata, in the central part of the county. Those climatic data are representative of those for the county, except in areas bordering the Potomac River and the lower parts of its tributaries.

The warmest period of the year is the last half of July, when the afternoon maximum temperature averages 89° F. Temperatures of 90° or higher occur about 34 days per

[7] By W. J. Moyer, climatologist for Maryland and Delaware, National Weather Service, U.S. Department of Commerce.

TABLE 12.—*Temperature and precipitation data*

[All data from La Plata, Maryland, for the period 1931–60]

Month	Temperature				Precipitation [1]				
	Average daily maximum	Average daily minimum	Two years in 10 will have at least 4 days with [1]—		Average monthly precipitation	One year in 10 will have—		Days with snow cover 1 inch or more	Average depth of snow on days with snow cover 1 inch or more
			Maximum temperature equal to or higher than—	Minimum temperature equal to or lower than—		Less than—	More than—		
	°F	°F	°F	°F	Inches	Inches	Inches	Number	Number
January	46.7	27.0	62	9	3.89	1.7	6.6	3	3
February	48.6	27.1	66	11	3.01	1.4	4.9	4	3
March	56.5	33.5	75	20	3.78	1.6	6.1	2	4
April	67.7	42.4	82	29	3.58	1.8	6.3	----------	----------
May	76.6	52.5	89	40	4.21	1.6	7.2	----------	----------
June	84.0	61.1	94	51	3.99	1.9	6.9	----------	----------
July	87.6	65.5	94	57	5.20	2.3	8.4	----------	----------
August	85.9	64.1	95	54	5.07	1.8	10.6	----------	----------
September	80.0	57.5	90	44	4.27	1.3	10.6	----------	----------
October	70.3	46.3	83	32	3.72	1.0	7.5	----------	----------
November	59.0	35.6	74	21	3.01	1.0	5.7	(2)	3
December	47.6	27.4	62	13	3.24	1.6	6.1	3	3
Year	67.5	45.0	[3] 99	[4] 4	46.97	35.1	56.1	12	3

[1] Record, 1933–47.
[2] Less than 0.5 day.
[3] Average annual maximum temperature.
[4] Average annual minimum temperature.

TABLE 13.—*Probabilities of last freezing temperatures in spring and first in fall*

[Data based on observations at La Plata, Charles County, Maryland, during the 30-year period, 1926-55]

Probability	Dates for given probability and temperature		
	32° F. or lower	24° F. or lower	16° F. or lower
Spring:			
9 years in 10 later than	Apr. 4	Feb. 28	Feb. 4
3 years in 4 later than	Apr. 11	Mar. 8	Feb. 13
2 years in 3 later than	Apr. 13	Mar. 11	Feb. 17
1 year in 2 later than	Apr. 18	Mar. 17	Feb. 24
1 year in 3 later than	Apr. 23	Mar. 23	Mar. 3
1 year in 4 later than	Apr. 25	Mar. 26	Mar. 7
1 year in 10 later than	May 2	Apr. 3	Mar. 16
Fall:			
1 year in 10 earlier than	Oct. 9	Nov. 2	Nov. 23
1 year in 4 earlier than	Oct. 15	Nov. 9	Nov. 30
1 year in 3 earlier than	Oct. 18	Nov. 12	Dec. 3
1 year in 2 earlier than	Oct. 22	Nov. 17	Dec. 8
2 years in 3 earlier than	Oct. 26	Nov. 22	Dec. 13
3 years in 4 earlier than	Oct. 29	Nov. 25	Dec. 16
9 years in 10 earlier than	Nov. 4	Dec. 2	Dec. 23

year. The coldest period is the last part of January and the beginning of February, when the early morning average minimum temperature is about 21°. The average number of days when the daily minimum temperature is 32° or lower is 100.

Freeze data, giving the average dates of the last spring and first fall occurrences of minimum temperatures that are equal to or below a specified threshold value, are given in table 13 for La Plata. The period between the last frost, or 32° F., temperature in spring and the first in fall, often defined as the growing season, is about 187 days.

The average annual precipitation is 47 inches. The monthly distribution is fairly uniform throughout the year. July and August are the wettest months, and February and November are the driest. Precipitation in the colder half of the year mainly is the result of low-pressure systems moving north or northeast along the coast. In summer precipitation occurs in the form of showers and thunderstorms.

The average annual snowfall is 18 inches, but it varies from year to year. For example, the total was 49.3 inches in 1939–40 and 4.0 inches in 1951–52. The maximum depth of snow was 24 inches, on January 28, 1922.

Drought occurs at any time, but it is more serious in summer. Generally, rainfall and stored soil moisture are adequate for good crop yields. However, the unequal distribution of summer showers and occasional dry periods at critical stages in crop development makes irrigation necessary for maximum crop yields in some years.

Thunderstorms occur on the average of 35 days per year. They occur in any month, but about 70 percent of them are during the period of May through August. Tornadoes hurricanes, and blizzards are rare. Prevailing winds are from northwest to west-northwest, except during summer, when they are more southerly. The average wind velocity is about 9 miles per hour. In places, winds reach 50 to 60 miles per hour and higher during severe thunderstorms, hurricanes, or intense winter storms.

Farming [8]

The first settlers of Charles County had to clear the land they farmed. The land was covered mostly by hardwoods, including oaks, chestnut, sweetgum, yellow-poplar, and beech. The first crops grown were corn, tobacco, small grains, and hay. Tobacco soon became the principal cash crop and a medium of exchange.

Early farm practices were wasteful. The land was cleared, cropped until yields were no longer profitable, and then abandoned. Level fields naturally regenerated without permanent injury, but erosion was moderate to severe on sloping areas before a plant cover was reestablished.

In 1919 the major crops were the same as those grown by the first settlers (*8*). Of the total acreage farmed, about 42 percent was in corn, 20 percent in wheat, and 10 percent in tobacco. Practically all of the harvested tobacco was exported to Europe. Hay ranked fourth in importance.

There was a decrease in acres cropped between 1879 and 1919.

Farms in the county have decreased in number, but they have increased in size. The average farm size was 118 acres in 1919 (*8*) and 126 acres in 1964 (*5*). There was about a 35 percent increase in the number of part-time farms between 1950 and 1960. Over half of the farm operators reported off-farm employment in 1959 (*3*). The value of farms and farm buildings increased by about 50 percent between 1958 and 1964.

Of the 1,009 farms reported in 1964, 141 were less than 10 acres in size; 265 farms were 10 to 49 acres; 163 were 50 to 99 acres; 257 were 100 to 219 acres; 151 were 220 to 499 acres; and 32 were 500 acres or larger (*3*). In 1964, 605 of the 714 commercial farms in the county were classified as tobacco farms.

In 1964, 8,800 acres were in corn, 5,500 acres in small grains, 2,000 acres in soybeans, and 5,200 acres in hay (*3*). Nursery and greenhouse products were also extensive. 9,002 acres of tobacco was planted in 1900 (*8*), 8,735 acres in 1959 (*3*), and 6,000 acres in 1968 (*5*). The tobacco harvest in 1968 was 7.1 million pounds, an average of 1,188 pounds per acre (*5*). In 1969 there were 6,300 acres of tobacco in the county. During 1960–70 about 75 percent of farm income was derived from tobacco.

The major tobacco-producing areas in Charles County are east of Route 301. The most important tobacco-producing soils are of the Westphalia, Sassafras, Rumford, and Evesboro series. These soils are moderately coarse to coarse in texture and are well drained to excessively drained. Yields generally are high, but they are only moderate on Evesboro soils.

Tobacco responds well to high-range applications of fertilizer. The results of a fertilizer-rate test conducted over a 3-year period showed that yield, value per acre, and average auction price increased with each increment of fertilizer. This test was conducted on Beltsville silt loam, one of the siltier soils used for tobacco. It is not so well

[8] CLAUDE G. MCKEE, extension tobacco specialist, Department of Agronomy, University of Maryland, and H. TRAVIS MCPHERSON, tobacco extension agent in Charles County, assisted in the preparation of this section.

drained or so well aerated as the soils on which tobacco generally is produced.

Tobacco varieties commonly grown in Charles County are Catterton, Maryland 10, Maryland 59, Maryland 64, and Maryland 609. In 1970 about half the total acreage planted to tobacco was in Maryland 609. This variety grows better on heavier textured soils than others. The results of the tobacco variety test conducted on Beltsville silt loam in Charles County showed that Maryland 609 had both the highest average price per pound and dollar return per acre of the varieties tested.

Charles County is not self-sufficient in livestock products. There has been a constant decrease in this area in recent years (*3*). Most livestock farms in the county are operated by owners or part owners, but in 1964 about 25 percent were operated by tenants. Most of the tenants operate on a share basis rather than paying rent.

Surface Features [9]

Charles County lies entirely within the province of the Atlantic Coastal Plain. The western boundary is 6 to 8 miles east of the edge of the Piedmont province in Virginia. A plateau fairly uniform in altitude forms a rough triangle in the north-central part, centered in the area along U.S. Route 301 between White Plains and Waldorf. This upland plateau is not deeply entrenched by stream valleys, but the land gently slopes west, south, and east and is cut by the major streams of the county, the larger of which flows south.

About two-thirds of the county lies within an altitude of 100 feet or more. The maximum elevation, about 240 feet, is near Waldorf. Along some parts of the shorelines of the Potomac and Wicomico Rivers, there is terracing, with a fairly abrupt slope change at the 40-foot contour line. Uniformly elevated terraces below the 40-foot contour are in the Marshall Hall, Stump Neck, and Moss Point areas, and at Maryland Point extending to the northwest along the Wicomico River shoreline. These broad flat areas are 25 to 40 feet in altitude and may be part of the Talbot terrace of late Pleistocene age.

With the exception of Swanson and Indian Creeks, which flow eastward into the Patuxent River, all drainage is into the Potomac River. The eastern half of the county is drained by the Zekiah Swamp Run and its tributaries and the Gilbert Swamp Run, the northern part by Mattawoman Creek, the central part by the Port Tobacco River, and the western part by Reeder Run, Nanjemoy Creek, Wards Run, and Mill Run.

Water Supply

Ground water is available nearly everywhere in Charles County. In a few places it is available from springs, but in most places it is obtained from drilled or dug wells. Several water-bearing formations are below the surface, and they can be tapped by wells ranging in depth from 10 feet or less to drilled wells greater than 1,000 feet in depth. Large amounts of water are stored in the Coastal Plain sediment beneath the area. Much of this water is not available because it is in strata that are too fine grained to yield water at significant rates to springs or wells.

Between 30 and 40 percent of the yearly precipitation infiltrates the ground-water reservoirs. The county receives about 800 million gallons of water per year for each square mile. The fairly low infiltration rate is due to topography and to the fine texture of many of the soils.

The major aquifers in Charles County are in the Patuxent, Patapsco, Raritan, and Magothy formations of the Cretaceous system, the Aquia Greensand of the Eocene series, and Pleistocene deposits.

Major aquifers beneath Pleistocene deposits are penetrated only by drilled wells. Upland deposits, mostly of Pleistocene age, are tapped by dug or bored wells that are seldom deeper than 40 feet. These shallow wells are at 50 to 200 feet above sea level. Most of them furnish only domestic water supplies. The sediment at these sites is saturated at depths of less than 40 feet.

The water source for these wells is absorbed precipitation which is released slowly to the underlying deposits. Commonly, streams have cut downward through these deposits, permitting them to drain. The shallow wells below an elevation of about 50 feet yield limited quantities of water to large-diameter wells, but they are locally subject to encroachment by salt water.

Water in the deeper formations is replenished from precipitation that filters through the soil zone in their outcrop areas, most of which are not in Charles County. These aquifers are recharged principally west of the Potomac River in Fairfax, Prince William, and Stafford Counties, Virginia. Ground water moves slowly through these aquifers toward the south and east, and water in upland deposits moves from the central upland of the county to the low-lying areas along major stream valleys. Ground water emerges in low places as seeps, swamps, and springs and maintains the flow of streams during periods of no runoff.

[9] This section is derived from "Availability of Ground Water in Charles County," Bul. 30, Maryland Geological Survey, by Turbit H. Slaughter and E. G. Otton. 1968 (pages 5 and 6).

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CHARLES COUNTY, MARYLAND

CONVENTIONAL SIGNS

WORKS AND STRUCTURES

Highways and roads

- Divided
- Good motor
- Poor motor
- Trail

Highway markers

- National Interstate
- U. S.
- State or county

Railroads

- Single track
- Multiple track
- Abandoned

Bridges and crossings

- Road
- Trail
- Railroad
- Ferry (FY)
- Ford (FORD)
- Grade
- R. R. over
- R. R. under

Buildings

- School
- Church

Mine and quarry

Gravel pit

Power line

Pipeline

Cemetery

Dams

Levee

Tanks

Well, oil or gas

Forest fire or lookout station

Lighthouse

Located object

BOUNDARIES

- National or state
- County
- Minor civil division
- Reservation
- Land grant
- Small park, cemetery, airport
- Land survey division corners

DRAINAGE

Streams, double-line

- Perennial
- Intermittent

Streams, single-line

- Perennial
- Intermittent
  - Crossable with tillage implements
  - Not crossable with tillage implements
  - Unclassified

Canals and ditches

Lakes and ponds

- Perennial (water, w)
- Intermittent (int)

Spring

Marsh or swamp

Wet spot

Drainage end or alluvial fan

RELIEF

Escarpments

- Bedrock
- Other

Short steep slope

Prominent peak

Depressions

	Large	Small
Crossable with tillage implements		
Not crossable with tillage implements		
Contains water most of the time		

SOIL SURVEY DATA

Soil boundary and symbol (Dx)

Gravel

Stoniness
- Stony
- Very stony

Rock outcrops

Chert fragments

Clay spot

Sand spot

Gumbo or scabby spot

Made land

Severely eroded spot

Blowout, wind erosion

Gully

Kitchen midden

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil serie
read the introduction to the section it is in for general information about its management. Dashes indi

Acreage and extent, table 1, p. 8.
Estimated yields of principal crops, table 2, p. 44.
Woodland management, table 3, p. 48.

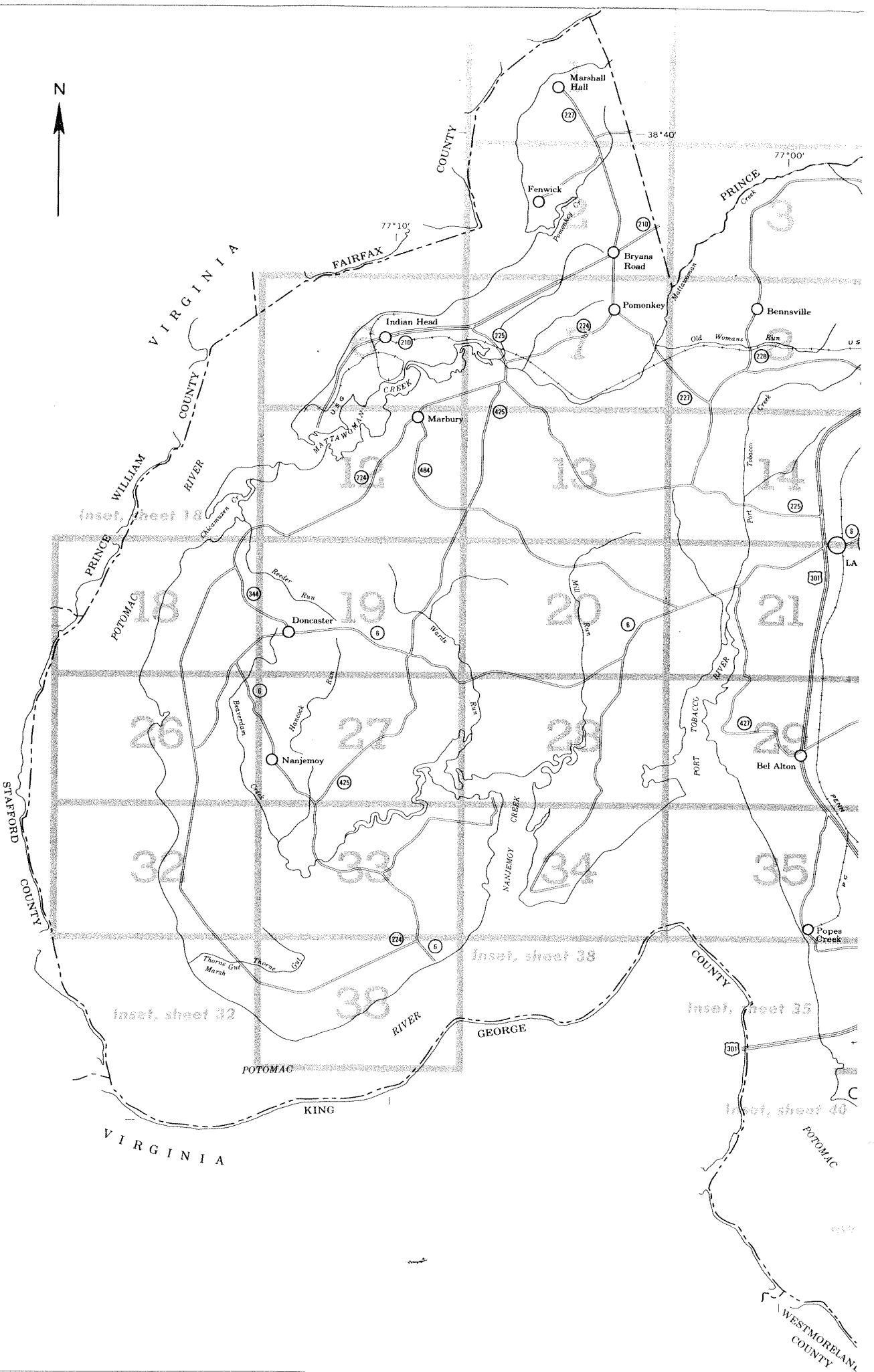
Map symbol	Mapping unit	Described on page	Capability unit		Woodland subclass	
			Symbol	Page	Symbol	Page
Ad	Alluvial land	7	VIw-1	43	2w	52
AuC2	Aura gravelly sandy loam, 5 to 10 percent slopes, moderately eroded	9	IIIe-9	39	3d	53
AuD2	Aura gravelly sandy loam, 10 to 15 percent slopes, moderately eroded	10	IVe-7	41	3d	53
AuD3	Aura gravelly sandy loam, 5 to 15 percent slopes, severely eroded	10	VIIe-2	43	3d	53
BlA	Beltsville silt loam, 0 to 2 percent slopes	11	IIw-8	37	3w	53
BlB2	Beltsville silt loam, 2 to 5 percent slopes, moderately eroded	11	IIe-13	36	3w	53
BlC2	Beltsville silt loam, 5 to 10 percent slopes, moderately eroded	11	IIIe-13	39	3w	53
BlC3	Beltsville silt loam, 5 to 10 percent slopes, severely eroded	11	IVe-9	42	3w	53
Bo	Bibb silt loam	12	IIIw-7	40	2w	52
BrB2	Bourne sandy loam, 2 to 5 percent slopes, moderately eroded	13	IIe-36	36	3w	53
BrC2	Bourne sandy loam, 5 to 10 percent slopes, moderately eroded	13	IIIe-36	40	3w	53
BuC3	Bourne sandy clay loam, 5 to 10 percent slopes, severely eroded	13	IVe-7	41	3w	53
ChB2	Chillum silt loam, 2 to 6 percent slopes, moderately eroded	13	IIs-7	38	3o	52
ChC2	Chillum silt loam, 6 to 12 percent slopes, moderately eroded	14	IIIe-7	39	3o	52
Co	Coastal beaches	14	VIIIs-2	43	--	--
CrB2	Croom gravelly loam, 3 to 8 percent slopes, moderately eroded	14	IIs-7	38	4d	54
CrC2	Croom gravelly loam, 8 to 15 percent slopes, moderately eroded	14	IIIe-7	39	4d	54
CrC3	Croom gravelly loam, 8 to 15 percent slopes, severely eroded	14	IVe-7	41	4d	54
Cu	Cut and fill land	15	-------	--	--	--
Ek	Elkton silt loam	15	IIIw-9	41	3w	53
ErE	Eroded land, steep	15	VIIe-2	43	3r	53
EvB	Evesboro loamy sand, 0 to 8 percent slopes	16	IVs-1	42	3s	53
EvC	Evesboro loamy sand, 8 to 15 percent slopes	16	VIIs-1	43	3s	53
EwB	Evesboro gravelly loamy sand, 0 to 8 percent slopes	16	IVs-1	42	3s	53
EwC	Evesboro gravelly loamy sand, 8 to 15 percent slopes	16	VIIs-1	43	3s	53
ExC2	Exum silt loam, 5 to 10 percent slopes, moderately eroded	17	IIIe-16	39	3o	52
ExD2	Exum silt loam, 10 to 15 percent slopes, moderately eroded	17	IVe-9	42	3o	52
EyC3	Exum clay loam, 5 to 10 percent slopes, severely eroded	17	IVe-9	42	4o	54
EyD3	Exum clay loam, 10 to 15 percent slopes, severely eroded	17	VIe-2	43	4o	54
EzB2	Exum-Beltsville silt loams, 2 to 5 percent slopes, moderately eroded	17	IIe-16	36	3o	52
Fs	Fallsington sandy loam	18	IIIw-6	40	2w	52
GaB	Galestown loamy sand, 0 to 8 percent slopes	19	IVs-1	42	3s	53
Gp	Gravel and borrow pits	19	VIIIs-4	46	--	--
GvE	Gravelly land, steep	19	VIIe-2	43	4f	54
Ik	Iuka fine sandy loam	20	IIw-7	37	1o	52
Im	Iuka sandy loam, local alluvium	20	IIw-7	37	1o	52
In	Iuka silt loam, local alluvium	20	IIw-7	37	1o	52
KeA	Keyport fine sandy loam, 0 to 2 percent slopes	21	IIw-9	38	3w	53
KeB2	Keyport fine sandy loam, 2 to 5 percent slopes, moderately eroded	22	IIe-36	36	3w	53
KpA	Keyport silt loam, 0 to 2 percent slopes	22	IIw-8	37	3w	53
KpB2	Keyport silt loam, 2 to 5 percent slopes, moderately eroded	22	IIe-13	36	3w	53
KpC2	Keyport silt loam, 5 to 12 percent slopes, moderately eroded	22	IIIe-13	39	3w	53
KrC3	Keyport silty clay loam, 5 to 12 percent slopes, severely eroded	22	VIe-2	43	3w	53
Le	Leonardtown silt loam	23	IVw-3	42	3w	53
MgA	Magnolia silt loam, 0 to 2 percent slopes	24	I-4	35	2o	52
MgB2	Magnolia silt loam, 2 to 5 percent slopes, moderately eroded	24	IIe-4	35	2o	52
MgC2	Magnolia silt loam, 5 to 12 percent slopes, moderately eroded	24	IIIe-4	38	2o	52

PPING UNITS

es to which the mapping unit belongs. In referring to a capability unit, a woodland subclass, or any other group, icate that the mapping unit is too variable for grouping. Other information is given in tables as follows:

Suitability of soils for wildlife, table 4, p. 56.
Engineering uses of soils, tables 5, 6, and 7, pp. 58 through 72.

Map symbol	Mapping unit	Described on page	Capability unit		Woodland subclass	
			Symbol	Page	Symbol	Page
MkC3	Magnolia clay loam, 5 to 12 percent slopes, severely eroded	24	IVe-3	41	2o	52
MlB2	Marr fine sandy loam, 2 to 5 percent slopes, moderately eroded	25	IIe-5	36	3o	52
MmA	Matapeake fine sandy loam, 0 to 2 percent slopes	25	I-5	35	3o	52
MmB2	Matapeake fine sandy loam, 2 to 5 percent slopes, moderately eroded	25	IIe-5	36	3o	52
MnA	Matapeake silt loam, 0 to 2 percent slopes	25	I-4	35	3o	52
MnB2	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded	25	IIe-4	35	3o	52
MnC2	Matapeake silt loam, 5 to 10 percent slopes, moderately eroded	26	IIIe-4	38	3o	52
MnC3	Matapeake silt loam, 5 to 10 percent slopes, severely eroded	26	IVe-3	41	3o	52
Ms	Matawan loamy sand	26	IIw-10	38	2o	52
MtA	Mattapex fine sandy loam, 0 to 2 percent slopes	27	IIw-5	37	3o	52
MtB2	Mattapex fine sandy loam, 2 to 5 percent slopes, moderately eroded	27	IIe-36	36	3o	52
MuA	Mattapex silt loam, 0 to 2 percent slopes	27	IIw-1	37	3o	52
MuB2	Mattapex silt loam, 2 to 5 percent slopes, moderately eroded	27	IIe-16	36	3o	52
MxC	Mattapex soils, 5 to 12 percent slopes	27	IIIe-16	39	3o	52
OcB	Ochlockonee fine sandy loam, local alluvium, 0 to 5 percent slopes	28	IIe-6	36	1o	52
Or	Osier loamy sand	28	IVw-6	42	2w	52
Os	Othello fine sandy loam	29	IIIw-6	40	3w	53
Ot	Othello silt loam	29	IIIw-7	40	3w	53
RdB2	Rumford loamy sand, 0 to 5 percent slopes, moderately eroded	29	IIs-4	38	3o	52
RdC2	Rumford loamy sand, 5 to 10 percent slopes, moderately eroded	29	IIIe-33	40	3o	52
RgB2	Rumford gravelly sandy loam, 0 to 5 percent slopes, moderately eroded	29	IIs-4	38	3o	52
RgC2	Rumford gravelly sandy loam, 5 to 10 percent slopes, moderately eroded	29	IIIe-33	40	3o	52
SaE	Sandy land, steep	30	VIIs-1	43	3s	53
ShA	Sassafras sandy loam, 0 to 2 percent slopes	30	I-5	35	3o	52
ShB2	Sassafras sandy loam, 2 to 5 percent slopes, moderately eroded	30	IIe-5	36	3o	52
ShC2	Sassafras sandy loam, 5 to 10 percent slopes, moderately eroded	30	IIIe-5	39	3o	52
ShC3	Sassafras sandy loam, 5 to 10 percent slopes, severely eroded	30	IVe-5	41	3o	52
ShD2	Sassafras sandy loam, 10 to 15 percent slopes, moderately eroded	31	IVe-5	41	3o	52
ShD3	Sassafras sandy loam, 10 to 15 percent slopes, severely eroded	31	VIe-2	43	3o	52
Sx	Swamp	31	VIIw-1	43	--	--
Tm	Tidal marsh	31	VIIIw-1	43	--	--
WaB2	Westphalia fine sandy loam, 2 to 6 percent slopes, moderately eroded	31	IIe-5	36	3o	52
WaC2	Westphalia fine sandy loam, 6 to 12 percent slopes, moderately eroded	31	IIIe-5	39	3o	52
WaC3	Westphalia fine sandy loam, 6 to 12 percent slopes, severely eroded	32	IVe-5	41	3o	52
WaD2	Westphalia fine sandy loam, 12 to 20 percent slopes, moderately eroded	32	IVe-5	41	3r	53
WaD3	Westphalia fine sandy loam, 12 to 20 percent slopes, severely eroded	32	VIe-2	43	3r	53
WeB2	Westphalia-Evesboro complex, 2 to 6 percent slopes, moderately eroded	32	IIe-5	36	3o	52
WeC2	Westphalia-Evesboro complex, 6 to 12 percent slopes, moderately eroded	33	IIIe-5	39	3o	52
WeC3	Westphalia-Evesboro complex, 6 to 12 percent slopes, severely eroded	33	IVe-5	41	3o	52
WkB2	Wickham fine sandy loam, 2 to 5 percent slopes, moderately eroded	33	IIe-5	36	2o	52
WkC2	Wickham fine sandy loam, 5 to 10 percent slopes, moderately eroded	33	IIIe-5	39	2o	52
WkD2	Wickham fine sandy loam, 10 to 15 percent slopes, moderately eroded	33	IVe-5	41	2o	52
WmC3	Wickham sandy clay loam, 5 to 10 percent slopes, severely eroded	33	IVe-5	41	2o	52
WmD3	Wickham sandy clay loam, 10 to 15 percent slopes, severely eroded	33	VIe-2	43	2o	52
WoA	Woodstown sandy loam, 0 to 2 percent slopes	34	IIw-5	37	2o	52
WoB2	Woodstown sandy loam, 2 to 5 percent slopes, moderately eroded	34	IIe-36	36	2o	52
WoC2	Woodstown sandy loam, 5 to 10 percent slopes, moderately eroded	34	IIIe-36	40	2o	52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Inset, sheet 35
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FAIRFAX COUNTY
VIRGINIA
PRINCE WILLIAM COUNTY
STAFFORD COUNTY
KING GEORGE COUNTY
WESTMORELAND COUNTY
POTOMAC RIVER
MATTAWOMAN CREEK
NANJEMOY CREEK
PORT TOBACCO RIVER
Chopawamsic Cr.
Reeder Run
Beaverdam Creek
Hancock Run
Wards Run
Mill Run
Old Womans Run
Tobacco Port Creek
Thorne Gut
Thorne Gut Marsh
Pomonkey Cr.
Mattawoman Creek
Tobacco Port Creek
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28
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SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, D, or E, shows the slope. Most symbols without a slope letter are those of nearly level soils, but some are for land types that have a considerable range of slope. A final number, 2 or 3, in the symbol shows that the soil is moderately eroded or severely eroded.

SYMBOL	NAME
Ad	Alluvial land
AuC2	Aura gravelly sandy loam, 5 to 10 percent slopes, moderately eroded
AuD2	Aura gravelly sandy loam, 10 to 15 percent slopes, moderately eroded
AuD3	Aura gravelly sandy loam, 5 to 15 percent slopes, severely eroded
BlA	Beltsville silt loam, 0 to 2 percent slopes
BlB2	Beltsville silt loam, 2 to 5 percent slopes, moderately eroded
BlC2	Beltsville silt loam, 5 to 10 percent slopes, moderately eroded
BlC3	Beltsville silt loam, 5 to 10 percent slopes, severely eroded
Bo	Bibb silt loam
BrB2	Bourne sandy loam, 2 to 5 percent slopes, moderately eroded
BrC2	Bourne sandy loam, 5 to 10 percent slopes, moderately eroded
BuC3	Bourne sandy clay loam, 5 to 10 percent slopes, severely eroded
ChB2	Chillum silt loam, 2 to 6 percent slopes, moderately eroded
ChC2	Chillum silt loam, 6 to 12 percent slopes, moderately eroded
Co	Coastal beaches
CrB2	Croom gravelly loam, 3 to 8 percent slopes, moderately eroded
CrC2	Croom gravelly loam, 8 to 15 percent slopes, moderately eroded
CrC3	Croom gravelly loam, 8 to 15 percent slopes, severely eroded
Cu	Cut and fill land
Ek	Elkton silt loam
ErE	Eroded land, steep
EvB	Evesboro loamy sand, 0 to 8 percent slopes
EvC	Evesboro loamy sand, 8 to 15 percent slopes
EwB	Evesboro gravelly loamy sand, 0 to 8 percent slopes
EwC	Evesboro gravelly loamy sand, 8 to 15 percent slopes
ExC2	Exum silt loam, 5 to 10 percent slopes, moderately eroded
ExD2	Exum silt loam, 10 to 15 percent slopes, moderately eroded
EyC3	Exum clay loam, 5 to 10 percent slopes, severely eroded
EyD3	Exum clay loam, 10 to 15 percent slopes, severely eroded
EzB2	Exum-Beltsville silt loams, 2 to 5 percent slopes, moderately eroded
Fs	Fallsington sandy loam
GaB	Galestown loamy sand, 0 to 8 percent slopes
Gp	Gravel and borrow pits
GvE	Gravelly land, steep
Ik	Iuka fine sandy loam
Im	Iuka sandy loam, local alluvium
In	Iuka silt loam, local alluvium
KeA	Keyport fine sandy loam, 0 to 2 percent slopes
KeB2	Keyport fine sandy loam, 2 to 5 percent slopes, moderately eroded
KpA	Keyport silt loam, 0 to 2 percent slopes
KpB2	Keyport silt loam, 2 to 5 percent slopes, moderately eroded
KpC2	Keyport silt loam, 5 to 12 percent slopes, moderately eroded
KrC3	Keyport silty clay loam, 5 to 12 percent slopes, severely eroded
Le	Leonardtown silt loam
MgA	Magnolia silt loam, 0 to 2 percent slopes
MgB2	Magnolia silt loam, 2 to 5 percent slopes, moderately eroded
MgC2	Magnolia silt loam, 5 to 12 percent slopes, moderately eroded
MkC3	Magnolia clay loam, 5 to 12 percent slopes, severely eroded
MlB2	Marr fine sandy loam, 2 to 5 percent slopes, moderately eroded
MmA	Matapeake fine sandy loam, 0 to 2 percent slopes
MmB2	Matapeake fine sandy loam, 2 to 5 percent slopes, moderately eroded
MnA	Matapeake silt loam, 0 to 2 percent slopes
MnB2	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded
MnC2	Matapeake silt loam, 5 to 10 percent slopes, moderately eroded
MnC3	Matapeake silt loam, 5 to 10 percent slopes, severely eroded
Ms	Matawan loamy sand
MtA	Mattapex fine sandy loam, 0 to 2 percent slopes
MtB2	Mattapex fine sandy loam, 2 to 5 percent slopes, moderately eroded
MuA	Mattapex silt loam, 0 to 2 percent slopes
MuB2	Mattapex silt loam, 2 to 5 percent slopes, moderately eroded
MxC	Mattapex soils, 5 to 12 percent slopes
OcB	Ochlockonee fine sandy loam, local alluvium, 0 to 5 percent slopes
Or	Osier loamy sand
Os	Othello fine sandy loam
Ot	Othello silt loam
RdB2	Rumford loamy sand, 0 to 5 percent slopes, moderately eroded
RdC2	Rumford loamy
	moderately e
RgB2	Rumford gravel
	moderately e
RgC2	Rumford gravel
	moderately e
SaE	Sandy land, ste
ShA	Sassafras sand
ShB2	Sassafras sand
	moderately e
ShC2	Sassafras sand
	moderately e
ShC3	Sassafras sand
	severely ero
ShD2	Sassafras sand
	moderately e
ShD3	Sassafras sand
	severely ero
Sx	Swamp
Tm	Tidal marsh
WaB2	Westphalia fine
	moderately e
WaC2	Westphalia fine
	moderately e
WaC3	Westphalia fine
	severely ero
WaD2	Westphalia fine
	moderately e
WaD3	Westphalia fine
	severely ero
WeB2	Westphalia-Ev
	moderately e
WeC2	Westphalia-Ev
	moderately e
WeC3	Westphalia-Ev
	severely ero
WkB2	Wickham fine s
	moderately e
WkC2	Wickham fine s
	moderately e
WkD2	Wickham fine s
	moderately e
WmC3	Wickham sandy
	severely ero
WmD3	Wickham sandy
	severely ero
WoA	Woodstown san
WoB2	Woodstown san
	moderately e
WoC2	Woodstown san
	moderately e

SOIL LEGEND

The first capital letter is the initial one of the soil name. A second capital letter, A, B, C, D, or E, shows the slope. Most symbols without a slope letter are those of nearly level soils, but some are for land types that have a considerable range of slope. A final number, 2 or 3, in the symbol shows that the soil is moderately eroded or severely eroded.

SYMBOL	NAME
Gp	Gravel and borrow pits
GvE	Gravelly land, steep
Ik	Iuka fine sandy loam
Im	Iuka sandy loam, local alluvium
In	Iuka silt loam, local alluvium
KeA	Keyport fine sandy loam, 0 to 2 percent slopes
KeB2	Keyport fine sandy loam, 2 to 5 percent slopes, moderately eroded
KpA	Keyport silt loam, 0 to 2 percent slopes
KpB2	Keyport silt loam, 2 to 5 percent slopes, moderately eroded
KpC2	Keyport silt loam, 5 to 12 percent slopes, moderately eroded
KrC3	Keyport silty clay loam, 5 to 12 percent slopes, severely eroded
Le	Leonardtown silt loam
MgA	Magnolia silt loam, 0 to 2 percent slopes
MgB2	Magnolia silt loam, 2 to 5 percent slopes, moderately eroded
MgC2	Magnolia silt loam, 5 to 12 percent slopes, moderately eroded
MkC3	Magnolia clay loam, 5 to 12 percent slopes, severely eroded
MlB2	Marr fine sandy loam, 2 to 5 percent slopes, moderately eroded
MmA	Matapeake fine sandy loam, 0 to 2 percent slopes
MmB2	Matapeake fine sandy loam, 2 to 5 percent slopes, moderately eroded
MnA	Matapeake silt loam, 0 to 2 percent slopes
MnB2	Matapeake silt loam, 2 to 5 percent slopes, moderately eroded
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MnC3	Matapeake silt loam, 5 to 10 percent slopes, severely eroded
Ms	Matawan loamy sand
MtA	Mattapex fine sandy loam, 0 to 2 percent slopes
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MuA	Mattapex silt loam, 0 to 2 percent slopes
MuB2	Mattapex silt loam, 2 to 5 percent slopes, moderately eroded
MxC	Mattapex soils, 5 to 12 percent slopes
OcB	Ochlockonee fine sandy loam, local alluvium, 0 to 5 percent slopes
Or	Osier loamy sand
Os	Othello fine sandy loam
Ot	Othello silt loam
RdB2	Rumford loamy sand, 0 to 5 percent slopes, moderately eroded
RdC2	Rumford loamy sand, 5 to 10 percent slopes, moderately eroded
RgB2	Rumford gravelly sandy loam, 0 to 5 percent slopes, moderately eroded
RgC2	Rumford gravelly sandy loam, 5 to 10 percent slopes, moderately eroded
SaE	Sandy land, steep
ShA	Sassafras sandy loam, 0 to 2 percent slopes
ShB2	Sassafras sandy loam, 2 to 5 percent slopes, moderately eroded
ShC2	Sassafras sandy loam, 5 to 10 percent slopes, moderately eroded
ShC3	Sassafras sandy loam, 5 to 10 percent slopes, severely eroded
ShD2	Sassafras sandy loam, 10 to 15 percent slopes, moderately eroded
ShD3	Sassafras sandy loam, 10 to 15 percent slopes, severely eroded
Sx	Swamp
Tm	Tidal marsh
WaB2	Westphalia fine sandy loam, 2 to 6 percent slopes, moderately eroded
WaC2	Westphalia fine sandy loam, 6 to 12 percent slopes, moderately eroded
WaC3	Westphalia fine sandy loam, 6 to 12 percent slopes, severely eroded
WaD2	Westphalia fine sandy loam, 12 to 20 percent slopes, moderately eroded
WaD3	Westphalia fine sandy loam, 12 to 20 percent slopes, severely eroded
WeB2	Westphalia-Evesboro complex, 2 to 6 percent slopes, moderately eroded
WeC2	Westphalia-Evesboro complex, 6 to 12 percent slopes, moderately eroded
WeC3	Westphalia-Evesboro complex, 6 to 12 percent slopes, severely eroded
WkB2	Wickham fine sandy loam, 2 to 5 percent slopes, moderately eroded
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WkD2	Wickham fine sandy loam, 10 to 15 percent slopes, moderately eroded
WmC3	Wickham sandy clay loam, 5 to 10 percent slopes, severely eroded
WmD3	Wickham sandy clay loam, 10 to 15 percent slopes, severely eroded
WoA	Woodstown sandy loam, 0 to 2 percent slopes
WoB2	Woodstown sandy loam, 2 to 5 percent slopes, moderately eroded
WoC2	Woodstown sandy loam, 5 to 10 percent slopes, moderately eroded

US Army Corps
of Engineers
Omaha District

Draft Report

Indian Head
Naval Ordnance Station
Phase I Environmental Audit

Contract No. DACW 45-89-D-0515
Delivery Order: 5008

May 1990

SIRRINE
ENVIRONMENTAL
CONSULTANTS

Encl (1)

DRAFT PHASE I ENVIRONMENTAL AUDIT

PREPARED FOR:

OMAHA DISTRICT U.S. ARMY CORPS OF ENGINEERS

PREPARED BY:

SIRRINE ENVIRONMENTAL CONSULTANTS
AND
RADIAN CORPORATION

MAY 31, 1990

TABLE OF CONTENTS

Executive Summary

1.0 INTRODUCTION

1.1 Audit Methodology
1.2 Site Description
1.3 Site History
1.4 Audit Team

2.0 OPEN BURNING/OPEN DETONATION UNITS

2.1 Brief Description of OB/OD Units

2.1.1 Production Thermal Treatment Point
2.1.2 Safety Thermal Treatment Point
2.1.3 Caffee Road Thermal Treatment Point

2.2 Regulatory Status of the OB/OD Units

2.2.1 RCRA Permit Standards for OB/OD Units
2.2.2 Assessment of Contaminant Migration Pathways
2.2.3 Corrective Actions at OB/OD Units

2.3 Summary

2.4 Recommendations

2.4.1 Waste Minimization, Segregation, Recovery
2.4.2 Advanced Alternative Treatment Technologies/Methods
2.4.3 Current Facility Upgrade
2.4.4 Range Relocation

3.0 WASTE MINIMIZATION

3.1 Waste Minimization Potential
3.2 Integrated Chemical Management
3.3 Summary and Recommendations

4.0 AIR EMISSIONS

4.1 Applicable Air Regulations and Compliance Status
4.2 Proposed Clean Air Act Amendments
4.3 Summary and Recommendations

TABLE OF CONTENTS (Continued)

5.0 ENVIRONMENTAL RESTORATION ISSUES AT NAVORDSTA

5.1 CERCLA and IR Activities at NAVORDSTA

5.1.1 CERCLA Reauthorization and Federal Facilities

5.2 RCRA Corrective Action at NAVORDSTA
5.3 RCRA/CERCLA Overlap at NAVORDSTA

5.3.1 Federal Facility Agreements

5.4 Environmental Releases at Indian Head

5.4.1 IRP Sites
5.4.2 RFA Identified Sites (RCRA)
5.4.3 Remedial Priorities

5.5 Summary and Recommendations

6.0 SARA TITLE III REPORTING

6.1 Recommended Compliance Strategy

7.0 WASTEWATER

7.1 Existing Wastewater System and Regulatory Status

7.1.1 Sanitary Wastewater
7.1.2 Industrial Wastewater

7.2 Wastewater Improvement Project
7.3 Recommendations

8.0 SOLID WASTE PROCESSOR

8.1 RCRA Incinerator Permits

8.1.1 Performance Standards
8.1.2 Operating Requirements

8.2 Incinerator Standards and the Solid Waste Processor

TABLE OF CONTENTS (Continued)

8.3 Other Regulatory Considerations

8.3.1 Exemption for Explosive Waste
8.3.2 The Solid Waste Processor as a Subpart X Unit

8.4 Priorities for Permitting the Solid Waste Processor

8.4.1 Status of Caffee Road Thermal Treatment Point
8.4.2 Other Uses for the Solid Waste Processor
8.4.3 Need for Alternative to Land Based Thermal Treatment

8.5 Summary and Recommendations

9.0 LOVA PROCESS REVIEW

9.1 Air Emissions
9.2 Wastewater Discharges
9.3 Solid and Hazardous Waste Generation
9.4 Summary and Recommendations

10.0 HAZARDOUS WASTE GENERATION AND STORAGE

10.1 Hazardous Waste Generation and Accumulation

10.1.1 Types of Hazardous Waste Generated
10.1.2 Hazardous Waste Container Management
10.1.3 Hazardous Waste Training
10.1.4 Contingency Plan and Energy Preparedness

10.2 Permitted Hazardous Waste Storage
10.3 Summary

11.0 ENVIRONMENTAL MANAGEMENT SYSTEMS

11.1 Existing Management System
11.2 Employee Interviews and Perceptions
11.3 Recommendations

List of Tables

Table 1	Audit Team
Table 2	Processes With Waste Reduction Potential
Table 3	LOVA Process Raw Materials
Table 4	Extrusion Process Raw Materials
Table 5	Biazzi Raw Materials
Table 6	Moser Raw Materials
Table 7	Miscellaneous Process Raw Materials
Table 8	Torpedo, MTV and MAPO Process Raw Materials
Table 9	SARA Title III Reporting Requirements

List of Figures

Figure 1 Waste Minimization Incentives

Figure 2 LOVA Waste Generation

Figure 3 Extrusion Process Flow Diagram

Figure 4 PNC Material Balance

Figure 5 Torpedo, MTV and MAPO Material Losses

EXECUTIVE SUMMARY AND RECOMMENDATIONS

Sirrine Environmental Consultants, working through a contract with the Army Corps of Engineer - Omaha district, performed an environmental audit of the Naval Ordnance Station (NAVORDSTA), Indian Head, Maryland. Conceptually, this project was conceived as a "recognition" audit with the intent of recognizing a broad spectrum of environmental related concerns such that these issues could be prioritized according to urgency. The recognition audit also had as a conceptual premise the development of specific recommendations to address existing or imminent deficiencies. Many of the recommendations contained in this report will be for more detailed study. Again, the purpose of the audit was to recognize deficiencies and rank them in terms of overall impact to NAVORDSTA. This audit report identifies and ranks ten environmental issues and provides the basis for the development of a comprehensive NAVORDSTA environmental plan of recommendations.

NAVORDSTA has been operated as a Federal facility with the Department of Defense (DOD) as client. The facility has been exempt from many of the environmental regulations which were initiated in the 1970's and have subsequently become more stringent. In addition, the nature of the primary products produced at Indian Head causes an absence of competitive pressures to update and modernize equipment and processes. These two generic factors have placed NAVORDSTA in an environmental "catch up" position relative to private sector industrial counterparts and are a root cause of many of the identified issues.

Sirrine has identified the following ten environmental issues at NAVORDSTA (shown ranked as to overall impact). Detailed discussion of these items are found in the audit report text.

1. Open Burning/Open Detonation
2. Waste Minimization
3. Air Emissions
4. Environmental Restoration
5. SARA Title III

6. Wastewater
7. Solid Waste Processor
8. LOVA Process
9. Hazardous Waste Generator/Storer Requirements
10. Environmental Management Systems

Sirrine strongly recommends that an alternative evaluation feasibility study be commissioned quickly regarding the Open Burning/Open Detonation (OB/OD) of waste explosives. We feel that this environmental issue is number one and it is critical to the operation of NAVORDSTA that a solution is developed. We do not believe that it is in the best interest of the facility to pursue a Subpart X Part B permit in its present form. Impacts to soil, ground water and air are likely to be highlighted by State/Federal review. Modifications to the existing process, including going to an all pan system, are improvements but the existing burn points are likely already contaminated. NAVORDSTA can continue operating the burn points but the EPA deadline for issuance or denial of an operating permit is November 8, 1992. Therefore, there is a two and one-half year window to evaluate burning of waste explosives in a controlled manner. The ultimate solution to the OB/OD issue could be a combination of reducing the volume of waste explosives, controlled burning of portions and perhaps pan burning of residuals. Regardless, a thorough study of alternatives should be performed as soon as possible.

Waste minimization at NAVORDSTA has already been identified by facility personnel as a generic necessity. Waste minimization is inherently linked to all the identified environmental issues. The solutions to many contemporary environmental problems lie not in classic end-of-pipe scenarios but reside in reduction at the source and systematic waste minimization. These are now the options of choice because it is increasingly more costly to generate and subsequently treat/dispose of hazardous by-products. Long-term economics now favor process modification, recycle and recovery, especially when ultimate potential hazardous waste liabilities are properly assessed and management time and effort to deal with these matters are taken into consideration.

Waste process and inventory studies have already been initiated by NAVORDSTA. Sirrine recommends that these efforts be intensified and given a high priority. Indeed, a large part of the OB/OD issue lies in the dated process equipment which produces much more waste material than contemporary equipment. To date, there has been little incentive to reduce the volume of hazardous waste production. We recommend that a system be developed to internally charge each department for waste disposal such that the costs of alternative process modifications can be properly compared. The systematic modernization of critical equipment and components will also result in the reduction of air and water discharges.

Due to the short-term urgency of environmental compliance, it may still be necessary to utilize some end-of-pipe or end-of-process treatment. Because of urgency, the immediate wastewater plan is end-of-pipe oriented. This solution, however, will be costly to operate (carbon adsorption/evaporation) such that competitive forces will mandate a reduction in wastewater generation in the longer term. Waste minimization will be critical to all NAVORDSTA operations and Sirrine recommends a comprehensive Waste Minimization Program Plan be developed. We have outlined in the audit report the steps of this process.

The NAVORDSTA has significant process air emissions. Most of these emissions are currently within regulatory guidelines and the facility has taken steps to comply with existing standards. Sirrine is of the opinion that the new Clean Air Act will substantially affect NAVORDSTA and create a concerted need for waste minimization and emissions control. Solvents are used extensively by several operations at the facility and these materials are intentionally vented to the atmosphere. Volatile organic compounds (VOCs), in particular, will come under much stricter control in the future due to their exhibited toxicity and implications of ozone destruction.

Because the Navy has made a commitment to comply with SARA Title III, air emissions (solvents) have the potential to create a large public relations problem for NAVORDSTA. Sirrine recommends that a comprehensive Air Emissions Study be initiated that inventories existing sources and compares emissions to existing and anticipated standards. Once completed, Sirrine recommends the development of an air emissions reduction strategy.

We feel this proactive strategy is a necessity for NAVORDSTA to defend itself once the SARA Title III information becomes public.

A concurrent air issue involves the LOVA process. The most significant environmental impact of LOVA is solvent drying to the atmosphere. Sirrine recommends an immediate evaluation of waste minimization and/or recovery options for this process. Air permits for this operation will likely be required because this should be considered as a new process. Again, SARA Title III emission calculations will highlight this process as a large source of VOCs without control equipment.

The potential for any significant environmental restoration (clean-up) is somewhat unknown at this time. Due to the mercury spill site, Indian Head could receive a Hazardous Ranking (HR) sufficient to get on the National Priorities List (NPL). Our research indicates that if this happens the entire facility, less permitted RCRA sites, will be controlled by CERCLA. This is a likely advantage to NAVORDSTA compared to the RCRA RFI program.

The politics of CERCLA vs. RCRA can get complicated. Jurisdictional disputes between the various EPA departments is commonplace. With regard to Federal facilities, these jurisdictional disputes are best addressed by Inter-Agency Agreements (IAG) or Federal Facility Agreements that precisely define which program will take the lead at a particular facility. IAGs also stipulate the standards for site investigations and remediation. Rather than recommend any specific site assessments or investigations at this time, Sirrine recommends that NAVORDSTA negotiate an IAG with EPA and DOD which defines regulatory control and resulting standards of investigation. Sirrine believes such an agreement is vital for the expeditious spending of funds to avoid the installation of monitoring wells, source removal, etc. to unknown standards. Once the IAG is in place, Sirrine recommends that a Restoration Program Plan be developed to standardize and schedule all activities which may be required. Such a Program Plan would be approved by EPA and will allow for the systematic addressing of sites and budgeting.

Wastewater is an environmental issue which is receiving current attention to achieve discharge compliance. Sirrine believes the current plan workable. We do feel, however, that the system will be expensive to operate and require significant operator attention. There is some risk that there will be moderate operational problems that may from time to time interfere with production in certain areas. Sirrine recommends a Wastewater Reduction Study be initiated in conjunction with Waste Minimization. The wastewater study would specifically identify, quantify and characterize all sources. A subsequent phase II would involve the development of process modifications, equipment changes, etc. toward flow recycle and reduction. Economies will likely be apparent when compared against carbon regeneration/disposal costs and carbon/evaporation operational costs.

The Solids Waste Processor could be an integral component of hazardous waste management at NAVORDSTA. Expanding its capabilities may require RCRA permitting. A full discussion of this issue is contained in the audit text. This unit could serve several functions, namely as a replacement for some of the materials currently at OB/OD and to regenerate spent carbon from the wastewater treatment. To obtain such multiple uses from this unit will require significant permitting time and equipment expense. Sirrine recommends that a study be initiated to determine the feasibility of permitting a multiple-use unit and how this unit would function in the overall NAVORDSTA waste management system.

The NAVORDSTA appears to be in general compliance with hazardous waste generator and storage requirements. Recommendations include increased training programs, particularly at the production level, to ensure proper handling, labeling, storage, etc. A management structure appears to be in place for periodic review of programs and updating per new regulatory requirements.

The Environmental Management Systems are in the formative stage. Personnel are generally young and lack some experience but show a willingness to learn. To create a central focus for environmental programs, Sirrine recommends that all environmental personnel be consolidated to report to the Director of Environmental Programs. This would

facilitate more effective communication and overall purpose and would allow for better planning, training and budgeting.

Sirrine recommends that a Management System Study be initiated to develop mission guidelines for a consolidated environmental group. Of equal importance would be the establishment of methods/procedures to link environmental personnel and production personnel. This is vital as Waste Minimization and other related efforts progress. Sirrine also recommends the creation of an Environmental Awareness Committee for NAVORDSTA composed of a wide spectrum of facility personnel (rotating). This committee would serve to provide ideas to the environmental division, provide technical guidance, and serve to anticipate public response to NAVORDSTA initiatives.

Summary of Recommendations

Recommendations have been made to the NAVORDSTA to assist in planning future environmental direction and progress. In many cases, Sirrine has recommended direction which includes the performance of additional studies by the NAVORDSTA for specific problem areas. The recommendations are discussed in detail in separate sections of this report.

OB/OD

- The NAVORDSTA should perform an Alternative Treatment Technologies Study including limited use of the solid waste processor to evaluate all possible options to the continued use of OB/OD as well as alternative treatment technologies. Sirrine recommends abandonment of the present burn points as soon as possible (pending the technologies study).

- To reduce the dependence on the OB/OD units, the NAVORDSTA should continue and increase waste minimization activities for all sources of explosive contaminated materials. These activities should include process evaluation, waste segregation and waste definition.

- The NAVORDSTA should continue to upgrade the existing OB/OD areas in the short term to minimize releases to soil, ground water and surface water.

- The NAVORDSTA should continue to monitor regulatory issues related to OB/OD activities including air emissions modeling and minimum technology standards. Where appropriate, the NAVORDSTA should provide comment to regulatory agencies' proposed permitting standards.

- The NAVORDSTA should immediately investigate alternative locations for OB/OD activity should some limited pan burning be necessary in the future.

Waste Minimization

- The NAVORDSTA should continue and expand its waste minimization program and develop a comprehensive Waste Minimization Program Plan.

- Substantial waste minimization opportunities exist at several production facilities. As a first phase, a detailed assessment of waste inventory for all processes should be conducted.

- Significant waste reduction can be achieved through improved procurement of hazardous substances at the NAVORDSTA. Sirrine recommends that NAVORDSTA develop and implement an Integrated Chemical Management System for inventory control/tracking.

Air

- The proposed amendments to the Clean Air Act are expected to become law by the end of 1990. The amendments will impact existing and new emission sources. The NAVORDSTA should continue to track the developments of the amendments and anticipate the need for significant reduction in air emissions (waste minimization) and

emission controls. NAVORDSTA should perform an Air Emissions Study to quantify existing emissions, compare to existing and anticipated standards, and develop corrective measures for anticipated noncompliance.

- The NAVORDSTA is currently submitting Air Registrations of all air emission sources to the State of Maryland Department of the Environment. This registration should be completed as soon as possible to achieve compliance with COMAR Section 26.11.02.

- The OB/OD areas operate under a local permit for open burning as well as under RCRA 40 CFR 265 Interim Status for miscellaneous units. The NAVORDSTA should make attempts to reduce the amount of waste burned at the OB/OD areas.

- The NAVORDSTA should develop and Air Permit Procedures Guidance for determining when an air permit is required for new and modified processes. Maryland Air Toxics regulations will have an impact on requirements for VOC control for new emission sources.

Environmental Restoration

- The NAVORDSTA should negotiate an Interagency Agreement (IAG) between DOD and EPA to establish EPA jurisdictional purview (CERCLA vs. RCRA) and to develop standardized investigation/remediation methods and procedures. Once an IAG is achieved, the NAVORDSTA should develop a Restoration Program Plan which will provide consistency and budget considerations for all waste sites.

- The restoration of hazardous waste sites at the NAVORDSTA will be subject to CERCLA and RCRA Corrective Action programs. One site on the Station has the potential to become a site on the National Priorities List (NPL). The NAVORDSTA should closely monitor the regulatory status of this site at EPA Region III. Additionally the Station should develop a Community Relations Plan to address restoration issues which will face the NAVORDSTA in the future.

SARA Title III

- The NAVORDSTA should immediately develop a SARA Title III Strategy to include methods and procedures for emission calculations, reporting format, proactive plans to address major emission sources, and a public relations plan.

Wastewater

- The NAVORDSTA should develop a comprehensive Industrial Wastewater Management Plan which identifies all sources, discharge locations, effluent limits, permitting requirements for new sources and identification of production responsibilities for discharge of wastewaters within acceptable NPDES limits. Wastewater source reduction/elimination should be an integral part of the Waste Minimization Program Plan.

- The existing activated sludge treatment facility will begin receiving pretreated industrial wastewaters. The treatment facility should be evaluated to determine the ability of the system to handle the additional flow and pollutant loadings with removal efficiencies within acceptable NPDES discharge limits.

- The characteristics of wastewater sources should be evaluated for current and future discharges of pretreated wastewaters to either the evaporation facility or the activated sludge facility. A Pretreatment Program should be developed for all sources discharging to either of the two treatment facilities.

- The sludge resulting from wastewaters containing explosives are classified as RCRA listed hazardous waste (K044, K045). The generation and disposal should be closely monitored. The NAVORDSTA should consider delisting the sludge.

- The large quantity (200,000 lbs per year) of spent carbon generated at the NAVORDSTA will also be classified as a RCRA hazardous waste. To reduce the amount of waste carbon generated, supplementary wastewater treatment technologies should be investigated. The use of the solid waste processor to regenerate spent carbon should also be evaluated.

- The existing sludge drying beds should be replaced with alternative dewatering devices such as filter presses, centrifuges, etc. to prevent the drying beds from being classified a land disposal unit under RCRA when the hazardous sludge is generated.

- Waste minimization at NAVORDSTA should include elimination of direct discharges of non-contact cooling water by the installation of cooling towers. Contamination of non-contact cooling waters with hydraulic oils should also be eliminated.

Solid Waste Processor

- The NAVORDSTA should perform a Solid Waste Processor Feasibility Study to determine if that unit could be modified to accept explosive hazardous waste and possibly other sources. This study should include a detailed evaluation of the processor, specific waste to be treated, and determination of permitting as an RCRA incinerator or as a miscellaneous unit (Subpart X) or if a permit exemption is applicable.

- The use of the solid waste processor for regeneration of spent carbon may also be feasible under a RCRA Subpart X permit for miscellaneous units. An evaluation of this potential use including a cost analysis should be conducted.

- The NAVORDSTA should begin to prepare for the eventual need to permit either the solid waste processor or similar units since the land base thermal treatment (OB/OD) units are likely to be discouraged by EPA in the future. Additional personnel with experience in incineration and RCRA permitting should be added to the existing environmental groups.

LOVA Process Review

- The LOVA process currently generates excessive quantities of Volatile Organic Compounds, spent activated carbon, and hazardous waste. Sirrine recommends an immediate LOVA Waste Minimization Study to evaluate control options for this process. Air permits will be required when the LOVA process goes to full production.

Hazardous Waste Generation and Storage

- The NAVORDSTA non-explosive hazardous waste management program is generally operated in compliance with applicable regulations. Additional Hazardous Waste Training Programs, particularly at the production facility level, are recommended to ensure proper handling, storage and disposal of hazardous waste and to encourage waste minimization.

Environmental Management Systems

- The importance to the NAVORDSTA mission of environmental compliance and public relations on environmental issues cannot be overstated. Sirrine believes the potential consequences of noncompliance warrant elevation and centralization of all existing environmental groups directly under the supervision and direction of the Director of Environmental Programs.

- The existing environmental management has done an excellent job, within a short time period, of establishing environmental programs at the NAVORDSTA. However the Environmental Protection Division's lack of experienced personnel has created some confusion and communication problems at the production level. Sirrine recommends additional training be conducted in upcoming issues such as OB/OD permitting, air emissions, environmental restoration and wastewater engineering.

- Sirrine recommends the establishment of a stationwide Environmental Awareness Program which includes increased environmental training, employee waste minimization incentive programs, and the creation of an environmental roundtable or committee made up of personnel from environmental, production and public affairs.

1.0 INTRODUCTION AND AUDIT FOCUS

Sirrine Environmental Consultants (Sirrine) and the Radian Corporation have contracted with the United States Army Corps of Engineers (USACE) to conduct a preliminary environmental audit of the Naval Ordnance Station (NAVORDSTA) at Indian Head, Maryland. The preliminary environmental audit was initiated by the NAVORDSTA to evaluate the current environmental programs at the Station and to identify future environmental requirements which the Station will be subject. The preliminary environmental audit will be used by the NAVORDSTA as a planning tool to obtain the necessary funds and manpower to comply with current and pending environmental regulations.

The primary objective of the environmental audit of the NAVORDSTA is to review the existing programs and to assist the NAVORDSTA plan for future compliance issues. Emphasis was placed on the general compliance with respect to environmental regulations and the ability of the existing management structures to handle current and future environmental requirements. A detailed compliance audit of applicable regulations was not conducted.

During a meeting with personnel from the USACE, NAVORDSTA, Sirrine and Radian, a list of general environmental issues were identified and emphasized. As a result of the audit, these issues have been ranked relative to the overall potential impact to the NAVORDSTA. The issues are:

1. Open Burning/Open Detonation
2. Waste Minimization
3. Air Emissions
4. Environmental Restoration
5. SARA Title III
6. Wastewater
7. Solid Waste Processor

8. LOVA
9. Hazardous Waste Generation and Storage
10. Environmental Management Systems

The ranking should be considered preliminary and is based upon Sirrine's and Radian's perception of the urgency of needed changes to either achieve regulatory compliance or obtain the resources needed to achieve compliance.

The issues are briefly described below for introductory purposes and are discussed in detail in separate sections of this report. The reader should keep in mind the issues are interrelated and a comprehensive approach or plan is often required to obtain the necessary solutions. The recommendations summarized in the Executive Summary are also discussed more fully in individual sections.

1. Open Burning/Open Detonation Units

The NAVORDSTA operates three open burning/open detonation (OB/OD) areas for the thermal treatment of explosive hazardous waste on the banks of the Mattowoman Creek. The units are regulated by EPA Region III under 40 CFR 264 Subpart X. The NAVORDSTA submitted a Subpart X permit application for the OB/OD units on November 1, 1988 to maintain interim status and thus continue operation. Disposal of explosive contaminated waste is critical to the operations at the NAVORDSTA. Areas of concern to the NAVORDSTA regarding the OB/OD units are:

- The large quantity of explosive contaminated waste generated and burned;
- Air emissions from the burning of explosive contaminated waste;
- The location of the burn areas in the 100 year flood plain of the Potomac River Basin; and
- Future Subpart X permitting requirements.

2.0 OPEN BURNING/OPEN DETONATION UNITS

The Naval Ordnance Station (NAVORDSTA) at Indian Head generates a variety of explosive, propellant, and explosive-contaminated wastes as a result of production operations, and experimental activities. There are three established locations (OB/OD units) on Station where these wastes have been or currently are being thermally treated. Regulatory and technical issues were examined to review the current status of the OB/OD units, and to identify areas of concern that could affect the continued operation of these units at Indian Head.

Information was obtained by (1) conducting interviews with key Indian Head personnel knowledgeable with the regulatory and technical aspects of the OB/OD units, (2) a review of the NAVORDSTA draft RCRA Part B permit application for the thermal treatment of explosive hazardous wastes (previously submitted November 1988 to the U.S. EPA Region III) and guidance recommendations propsed by the Institute of Makers of Explosives in their draft version of the "RCRA Guidance Manual for Permitting Commercial Explosives Industry Open Burning/Open Detonation Units, and (3) physical inspections of the three thermal treatment units, including the witnessing of a thermal treatment burn at one of the units.

2.1 BRIEF DESCRIPTION OF OB/OD UNITS

The three OB/OD units located at Indian Head are:

- Production Thermal Treatment Point at the end of Strauss Avenue;
- Safety Thermal Treatment Point near the Production Thermal Treatment Point, adjacent to Strauss Avenue; and

- Caffee Road Thermal Treatment Point at the end of Caffee Road adjacent to Mattowoman Creek.

2.1.1 Production Thermal Treatment Point

The Production Thermal Treatment Point is located on a spit of land extending into the Mattowoman Creek on the southwest end of the Indian Head peninsula. This unit is currently where the majority of the explosive and explosive-contaminated wastes are thermally treated. In the past, explosive wastes were placed directly on the ground and ignited remotely, with the exception of explosive-contaminated solvents, which were treated in an above-ground vessel. Burn pans have recently been installed in an effort to prevent thermal treatment residues from contacting the ground surface.

2.1.2 Safety Thermal Treatment Point

The Safety Thermal Treatment Point is also located on a spit of land extending into the Mattowoman Creek, approximately 1000 feet northwest of the Production Thermal Treatment Point. Until recently, this unit has been a location for the thermal treatment of explosive wastes, usually in smaller amounts than the Production Thermal Treatment Point. This unit is also used for the experimentation and testing of explosive materials (not wastes). In late 1988, approximately 100 drums of contaminated soil from an area at the Safety Thermal Treatment Point were removed and sent off site for disposal. Thermal treatment activities have been temporarily suspended at this unit at the request of the State of Maryland; however the explosive testing portion of the Safety Thermal Treatment Point is still operating.

2.1.3 Caffee Road Thermal Treatment Point

The Caffee Road Thermal Treatment Point is located on the southwest end of the Indian Head peninsula, approximately 2000 feet east of the Production Thermal Treatment Point. Materials that are thermally treated at the Caffee Road Thermal Treatment Point include various types of decommissioned or scrapped equipment. These materials are thermally treated as a precaution, and may include empty ammunition containers, spent rocket motors, and smaller amounts of non-metal wastes (e.g., cardboard, rags, packing materials) from explosive production facilities. Because these wastes do not ignite readily, supplemental fuels such as oil and wooden pallets are added to aid in the flashing process. Much of the material at the Caffee Road Thermal Treatment Point is then demilitarized and sold as scrap. Much of the metal waste treated at the Caffee Road unit will eventually be thermally treated in a "solid waste processor," designed to flash the scrap material in an enclosed unit.

2.2 REGULATORY STATUS OF THE OB/OD UNITS

Thermal treatment of explosive hazardous wastes is a hazardous waste management activity requiring a RCRA permit. Presently, the thermal treatment units at Indian Head are not covered by a RCRA permit, although a Part B permit application was submitted in November 1988. The Indian Head facility originally obtained interim status under RCRA through the submittal of a Part A permit application in 1980. At that time, the OB/OD units were regulated under the interim status thermal treatment standards in 40 CFR Part 265, Subpart P. These standards are not very substantive, and consist primarily of a prescribed set of minimum safe distances for OB/OD activities, and a prohibition on the open burning of any hazardous waste other than explosive waste. The State of Maryland received authorization to implement the RCRA program (pre-HSWA) on February 11, 1985, and presently the OB/OD units are regulated under similar standards in COMAR 10.51.05.16(F).

On December 10, 1987, the U.S. EPA promulgated standards for the permitting of miscellaneous units, including OB/OD units (40 CFR Part 264, Subpart X; see 52 FR 46946). Until the State of Maryland adopts similar permitting standards for OB/OD units (which is ultimately required), the U.S. EPA is responsible for the review and issuance of RCRA permits for miscellaneous units.

Since the OB/OD units at Indian Head had interim status as of 1984 (the date of HSWA enactment), Part B permit applications for Subpart X units were required to have been submitted by November 8, 1988; this deadline was met with the submission of a Part B application covering the Indian Head OB/OD units to the U.S. EPA Region III. Due to the lack of any U.S. EPA guidance for OB/OD permits, and the short time period (11 months) between the promulgation of miscellaneous unit permitting standards and the deadline for Part B submission, the Subpart X permit application for the Indian Head thermal treatment units is still being revised by the contractor responsible for writing it. A draft version of a Guidance Manual for OB/OD units was prepared by the Institute of Makers of Explosives for the Office of Solid Waste and submitted to the EPA on August 18, 1988. A review of this draft, along with the December 16, 1988 comments from the EPA, indicate that there are several areas in which the existing Part B application would be deficient if these guidance recommendations are adopted.

The U.S. EPA has congressionally mandated deadlines for the issuance (or final denial) of RCRA permits, including permits for miscellaneous units that had interim status as of 1984 (see RCRA Section 3005(c)(2)). The deadline for the issuance (or final denial) of the Subpart X permit for the Indian Head OB/OD units is November 8, 1992. Submission of the Part B application on time (as was done) ensures that the OB/OD units at Indian Head can continue to operate should the U.S. EPA fail to make a final determination on the Subpart X permit application by November 8, 1992.

2.2.1 RCRA Permit Standards for OB/OD Units

The NAVORDSTA Environmental Policy Formulation Branch has responsibility for the Part B permit application for the OB/OD units. The permit application was written by a consultant (Tech International), and although already submitted, it is still being revised. The version of the Part B application that was reviewed for this assessment made indirect references to the principal regulatory standard unique to Subpart X units; the environmental performance standard. Because the miscellaneous unit provisions are intended to cover many potentially different types of hazardous waste management units, the Subpart X permitting standards were written with a strong emphasis on controlling the migration of hazardous constituents into the environment, rather than on specific design or technical performance standards. As a result, the environmental performance standard (40 CFR Section 264.601) requires that three major pathways of contaminant migration be evaluated:

- Groundwater or Subsurface Environment;
- Surface Water, Wetlands, or Soil Surface; and
- Air.

Each pathway must be addressed in the Subpart X permit. With respect to each of the environmental pathways that must be evaluated in Subpart X permits, the U.S. EPA has stated, "...while each of these objectives must be addressed in the permit, a permit may not need to specify conditions that protect each of these environmental media." (52 FR 46955).

The permittee would need to perform a detailed hydrologic, geologic, and meteorologic assessment of the region surrounding the site (or the unit) as part of the permit process. If the assessments show that there will be no impact on a specific medium, the permit need not specify conditions to protect that medium. However,

preliminary hydrologic, geologic, and meteorologic assessments may suffice (at the discretion of the permitting agency) if the applicant can demonstrate that the environmental performance standard will not be violated for a specific medium or pathway. In the EPA's response comments to the draft Guidance Manual, the point is clearly made that preliminary assessments of each pathway will be required (pursuant to requirements of Section 3004(u) of RCRA) to determine:

- if there have been releases to ground-water, surface water, air or soil;
- if interim corrective measures or corrective measure studies are necessary; and
- whether permits must specify specific conditions.

Furthermore, the EPA states that these existing units will require "clean" closure by removal of all hazardous wastes and constituents, or otherwise "dirty" or "hybrid" closure as a landfill. This position by the EPA requires close monitoring in the future as it obviously impacts the current and future use of the existing three burn points.

2.2.2 Assessment of Contaminant Migration Pathways

Due to the nature and location of the OB/OD units at Indian Head, the migration of hazardous constituents into each of the three contaminant pathways identified in the environmental performance standard must be considered. The existing Subpart X permit application does address these pathways in a preliminary fashion, but considering the Draft Guidance recommendations and the comments by the EPA, these preliminary assessments would not satisfy the intent of the environmental performance standard as viewed by the U.S. EPA Region III. More detailed assessments will ultimately be required for one or more of these contaminant pathways.

- Groundwater or Subsurface Environment

There is no specific groundwater quality data or water level data for any of the OB/OD units, since none of the units currently have or previously have had any groundwater monitoring wells. In the Part B permit application, the entire threat to groundwater is discounted by geologic conditions and the anticipated unit design and management practices. Without specific guidance on miscellaneous units and the environmental performance standard, it is unclear whether or not these preliminary assessments are sufficient. Likely, additional controls would be required to totally prevent contaminant migration beyond the burn pans. The installation of burn pans and protective covers at the Production Thermal Treatment unit and the Safety Thermal Treatment unit, as well as routine visual inspection of treatment residuals, is the primary mechanism to avert contaminant migration into the groundwater and subsurface environment.

What is probably more significant, considering the closure stance that EPA has made, is the potential for existing subsurface contamination from past thermal treatment activities. Since two of the three OB/OD units have been operating for approximately 40 years, the subsurface environment (including sediments in the Mattowoman Creek) likely have already been impacted by the migration of hazardous constituents from the thermal treatment units. Previous contamination would need to be evaluated as part of the corrective action portion of the permitting process (i.e., RCRA Sections 3004(u) and (v)). However, the extent and location of existing contamination could provide useful information in any design and operating modifications of the OB/OD units being permitted.

- Surface Water, Wetlands, or Soil Surface

All of the thermal treatment units at Indian Head are located adjacent to surface waters, and are within the designated 100-year flood plain. Treatment has historically

been performed directly on the ground in most cases. However, containment devices ("burn pans") have recently been installed at the Production Thermal Treatment Unit, and much of the scrap waste presently handled at the Caffee Road Thermal Treatment Unit will be treated in the solid waste processor, once the unit has been built. As with the groundwater and subsurface considerations, it is intended that the installation of burn pans and protective covers, together with appropriate management practices, will prevent hazardous constituent migration into surface waters and soils.

Procedures outlined in the Subpart X permit application, intended to prevent contaminant migration to surface waters and surrounding soils in the event of a flood, appear rather involved and possibly difficult to implement correctly if a flood did occur. The only alternative to avoid flood conditions would be to relocate the OB/OD units to higher elevations on Indian Head. A risk assessment evaluating the potential impact of a release of hazardous constituents to surface waters in the event of a flood may be necessary if the permitting agency views this situation as a high priority. The regulatory requirements for floodplains require that the facility must prevent washout from such a flood. The nature of OB/OD would require the immediate relocation of all materials to an alternative location. Safety and logistics aspects of such an operation may prove difficult to support in the application. These factors would need to be weighed against the feasibility of safely conducting OB/OD activities elsewhere on Indian Head.

No mention was made in the Subpart X permit application of potential wetlands impacts, although there is an area that might be considered wetlands present along the Mattowoman Creek. The prevention of waste migration to surface waters may serve to protect nearby wetlands. The classification of these marsh areas needs to be evaluated to confirm whether or not these areas need to be addressed in the Subpart X permit.

The soils at the OB/OD units have already been impacted by hazardous constituents released from thermal treatment activities. Contaminated soil removal has been conducted at the Safety Thermal Treatment Point. The installation of burn pans and protective covers will reduce further soil contamination, however there will be a certain amount of ejecta from kick-out and other materials coming in contact with soils and shallow creek sediments in the areas outside of the burn pans, particularly at the Production Thermal Treatment Point. Soil and sediment sampling in these areas may provide information as to the quantity and type of constituents that have escaped the immediate treatment area. If this appears to be a significant pathway of contaminant migration, this may provide further incentive to move the OB/OD units further inland, where a larger area of surface soils can be protected.

- Air

Problems associated with the assessment of releases of hazardous constituents to the air are one of the primary concerns identified in speaking both with Indian Head personnel and with a representative of U.S. EPA Region III. Whereas other constituent pathways can be evaluated and in many cases protected, explosive detonations and deflagrations produce large, albeit intermittent, releases to the ambient air.

The Subpart X permit application recognizes the need for further study of the wastes being thermally treated at NAVORDSTA, to assess the quantities and types of hazardous constituents being released into the air. If certain other equipment is required at the OB/OD units to control releases to other media (e.g., open top enclosures, protective shields, etc.), an evaluation would need to consider to what extent such configurations would affect the thermal treatment conditions and the resultant combustion products released to the air. Without ambient air monitoring data to quantify air emissions from thermal treatment operations (due to difficulties in sampling large deflagrations), extensive modelling must be performed to characterize

these emissions. Only after the air emissions have been characterized more accurately can decisions be made regarding the necessity to control or eliminate the release of specific constituents, or whether controls are even necessary. The U.S EPA and state agencies are likely to look to the Department of Defense to provide guidance to some of these air-related issues associated with OB/OD activities.

2.2.3 Corrective Action at OB/OD Units

The U.S. EPA Region III currently is the agency with RCRA corrective action authority in the State of Maryland. These authorities are implemented simultaneously with or at any time after the issuance of a final RCRA permit. At NAVORDSTA, the overall facility has a RCRA operating permit covering the storage of hazardous waste. It is through this operating permit that the corrective action requirements of RCRA can be implemented for the OB/OD units; it is not a prerequisite that the OB/OD units receive unit-specific Subpart X permits for corrective action to be undertaken at these units.

After a discussion with the U.S. Region III contact in charge of corrective action at NAVORDSTA, it appears unlikely that the corrective action process will result in remediation at the active OB/OD units until it is decided how these units will be permitted. The rationale from the regional corrective action contact was that until sufficient controls are implemented at the OB/OD units through the permit process. It does not make sense to clean up the units, only to have them re-contaminated by resuming thermal treatment activities. The exception to this may be the temporarily closed portion of the Safety Thermal Treatment Point.

The importance of understanding the corrective action process at the OB/OD units, aside from being able to anticipate costs associated with these activities, is that the potential for corrective action at these units will affect the current design and modification of these units. If, for example, a permanent structure is being installed

at one of the OB/OD units where soil contamination exists, there may be a need in the future to sample and/or remove soil from areas underneath this structure. This situation may be avoided by sampling the areas prior to construction, in consultation with the State, to document the levels of contamination.

2.3 SUMMARY

Based on information available for review during this audit, the permit process for the OB/OD units is being handled in an appropriate manner by NAVORDSTA. The permit application was submitted on time. Communication has been maintained between the regional permit contact, the contractor who is writing the permit application, and DOD agencies knowledgeable in technical and regulatory areas of OB/OD activities. Subpart X permittees are waiting for U.S. EPA headquarters to issue the OB/OD permit guidance. Because of some of the more unique aspects of the NAVORDSTA OB/OD units (e.g., proximity to surface waters, nature of wastes generated, etc.), there are issues specific to Indian Head not spelled out in any forthcoming guidance. In these cases, the U.S. EPA Region III can not necessarily dictate what is expected in the Subpart X permit, without first listening to proposals from the permit applicant.

The minimization of explosive wastes at NAVORDSTA, while certainly not eliminating the need for thermal treatment altogether, would help ease the facility's dependance on the current level of OB/OD treatment activity. A review of the methods in which explosive wastes are identified, particularly those wastes deemed "explosive-contaminated," might also reduce the volume of wastes traditionally sent to the burn points for treatment.

Alternative treatment units, such as the solid waste processor for the Caffee Road Thermal Point wastes, could be constructed and permitted to incinerate various explosive-contaminated wastes. In the long term, there will be increased pressure from regulatory agencies to eliminate routine open burning altogether, particularly as alternative technologies

are developed. It would be to the facility's advantage to have alternative plans and procedures thought out in advance should OB/OD activities be severely restricted in the future.

2.4 RECOMMENDATIONS

The findings of our review of the current operation at NAVORDSTA, combined with the rapidly changing regulatory environment surrounding OB/OD activities nationwide, suggest that it would be prudent on the part of NAVORDSTA management to investigate the potential improvements and alternatives to the existing practices used at Indian Head. An OB/OD alternative evaluation feasibility study should be immediately begun as the permitting deadline is approaching.

The recommendations we offer recognize the need for continued OB/OD activities now and in the future at Indian Head. However, we have identified several areas in which potentially significant improvements are both practicable and available. Additional consideration should be made toward developing plans and ideas for future alternative methods to deal with the disposal of the OB/OD wastes as well.

2.4.1 Waste Minimization, Segregation, Recovery

A process-by-process evaluation and optimization evaluation should be performed to identify areas or procedures where waste generation can be reduced. This evaluation would not only consider means of reducing the quantity of material generated, but would also identify ways of increasing the usefulness of the waste in terms of its treatability, recovery potential, homogeneity for further processing and its degree of hazard or toxicity impacting final disposal. Commingling of various initially separate waste materials is the principal source of uncertainty surrounding the identification and handling of any waste stream. With explosive waste, this uncertainty necessitates

treatment only by OB/OD, for justifiable safety reasons. Segregation or separation, if feasible, at the source of generation, could result in a waste stream that may be handled by means other than OB/OD. These could include recovery and reuse of the material or more environmentally sound disposal methods such as controlled thermal or chemical destruction with appropriate pollution abatement technologies included.

2.4.2 Advanced Alternative Treatment Technologies/Methods

The solid waste processor currently planned for NAVORDSTA is the first of several options that should be investigated to reduce dependence on OB/OD. It should be evaluated for application of other waste streams currently produced at Indian Head. Modifications in both the management of waste produced and in the processes generating the waste, could lead to expanded use of the processor.

Several other alternative treatment options are possible and should be fully analyzed for use. Briefly, technologies that could be appropriate, include:

- Incineration
- Wet Air Oxidation
- Molten Bath Oxidation
- Fluid Bed Combustion
- Alkaline Destruction
- Solvent (aqueous and organic) Solubilization with subsequent Incineration
- Submerged (liquid or solid) Detonation
- Solvent Vacuum Distillation

These alternate treatment methods would require development after an initial review and characterization of each waste stream. Commercial, off-the-shelf technology is not generally proven on these waste streams. Therefore, some level of testing and process development should be anticipated.

2.4.3 Current Facility Upgrade

The present plan to use burn pans at the Production Thermal Treatment Plant and the Safety Thermal Treatment Plant is a significant step forward. These containment devices should be evaluated fully for efficiency of preventing waste contact with soil and surrounding surface waters by way of washout, leakage, or kick-out.

Secondary containment systems which include a diked, thermally insulated concrete pad should also be evaluated to provide soil and surface water protection. Such a system could also be utilized in place of the fabricated pan for large burns in which the residues are nonhazardous (as with black power, for example). Additionally, covers for the burn pans during processing, such as wire mesh made of expanded metal, should be employed to minimize kick-out. Similar, containment devices are in common use throughout the county. Open burning in direct contact with soil is becoming much less acceptable than it has in the past. Sirrine recommends the NAVORDSTA eliminate all direct contact burning at all three sites, and develop the burn pan method to its full capability.

2.4.4 Range Relocation

Recognizing the continuing need for an OB/OD operation in light of the developments regarding permitting of OB/OD in the nation, we recommend that alternate sites be investigated for this operation. Known contamination has been identified at the Safety Thermal Treatment Point and most likely exists at both Production Thermal Treatment Point and Caffee Road Thermal Treatment Point. This situation will necessitate some level of remediation prior to any future modification of the operation at these sites. Furthermore, difficulty in getting these contaminated sites permitted and the corresponding delays during clean-up could significantly disrupt operations.

The ability of NAVORDSTA to function economically and productively without the capability to perform on-site OB/OD is doubtful. Offsite disposal/treatment at either another military range or a commercial facility would severely limit the flexibility of the station. We feel a programmatic approach to developing OB/OD at Indian Head would be successful. The program would consist of revising and resubmitting the Part B application in accordance with a guidance document when issued. In preparation for this resubmittal, steps should be taken immediately to evaluate and implement the recommendations we have made and the findings resulting from further study, if appropriate. A proactive approach will provide the most benefit to NAVORDSTA during this period leading up to and beyond the issuance of a permit.

5.0 ENVIRONMENTAL RESTORATION ISSUES AT NAVORDSTA

The Naval Ordnance Station (NAVORDSTA) at Indian Head is a facility that has been active for nearly one hundred years. The production, testing, and research operations that are associated with ordnance manufacture typically involve the use or generation of various types of hazardous substances. Over the years, there have been both unpermitted and accidental releases of hazardous substances and constituents into the environment at Indian Head. Although chemical handling and waste management practices have improved, releases can still occur.

The releases of hazardous substances and constituents at the NAVORDSTA are presently being addressed by several state and Federal environmental programs designed to prevent or minimize further releases, and to reduce or eliminate potential threats to human health and the environment from previous releases. Because of the potential overlap of regulatory authorities designed to meet this latter objective, it is important that this objective be achieved in a manner that is as effective as possible, and to avoid duplicative efforts or needless delays. Understanding each of the statutory and regulatory authorities associated with environmental releases, specifically the RCRA (Resource Conservation and Recovery Act), CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act), and IR (Installation Restoration) programs, allows for the better management of the activities associated with each.

Information on existing waste sites was obtained by (1) conducting interviews with key NAVORDSTA personnel knowledgeable with the environmental and regulatory programs affecting the facility, (2) a review of relevant reports and documentation associated with these programs at Indian Head, and (3) discussions with regional U.S. EPA personnel overseeing the RCRA and CERCLA activities at the Indian Head NAVORDSTA facility.

5.1 CERCLA AND IR ACTIVITIES AT NAVORDSTA

In 1983, an Initial Assessment Study (IAS) was completed for the Indian Head and Stumpneck facilities to identify and assess those sites that may pose potential threats to human health and the environment. The IAS report identified 38 potential sites (29 on Indian Head) where releases or threats of releases of hazardous substances were suspected or known. The IAS also recommended that Confirmation Studies be performed at 5 of the sites. The IAS was submitted to both the U.S. EPA Region III and to the State of Maryland on July 20, 1984. Following the completion of the IAS, a Confirmation Study (CS) was completed in 1985. This CS identified 3 out of the 38 sites listed in the IAS as requiring either additional monitoring (2 sites) or remedial action (1 site). Further Confirmation Studies at two other sites were also recommended. This CS was submitted to both the U.S. EPA Region III and to the State of Maryland on November 19, 1985. A Remedial Alternatives Evaluation Report was completed in June, 1988, recommending specific remedial actions at the site for which remediation was recommended in the CS report.

By 1989, the State of Maryland had submitted comments on the IAS to U.S. EPA Region III, critical of the IAS and recommending that additional work be performed to further evaluate many of the sites identified in the IAS. In August, 1989, the U.S. EPA in Region III (Federal Facilities Section) submitted to Indian Head a letter stating that there was not enough information from the sites on Indian Head to complete a Hazard Ranking System (HRS) score for the facility, and that additional data needed to be collected. Attached to this letter was the State of Maryland's comments on the IAS and a preliminary HRS score (32.5) calculated for the Indian Head facility based solely upon a mercury contaminated location on Indian Head.

5.1.1 CERCLA Reauthorization and Federal Facilities

The CERCLA process involves several stages in evaluating sites where releases or threats of release of hazardous substances have been identified. A preliminary assessment (PA) is designed to determine the nature and extent of a release, and to recommend either further study (through a site inspection (SI)), or no further action (NFA). Site inspections are intended to determine in more detail the nature and extent of the release, and to collect sufficient data to score the site using the HRS. The IAS and CS studies under the IR program are essentially equivalent to the PA/SI under CERCLA.

Sites with HRS scores of 28.5 or higher are subsequently proposed for inclusion on the National Priorities List (NPL). Once on the NPL, a Remedial Investigation/Feasibility Study (RI/FS) is conducted to evaluate the site contamination in detail, and to propose remedial alternatives for cleaning up the site. Once a remedy is selected (through the signing of a Record of Decision, or ROD), remedial activities are initiated.

In 1986, the CERCLA program was changed by the Superfund Amendments and Reauthorization Act (SARA). SARA contained important revisions not only to the CERCLA process described above, but also to how the CERCLA program affects federal facilities. These revisions included a requirement to reassess those PAs where no corresponding SI had been performed. Determining which PAs would be reassessed would be at the discretion of the U.S. EPA regional offices.

SARA also made it clear that the CERCLA provisions applied to federal facilities in the same manner as private facilities. Section 120(c) of CERCLA as amended required the establishment of a Federal Facilities Hazardous Waste Compliance Docket. This docket has three purposes:

- To identify the universe of federal facilities that must be evaluated to determine if they pose risk to public health and the environment;

- To compile and maintain the information submitted to EPA on those facilities under the provisions listed in section 120(c) of CERCLA; and

- To provide a mechanism to make this information available to the public.

The initial list of federal facilities in the Federal Facility Hazardous Waste Compliance Docket was published in the Federal Register on February 12, 1988 (53 FR 4280). The Naval Ordnance Station at Indian Head was included in this initial list (53 FR 4291). CERCLA section 120(d) requires that for any federal facility included in the Federal Facility Hazardous Waste Compliance Docket:

- A PA must be completed by April 17, 1988; and

- HRS scoring packages must be completed (where warranted by the PA) such that listing on the NPL will occur by April 17, 1989.

Additionally, under Executive Order No. 12580 (January 23, 1987). the governing federal agencies are responsible for performing PAs at federal facilities. EPA and the states are not authorized to perform them.

As a result of the request from the U.S. EPA Region III for a reassessment of the sites on Indian Head, the Naval Energy and Environmental Support Activity (NEESA) will be conducting additional studies at Indian Head in June of 1990. The NEESA study will assess previously identified sites on Indian Head, as well as recently identified sites. It is expected that the result of the NEESA study will be the development of an

HRS package, to determine whether or not the NAVORDSTA should be proposed for inclusion on the NPL.

Based on the request from the U.S. EPA Region III, the HRS package will use the criteria contained in the revised HRS (proposed December 23, 1988; 53 FR 51962), and not the existing HRS. The CERCLA statute requires that the existing HRS be used to score sites until the revised HRS is finalized (CERCLA Section 105(c)(I)); it appears, however, that the U.S. EPA intends to use the revised HRS for the Indian Head facility. The revised HRS cannot be officially used until it is finalized, which is expected in the summer of 1990. Should promulgation of the revised HRS be delayed significantly, this could delay the scoring process for the NAVORDSTA. Regardless of which HRS is used, it is clear that the NAVORDSTA will be evaluated for possible inclusion on the NPL.

5.2 RCRA CORRECTIVE ACTION AT NAVORDSTA

Concurrent with the CERCLA and IR activities at Indian Head, there has been RCRA corrective action activities as well. The Hazardous and Solid Waste Amendments of 1984 (HSWA) gave the U.S. EPA (and states granted corrective action authority) expanded authorities to require corrective action at facilities seeking RCRA permits. This allows the agency with corrective action authority to require that releases from any and all solid waste management units (SWMUs) be addressed as a requirement for obtaining a RCRA permit. The corrective action authorities are usually written into a facility's RCRA permit either concurrent with the issuance of a final permit, or when the permit is renewed. For RCRA facilities located in Maryland, the U.S. EPA regional office presently has corrective action authority, and is responsible for the corrective action portion of a facility's permit. RCRA permits in Maryland are renewed every three years, and the NAVORDSTA operating permit is currently being renewed (it expires April 1991). Since the Indian Head facility is a RCRA permitted facility, it is subject to corrective action authorities.

The corrective action process operates in a similar fashion to the CERCLA process. A RCRA Facility Assessment (RFA) is initially performed to identify the SWMUs at a RCRA facility. The RFA also identifies those SWMUs requiring a more detailed assessment; this is performed through a RCRA Facility Investigation (RFI). The RFI identifies which SWMUs require corrective action, and these units are then evaluated in a Corrective Measure Study (CMS).

The CMS will evaluate alternative corrective measures to address each of the SWMUs requiring corrective action, and a corrective measure or measures is then selected. Following the selection of a corrective measure, a Corrective Measures Implementation (CMI) is developed to design, construct, operate, maintain, and monitor the performance of the corrective measure or measures selected.

An RFA was conducted at the Indian Head and Stumpneck facilities, and completed in August, 1988. The RFA identified 78 SWMUs at both facilities, along with 13 "Areas of Concern." Most of the SWMUs identified in the RFI were also identified in the IAS performed at Indian Head in 1983. Currently, the U.S. EPA Region III is requiring corrective action at Stumpneck as part of the renewal of the Stumpneck RCRA permit, which expires November 13, 1990.

Discussions with the NAVORDSTA Environmental Policy Formulation Branch, and with RCRA and CERCLA personnel at the U.S. EPA Region III, have indicated that the SWMUs identified at the Indian Head facility will be addressed under CERCLA authorities, not under RCRA. This decision was made at the U.S. EPA regional level, and reflects their present opinion that most of the contamination at Indian Head would be better suited to a CERCLA response than a RCRA corrective action. The exception to this would be any contamination located at active RCRA-regulated units at Indian Head, where CERCLA authorities do not apply.

5.3 RCRA AND CERCLA OVERLAP AT NAVORDSTA

It should be stressed that the decision by the U.S. EPA Region III to address most of the contamination at Indian Head under CERCLA rather than RCRA is a decision that may change, and may be highly dependent upon NAVORDSTA being placed on the NPL. If Indian Head does become an NPL site, it has been stated by the U.S. EPA Region III that CERCLA will address the contamination at Indian Head; however, any contamination directly associated with RCRA units at the facility (e.g., the thermal treatment units) would likely remain under the RCRA corrective action process. If Indian Head does not score high enough for inclusion on the NPL, then it is likely that RCRA corrective action authorities alone would be used to address all of the SWMUs at Indian Head. If the State of Maryland becomes authorized to implement corrective action in the future, this could further complicate matters. State priorities may not favor the slow CERCLA process, and corrective action could end up addressing all of the contamination at NAVORDSTA.

Although it is official EPA policy to use RCRA corrective action authorities wherever possible, rather than CERCLA response authorities (see RCRA/NPL policy statements, 53 FR 30002 and 30005), this policy does not currently apply to federal facilities (see 52 FR 17991). In situations where there may be both CERCLA response and RCRA corrective action occurring simultaneously, it is important that these two programs are coordinated so that similar goals and cleanup levels are achieved by both programs.

5.3.1 Federal Facility Agreements

CERCLA Section 120(e) requires that once a federal facility is included on the NPL, the federal agency (e.g., DOD) and the EPA must enter into a federal facility agreement in which the remedial actions to be undertaken at the federal facility are outlined. The DOD has written a model language federal facility agreement for use

with DOD facilities on the NPL. Federal facility agreements are negotiated agreements, and states may participate as well.

In situations where there are federal facilities with both RCRA and CERCLA activities anticipated (as may occur should Indian Head be placed on the NPL), the federal facility agreement or Inter-Agency Agreement (IAG) can become a useful tool in delineating which portions of the facility will be handled by CERCLA, and which by RCRA. These agreements may also help in establishing uniform clean up standards between the RCRA and CERCLA programs. In a memorandum from the EPA Assistant Administrator of OSWER to the EPA Regional Administrators (January 25, 1988), J. Winston Porter stated,

> "... I encourage the use of a Section 120 IAG to incorporate both RCRA and CERCLA activities under one enforceable agreement and to serve as a comprehensive plan for investigatory and remedial activities at the facility, whether RCRA or CERCLA. EPA, the state, and the federal facility would agree on a facility wide strategy, setting priorities and schedules for action. If properly framed, the agreement would satisfy the facility's RCRA corrective action requirements, as well as the public participation requirements of Section 117 of CERCLA and Part 124 of RCRA."

Because of a large backlog of federal facility agreements awaiting negotiation (according to the U.S. EPA Headquarters), the NAVORDSTA should initiate discussions with EPA on the development of an IAG.

5.4 ENVIRONMENTAL RELEASES AT NAVORDSTA

There have been several investigations at NAVORDSTA designed to identify, assess, and in some cases remediate potential problems associated with the release of hazardous substances and hazardous constituents into the environment. This effort is still ongoing, with the potential for some of these releases to ultimately be addressed by either the Installation Restoration (IR) program, CERCLA response actions, or RCRA corrective actions.

There has also been a degree of overlap in some of these studies, where some releases (or potential releases) have been identified under both the IR program's Initial Assessment Study (IAS)/Confirmation Study (CS), and the RCRA Facility Assessment (RFA).

Regardless of which environmental program ultimately addresses these releases, it is important to evaluate which releases are the most significant in terms of potential, more immediate threats to human health and the environment, and which releases might require remedial action under the CERCLA, RCRA, and IR programs as these programs move forward within their respective schedules.

5.4.1 IRP Sites

The first comprehensive assessment of environmental releases at Indian Head, an IAS, was completed in 1983. The IAS referred to individual releases as "sites", and 29 sites were identified on the Indian Head peninsula. The IAS recommended further studies at five of these sites (two of these sites received conditional recommendations for further study), and the CS was completed in 1985 for three of these sites:

- Silver contamination (estimated 720 lbs of silver) in drainage and marsh areas adjacent to Building 731;

- Mercury contamination (estimated 146-245 lbs) in stream and tidal pond system adjacent to Building 766; and

- A closed landfill (Town Gut Landfill) which accepted varnish, paint sludges, barium sludge, bagged asbestos, and other wastes.

Remedial actions were recommended for only one of these sites (the mercury-contaminated stream and tidal pond system), and in 1985 300, 55-gallon drums containing mercury-contaminated soil were excavated and sent off site. The State of Maryland became involved in the mercury spill issue, requesting that NAVORDSTA conduct a mercury monitoring program for fish in the Mattawoman Creek. This study was completed and transmitted to the state in 1989; no evidence of abnormal mercury levels was found in the study. Samples from two drinking water wells located between NAVORDSTA and the Town of Indian Head were analyzed in 1985, and again in 1989, with no evidence of mercury contamination found. The mercury spill area is still undergoing study as part of ongoing IR activities at Indian Head.

The data from the mercury spill area was also used by the U.S. Region III in calculating a preliminary Hazard Ranking System (HRS) score for the Indian Head facility, as part of ongoing CERCLA activities. The mercury spill site resulted in a preliminary HRS score of 32.25 (listing criteria for the National Priorities List is 28.5).

5.4.2 RFA Identified Sites (RCRA)

In 1988, an RFA was conducted at the Indian Head facility as part of the RCRA permitting process. A total of 78 solid waste management units were identified, including 24 of the 29 sites identified in the original IAS from 1983. The RFA included active RCRA hazardous waste management units, which would not have been studied under the IR program.

Three open burning/open detonation (OB/OD) units were identified in the RFA. One of these units (Safety Thermal Treatment Unit) has apparently been the subject of a state enforcement action. Approximately 100 drums of soil contaminated with lead and acid residues were excavated and sent off site in 1988. The waste management portion of the Safety Thermal Treatment Unit has been temporarily closed pending additional soil analyses.

Another unit, the Caffee Road Thermal Treatment Unit, is located atop the closed Caffee Road Landfill. It was suggested by NAVORDSTA personnel that the state was discouraging the practice of open burning scrap metal and other explosive-contaminated debris, which is typically done by adding supplemental fuels such as oil (possibly waste oil) to the materials to be treated.

The RFA also identified another closed landfill (Bronson Road Landfill) that was included in the IAS, but was not recommended for further study under the IR program. This landfill is reported to have accepted paint sludges, zinc and lead, non-chlorinated solvents, and bagged asbestos.

5.4.3 Remedial Priorities

The sites/releases described above represent areas where further actions (including possible remedial actions) are anticipated due to previous responses at these sites, or where regulatory requirements may require further responses. The landfills were also mentioned because they represent relatively large areas where little or no subsurface investigation has taken place, and therefore the potential for releases of hazardous substances or hazardous constituents into the subsurface is high but relatively unknown.

All of the sites/releases identified in both the IAS and the RFA (except for active RCRA units) are scheduled to be reviewed as part of the IR program, primarily in response to concerns expressed by the State of Maryland and the U.S. EPA Region III. This reassessment may uncover additional priorities and newly identified releases at NAVORDSTA.

The mercury spill area is representative of a type of release that created much concern once the nature and extent of the contamination was known. A removal action was undertaken at the mercury spill area (the removal of 300 drums of contaminated soil), and this area, which is still being studied, has maintained a relatively high profile ever since. The other sites/releases described are more likely to be addressed as part of the ongoing IR activities in concert with the CERCLA program, except for the active RCRA units. These processes may take several years to be completed, after which significant monitoring and/or remediation may be required in some instances.

If additional investigations identify previously unknown or poorly characterized releases that create immediate concerns similar to those encountered with the mercury spill area, there may be additional high-priority, short-term removal or response actions undertaken. Otherwise, the time frame in which potentially extensive remedial activities might occur is likely to be defined by the state and Federal programs under which these actions are required, with the exception of environmental priorities established by the IR program and the NAVORDSTA facility itself.

5.5 SUMMARY AND RECOMMENDATIONS

It is uncertain exactly how the CERCLA, RCRA, and IR programs will ultimately be implemented at NAVORDSTA. It is important that if any IR activities are to be performed

at Indian Head in the future, it should be understood how the activities are affecting (or being affected by) existing or future RCRA and CERCLA activities. The Indian Head facility is currently on track (although behind statutory schedules) in the CERCLA process for NPL consideration, and may very well end up on the NPL (if the preliminary HRS score of 32.5 is accurate). If NAVORDSTA does become an NPL site, aside from the CERCLA implementation issues discussed here, there would be a need to plan for appropriate community relations as well.

The inconsistent ways that RCRA and CERCLA authorities can be implemented is very evident at Indian Head; while RCRA permit renewal is triggering RCRA corrective actions at Stumpneck, the same authorities are being deferred to the CERCLA program at Indian Head. These decisions can change as priorities change at the U.S. EPA regional level. It is important to keep in frequent contact with the regional (and state) personnel who are making decisions that affect the Indian Head facility. The NAVORDSTA should begin discussions with EPA Region III on an Interagency Agreement (IAG) in an attempt to develop consistent investigation/remediation methods and procedures. Once an IAG is negotiated, the NAVORDSTA should develop an Environmental Restoration Program Plan which addresses the approach, rationale, budget, and schedule for all CERCLA and RCRA sites exclusive of the OB/OD areas.

Master Plan Update

Naval Ordnance Station Indian Head, Maryland

Chesapeake Division, Naval Facilities Engineering Command

January 1990

Prepared for Chesapeake Division, Naval Facilities Engineering Command

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TABLE OF CONTENTS

	Page
1. Executive Summary	1-1
2. Introduction	2-1
Purpose and Use of the Plan	2-1
Processes Used to Develop the Plan	2-1
Description of Format	2-2
3. Background	3-1
Location	3-1
History	3-1
Real Property	3-4
Mission	3-12
Organization	3-12
Tenant Activities	3-18
4. Regional and Local Conditions	4-1
Climate	4-1
Natural Conditions	4-1
Local Development History	4-2
Land Use	4-2
Population	4-3
Economy	4-4
Utilities	4-4
Transportation	4-4
Community Facilities	4-5
Encroachment	4-6
5. NOS Environmental Features	5-1
Geology	5-1
Topography	5-1
Soils	5-4
Surface Water	5-4
Groundwater	5-12
Vegetation	5-12
Wildlife	5-15
Cultural Resources	5-16
Outdoor Recreation	5-18
Summary	5-19
6. Environmental Management	6-1
Air Quality	6-1
Wastewater	6-1
Stormwater and Sediment Control	6-2
Hazardous Waste	6-2
Non-Hazardous Solid Waste	6-6
7. Man-Made Features	7-1
Land Use	7-1
Facilities	7-4
Transportation	7-12
Utilities	7-18
Communications	7-36
ESQD	7-37
Navigational Danger Zone	7-40
8. Development of Concepts for Land Use Alternatives	8-1
Circulation, Safety and Security	8-1
Conflicts with Off-Station Uses	8-8
Stump Neck Expansion	8-10
Consolidation	8-10
Explosive Safety	8-12
Environmental Protection	8-13
9. Proposed Land and Facility Use Plan	9-1
Proposed Land Use Plan--Indian Head	9-1
Proposed Land Use Plan--Stump Neck	9-6

10. Preliminary Environmental Assessment (PEA)	10-1
Summary	10-1
Introduction	10-2
Existing Environment	10-2
Project Descriptions and Potential Environmental Concerns	10-3
11. Energy Conservation Plan	11-1
Action Programs	11-1
Policy Statement	11-2
Sensitivities and Assumptions	11-2
Energy Conservation Projects Completed Or In Progress	11-2
Engineering Service Requests	11-3
Proposed Energy Conservation Projects	11-4
Employee Awareness Programs	11-5
12. Bibliography	12-1
Capital Improvements Plan (CIP)	CIP-1
Planning Objectives	CIP-1
MILCON Project Descriptions	CIP-1
Unprogrammed Projects	CIP-8
Other Facilities Projects (Non-MILCON)	CIP-10
Recommended Projects	CIP-11

List of Figures

		Page
1-1.	Project Locations - Indian Head	1-2
1-2.	Project Locations - Stump Neck	1-3
3-1.	Location - NOS, Indian Head	3-2
3-2.	Real Property - Indian Head	3-5
3-3.	Real Property - Stump Neck	3-6
3-4.	Real Property - Remote Sites	3-7
3-5.	Organization - NOS, Indian Head	3-14
5-1.	Topography - Indian Head	5-2
5-2.	Topography - Stump Neck	5-3
5-3.	Soil Constraints - Indian Head	5-5
5-4.	Soil Constraints - Stump Neck	5-6
5-5.	Septic Limitations - Stump Neck	5-7
5-6.	Hydrology - Indian Head	5-9
5-7.	Hydrology - Stump Neck	5-10
5-8.	Vegetation - Indian Head	5-13
5-9.	Vegetation - Stump Neck	5-14
6-1.	Former Waste Disposal Sites - Indian Head	6-4
6-2.	Former Waste Disposal Sites - Stump Neck	6-5
7-1.	Existing Land Use - Indian Head	7-2
7-2.	Existing Land Use - Stump Neck	7-3
7-3.	Functional Areas - Indian Head	7-5
7-4.	Functional Areas - Stump Neck	7-6
7-5.	Facility Assets	7-10
7-6.	Existing Circulation - Indian Head	7-13
7-7.	Existing Circulation - Stump Neck	7-15
7-8.	Rail System - Indian Head	7-16
7-9.	Government Rail Spur - Indian Head	7-17
7-10.	Electrical System - Indian Head	7-20
7-11.	Electrical System - Stump Neck	7-21
7-12.	Water Consumption vs. Allowable Limits	7-23
7-13.	Low Silica Water System - Indian Head	7-24
7-14.	High Silica Water System - Indian Head	7-25
7-15.	River Water System - Indian Head	7-26
7-16.	Water System - Stump Neck	7-28
7-17.	Steam System - Indian Head	7-30
7-18.	Compressed Air System - Indian Head	7-32
7-19.	Sanitary Sewer System - Indian Head	7-33
7-20.	Sanitary Sewer - Stump Neck	7-35
7-21.	Inhabited Distance ESQD Arcs - Indian Head	7-38
7-22.	Inhabited Distance ESQD Arcs - Stump Neck	7-39
7-23.	Navigational Danger Zone	7-41
8-1.	Fence Realignment - Indian Head	8-2
8-2.	Proposed Circulation, Indian Head	8-4
8-3.	Recommended Improvements, Indian Head	8-5
8-4.	Indian Head Main Gate Phase I	8-6
8-5.	Indian Head Main Gate Phase II	8-7
8-6.	Proposed Circulation, Stump Neck	8-9
8-7.	Land Use Compatibility Matrix - NOS, Indian Head	8-11
8-8.	Development Constraints - Indian Head	8-14
8-9.	Development Constraints - Stump Neck	8-15
9-1.	Proposed Land Use - Indian Head	9-2
9-2.	Proposed Land Use - Stump Neck	9-3
CIP-1.	Project Locations - Indian Head	CIP-2
CIP-2.	Project Locations - Stump Neck	CIP-3

List of Tables

		Page
3-1.	Summary of Real Estate (Real Property) Aquisitions and Disposals	3-8
3-2.	Current and Projected Base Loadings	3-13
4-1.	Climate Summary	4-1
5-1.	Key to Wetland Symbols	5-8
5-2.	Common or Abundant Wildlife in Charles County, Maryland	5-17
7-1.	Facilities Construction	7-7
7-2.	Facilities Usage Summary	7-8
10-1.	Environmental Concerns for all Projects	10-1
10-2.	Potential Environmental Concerns for Specific Projects	10-2

1

Executive Summary

EXECUTIVE SUMMARY

The Naval Ordnance Station, Indian Head, located at the southern terminus of Indian Head Highway, 22 miles from Washington, DC, is involved in pilot operations for the development of ordnance and the production of specialized ordnance products. The Station is divided into two main operational areas; the Indian Head area, consisting of 2,009 acres and the Stump Neck area consisting of 1,171 acres.

This plan includes an analysis of existing conditions and recommendations for the future development of the Station and its major tenants, the Naval Explosive Ordnance Disposal Technology Center (NAVEODTECHCEN) and the Naval School, Explosive Ordnance Disposal (NAVSCOLEOD).

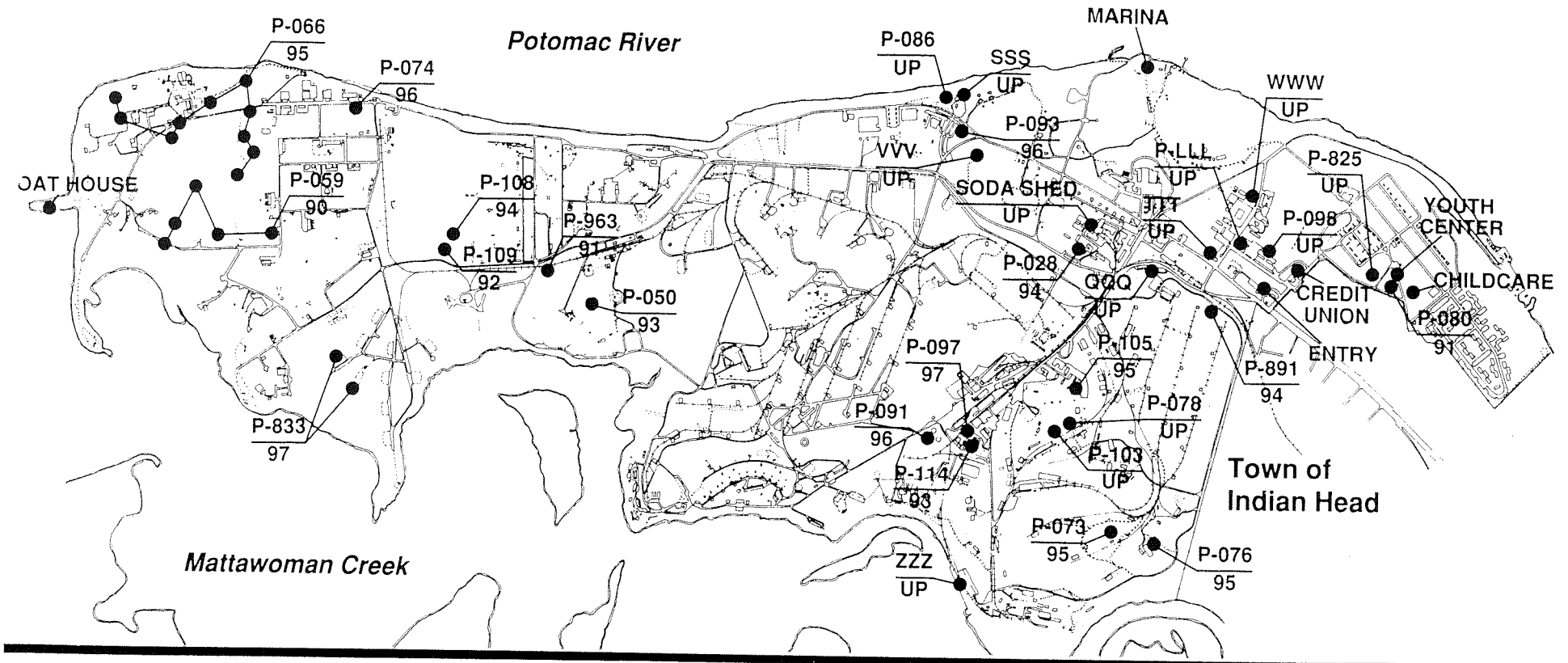
The key issues addressed in this plan are:

- The need for improved circulation patterns, especially as related to Station safety and security needs.
- The potential for conflict with off-site uses due to the steady increase in development in the vicinity of the Station.
- The need to consolidate uses to facilitate management and services.
- Construction of facilities to alleviate space problems and to efficiently organize the Station through careful project siting in the appropriate land use area.
- Development of administrative, community support and supply areas.
- The importance of protecting natural resources, recognizing limitations imposed by environmental features such as water supply availability, and ensuring compliance with all applicable environmental laws and regulations.

The major recommendations of this plan that address these issues are:

- Realignment of the restricted area perimeter fence to exclude work areas that do not need to be within the restricted area. Related recommendations are the creation of two new gates to the restricted area, improvements to circulation and functions at the main gate and pass office, and a perimeter fence around the entire Station.
- Designation of development-limited zones along portions of the Station to provide a buffer between the Station and off-site use areas, and to conserve sensitive environmental resources.
- Designation of land use areas based on use consolidation. A related recommendation is consideration of on-station land use compatibilities in siting decisions (see Proposed Land Use maps, pages 9-2 and 9-3).
- Consideration of natural resources in the siting of new projects, and in project design and construction. Specific recommendations in the form of a constraints map, siting guidelines, and sites for MILCONs (in the Capital Improvements Plan) are provided.

Specific project recommendations in the Master Plan that relate to the above issues and recommendations are provided in the Capital Improvements Plan, and are shown on the next pages (Figures 1-1 and 1-2).



INDIAN HEAD
Project Locations

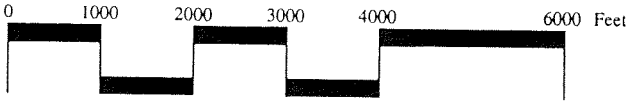
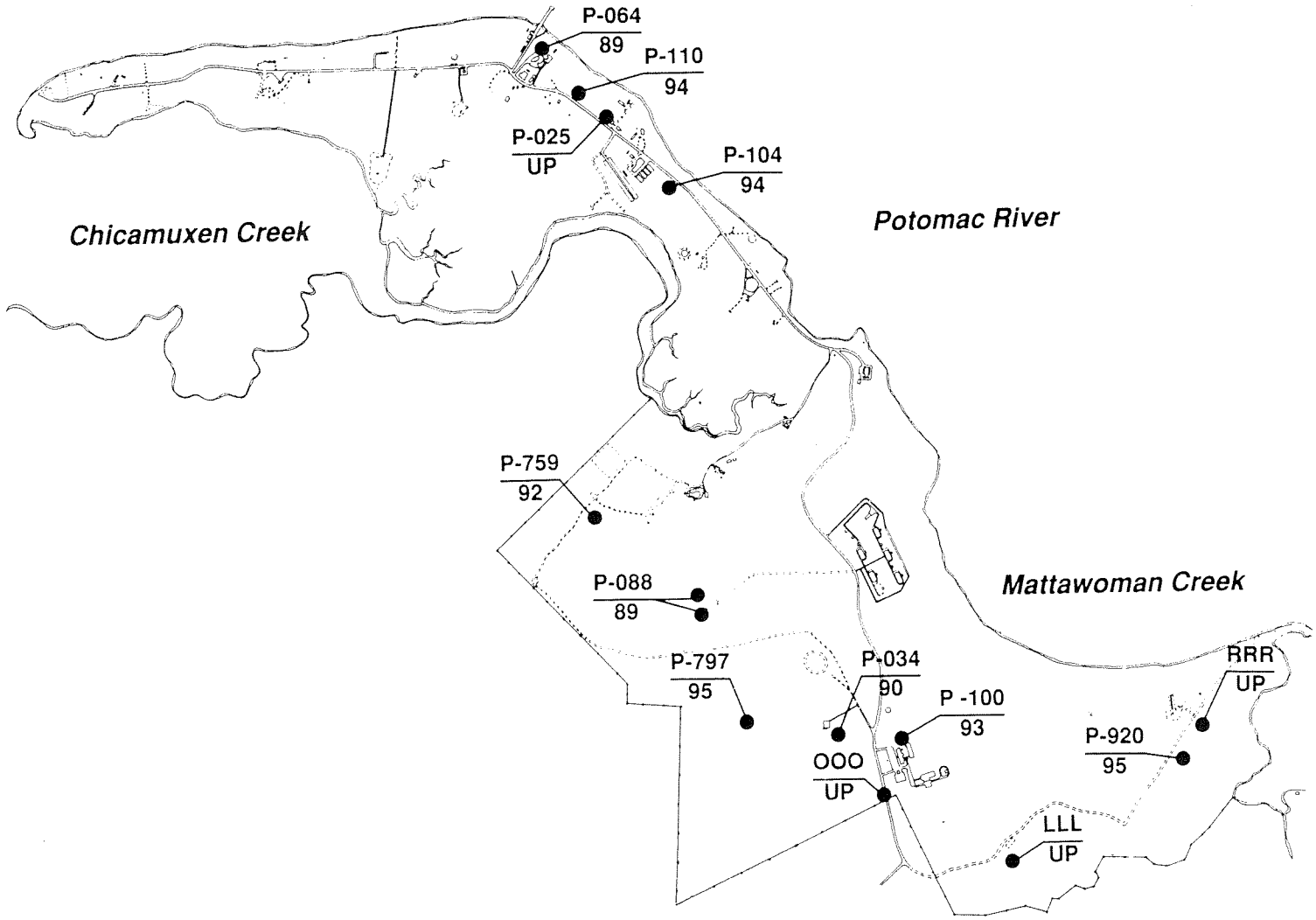


Figure 1-1

Naval Ordnance Station, Indian Head



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Naval Ordnance Station, Indian Head

2

Introduction

INTRODUCTION

The Master Plan Update for Naval Ordnance Station, Indian Head is the result of a comprehensive planning process designed to insure logical and efficient use of facilities and real property assets, and to guide growth and change. Projects are sited to meet operational, safety, and environmental requirements, with consideration of infrastructure support and site improvement needs. The Master Plan Update provides a vehicle for implementing planning recommendations and proposals, and serves as a compendium of factual material describing NOS, its mission, and the natural and built environments in which it operates. More detailed information on specific activities and requirements is contained in the Department and Station Strategic Plans. The strategic plans address mission-related strategies, resources, and managment; the Master Plan Update addresses the physical conditions (i.e., the natural and built environments) within which the strategic plans are carried out.

This Update has been prepared in accordance with OPNAV Instruction 1100.16A (Command Responsibility for Shore Activity Land Facilities), NAVFAC Instruction 11010.63B (Planning Services for Navy and Marine Shore Activities) and 11010.44E (Shore Facilities Planning Manual).

Purpose and Use of the Plan

The Master Plan Update provides a guide to development over a 20 to 25 year planning horizon. This guidance is in the form of a recommended long term land use plan. The Master Plan Update also includes specific guidance for a 5 to 7 year planning horizon, in the form of siting recommendations for specific projects identified in the Capital Improvements Plan, a part of the Master Plan. Project siting recommendations are consistent with the long term land use plan.

The Master Plan Update should be used by all project planners when making siting decisions for projects. This document provides information on both appropriate and inappropriate siting locations based on project function and existing natural and man-made constraints. The Master Plan Update can also be used as a convenient reference tool when information is needed about the natural and built environment. This document will either provide the information needed, or identify the references that contain more specific information.

Processes Used to Develop the Plan

The Master Plan Update is the result of extensive data collection at NOS and off-station. Two general types of data collection activities were conducted: interviews with knowlegeable personnel, and collection of existing documentation.

Formal interviews were conducted with command staff, all department heads and all tenant organizations. Follow-up interviews were held with key personnel when more specific information was required. The results of these interviews were incorporated into the planning process in several ways. Specific information about location and function was incorporated into mapping of current conditions. Information about problems and limitations pertaining to each organization, or to NOS in general was used to develop and evaluate land use alternatives.

Existing documentation related to the natural and built environments at NOS was gathered to determine opportunities and constraints for land use planning. The content of these documents is summarized and referenced in the appropriate sections of the Master Plan Update if the content has general applicability for land use decision-making (for example, availability and capacity of infrastructure, or construction limitations posed by natural features). This information is also used to guide the development and evaluation of land use alternatives.

Description of Format

Chapter 1, the Executive Summary, presents the Master Plan Update highlights and recommendations. Chapter 2 is this Introduction. Following this Introduction, the Master Plan Update begins with a Background chapter (Chapter 3) that provides a general description of the Station's history, previous real property transactions, and current mission and organization, including on-site tenants.

Chapter 4, Regional and Local Conditions, provides an overview of conditions surrounding the Station. The emphasis of this overview is to identify factors that may be relevant to the Station's operation now or in the future.

Chapter 5, NOS Environmental Features, describes on-site natural conditions. The emphasis of this chapter is to identify areas that may impose natural limitations to future development, and areas that offer opportunities for development or other use.

Chapter 6 describes the Environmental Management Programs at NOS. These are the programs directed toward controlling environmental releases from the Station in compliance with Federal and state regulations and other directives. All new development at NOS must be evaluated for consistency with existing environmental management programs.

Chapter 7 contains a description and analysis of Man-Made Features at NOS. These include the built environment, infrastructure, and hazard areas.

Development and analysis of alternative planning concepts are contained in Chapter 8. In this chapter, the various development challenges confronting NOS are discussed, and plans for meeting these challenges are described. The combined result of alternatives is presented as the Proposed Land and Facility Use Plan in Chapter 9. This chapter highlights the programmed and unprogrammed projects needed to accomplish the goals of the land and facility use plan. The Preliminary Environmental Assessment (PEA) for programmed MILCONs is presented in Chapter 10. The PEA is prepared as an integral component of the Master Plan, in compliance with the National Environmental Policy Act.

Chapter 11 presents the Energy Conservation Plan for NOS, Indian Head. This plan addresses specific conservation methods and recommendations for implementing a conservation program.

A list of references cited in or used to prepare this Master Plan Update is presented in the Bibliography, Chapter 12, which is followed by the Capital Improvements Plan (CIP) for the Station. The CIP is provided as removable document at the end of the Master Plan.

3

Background

BACKGROUND

Location

The Naval Ordnance Station (NOS), Indian Head, is located in the northwestern portion of Charles County, Maryland, 22 miles south of Washington, DC (see Figure 3-1).

Charles County is geographically located in the Atlantic Coastal Plain physiographic province, and is one of five counties which comprise the geographic region known as Southern Maryland. Southern Maryland is an irregularly shaped peninsula of 1,944 square miles, bounded on the south and west by the Potomac River, on the northwest by the District of Columbia, on the north by the Patapsco River, and on the east by the Chesapeake Bay.

Charles County adjoins Prince George's County to the north, and Saint Mary's County to the east; the county is part of the Southern Maryland Tri-County Council (with Saint Mary's and Calvert Counties). Charles County has also recently joined the Metropolitan Washington Area Council of Governments (COG), an organization of 15 area counties and municipalities in the Washington, DC area.

The principal facilities of NOS are located on the Indian Head peninsula, which is bounded on the west by the Potomac River, on the east by Mattawoman Creek, and on the north by the Town of Indian Head. Other NOS facilities are located on a nearby parcel of land known as Stump Neck. Stump Neck is bounded by Mattawoman and Chicamuxen Creeks.

The total land area of NOS is approximately 3,405 acres, of which 2,009 acres are within the boundaries of the Indian Head area and 1,171 acres are within the boundaries of the Stump Neck area. The remaining Station acreage is split among Bullets Neck (a 47-acre promontory in the Mattawoman Creek estuary), housing sites in Waldorf and La Plata (about 18 acres total) and a right-of-way for the White Plains Railroad which connects NOS, Indian Head to the CONRAIL junction at White Plains, Maryland (see Figure 3-1).

The primary access to NOS is via Indian Head Highway (Maryland Route 210), which terminates at the Station's main gate. Due to its location, NOS has enjoyed both a degree of isolation from the pressures of the metropolitan area and convenient access to that area.

History

The Naval Ordnance Station, Indian Head, has been prominent in local county history since its establishment as the Naval Proving Ground in 1890. Until 1900, the U.S. Naval Proving Ground was strictly a facility for testing and proving all powder purchased by the Department of the Navy and all naval guns turned out at the Navy Yard in Washington, DC. In addition, the facilities at Indian Head were occasionally used to evaluate the effects of different projectile types on armor plate. During this period, all provisioning and shipments into and out of the Naval Proving Ground were made across the Indian Head wharf on the Potomac River. In 1900, the Naval Proving Ground was the first to produce smokeless powder, on the Mattawoman Creek side of the present Station.

The Stump Neck Annex properties were purchased in 1901 as a matter of precaution because the testing of larger naval guns sometimes

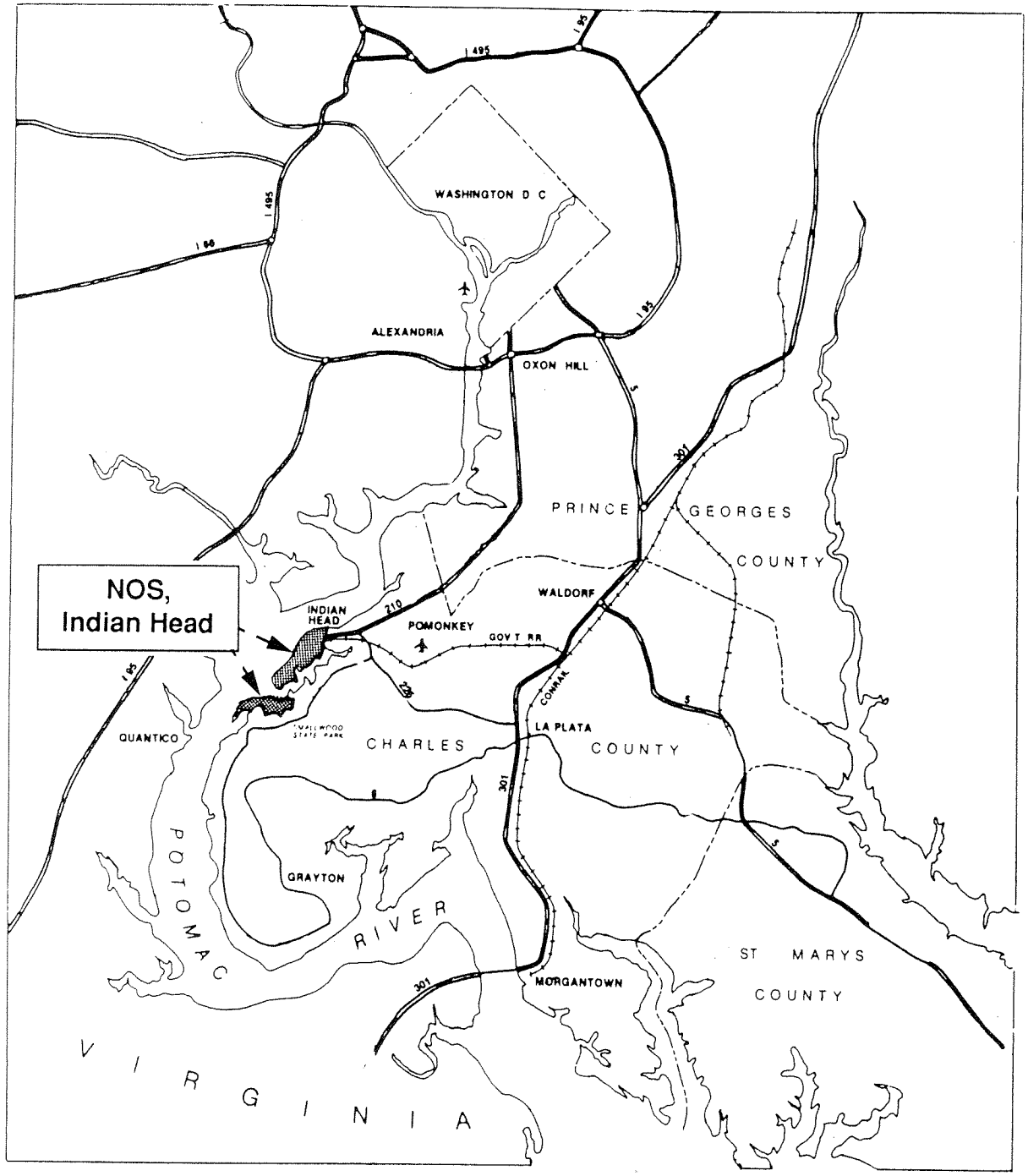


Figure 3-1
Location-
NOS, Indian Head

Source: Land Use Compatibility Study (1987).

resulted in inadvertent shelling of that property. Additional plant facilities on the single base gun propellants line and a new acid plant were built in 1915; the latter to offset the rising production costs resulting from increased sulfuric and nitric acid purchases.

In 1918, during World War I, the Station was enlarged by the purchase of 1,160 acres of adjacent land, and a 14.4 mile railroad spur was laid from the Naval Proving Ground to the Pennsylvania Railroad Junction at White Plains, Maryland. Finally, the hazards of shot and shrapnel exceeded the safety limits of the Station and in 1921 all proving ground activities were moved to Dahlgren, Virginia. In 1932, the Dahlgren Naval Proving Ground was established as a separate command and Indian Head was redesignated the Naval Powder Factory.

As World War II approached, smokeless powder was the mainstay gun propellant but it lacked a flashless quality. The Naval Powder Factory developed a technique for producing flashless powder and pellets. Coincident with the National Defense effort, new production facilities were built and new products were manufactured. Fundamental research in rocketry and rocket propellant grains for bombardment rockets, bazookas and air-to-ground anti-tank weapons began in 1940. A new Explosive "D" Plant was completed in 1942 and the Extrusion Plant with a new double-base product line began operations in 1943. Construction of Route 210 as a Defense Access Road was also completed in 1943 (jurisdiction was transferred to the state in 1954). As the war drew to a close in 1945, propellant research and development was added to the mission of the Station. This was followed in 1949 by the opening of the Patterson Pilot Plant for scaled-up experimental production.

The Korean conflict brought the Naval Powder Factory back to World War II status and four new production plants were built. The Station was redesignated as the Naval Propellant Plant in 1958. Following earlier development work in the Polaris Program, 23 new buildings for the manufacture of Polaris base grain were completed in 1960.

As the Naval Propellant Plant continued to grow in capability, an "on-line" computer facility for ballistic evaluation was completed in 1961 and nitroplasticizers were first produced for the Polaris Program. Manufacture of the X-248 Scout, a space-oriented program, was added to the plant capabilities in 1962. During the same year the Station developed Otto Fuel II, a liquid monopropellant for use in the Mark 46, Mod 1, and Mark 48 torpedoes. Inert diluent and pneumatic mixing processes were developed and, in 1966, the entire facility was redesignated the Naval Ordnance Station and approached maximum production capability in support of the Vietnam conflict.

Within the last 20 years, the Station has produced NACO, or Navy cool gun propellant, and high energy casting powder for the second stage of the C-3 Poseidon Missile.

After experiencing a surge of activity generated by the Vietnam conflict, the Station's workload was shifted from primarily a production facility to a highly technical engineering support operation. The Station has been designated by the Secretary of Defense to be the Engineering/Production Center for the Tri-Service Cartridge Actuated Devices/Propellant Actuated Devices Program. The Station also modified and reactivated two "mothballed" plants to produce UDMH for the Department of Defense when the only remaining private producer of this important chemical ceased its production. UDMH production has since been discontinued.

In 1976, the Station was assigned the task of producing 1,000 Standard ARM Rocket Motors. The following year the Station was designated the design agent for Standard Missile Motors.

Modernization of the Moser Nitrating Plant was completed in 1978, making the Naval Ordnance Station the most flexible producer of speciality chemicals in the free world.

In 1982, NOS developed the Standard Missile Extended Range and the Terrier Simulator MK 89. In 1983, the mothballed Polaris Plant was reactivated for limited production of Polaris Second Stage casting powder. Modification of the Polaris Plant facilities as a pilot production source for Low Vulnerability Ammunition (LOVA) propellant is now complete.

The Station was awarded the Secretary of the Navy's Energy Conservation Award in 1981. In 1983, the Station received 3 awards: Honorable Mention in the Secretary of the Navy's Energy Conservation Contest, the Secretary of the Navy's Meritorious Unit Commendation Award, and the Outstanding Business and Industry Award from the Maryland Association for Cooperative Education.

NOS was established as a Center of Excellence in 1987 to promote technological excellence in specialized fields. The six Centers of Excellence at NOS are:

- Energetic Chemicals
- Guns, Rockets & Missile Propulsion
- Ordnance Devices
- Explosives
- Safety & Environmental Protection
- Simulators & Training Shapes

Real Property

NOS is composed of ten separately identifiable sites in four discrete areas:

1) The Indian Head area, including the main Indian Head site, Hog Island, Thoroughfare Island and Marsh Island,

2) The Stump Neck area, which is made up of the Stump Neck site and Rum Point,

3) Bullet's Neck, a promontory near Rum Point, and

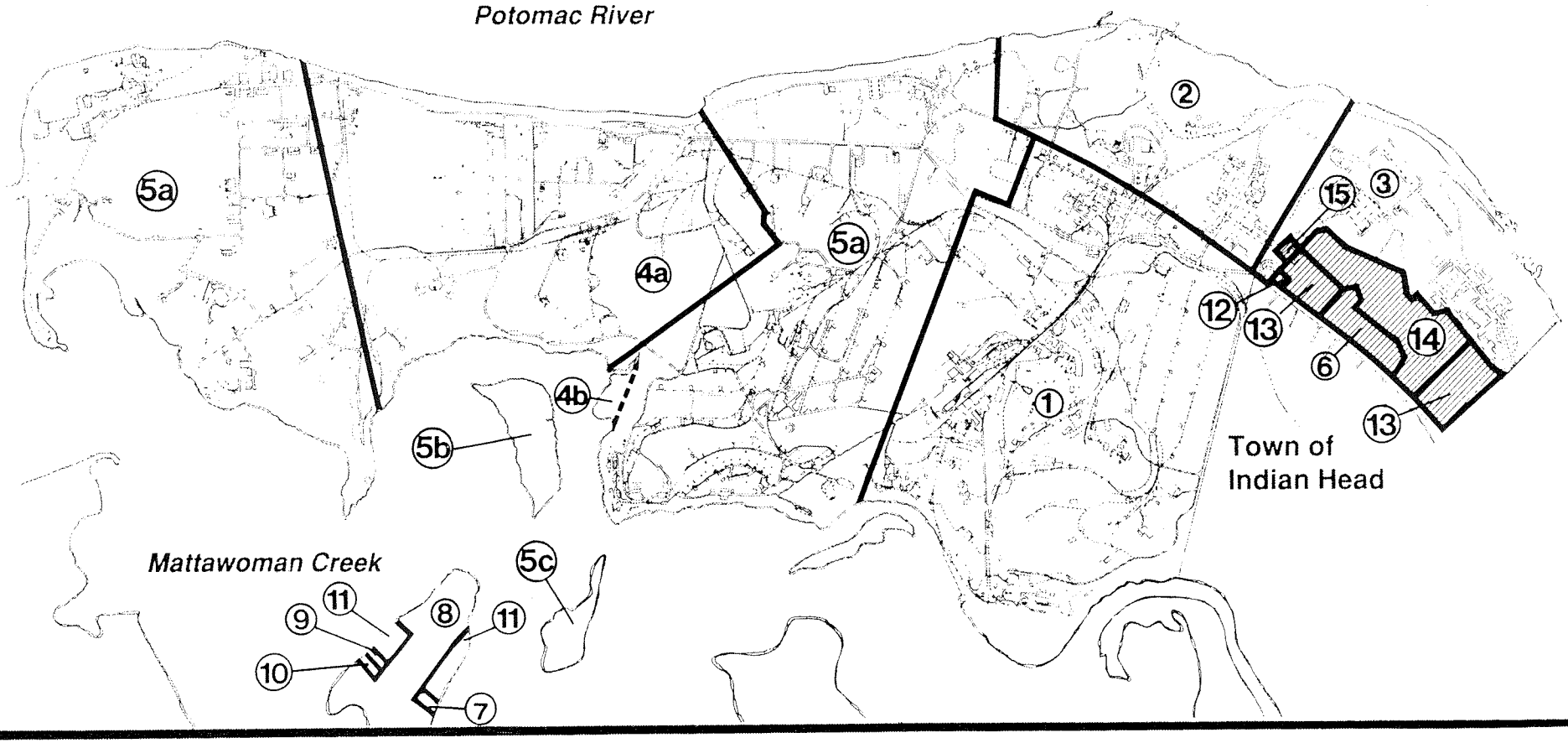
4) The remote sites owned by NOS: the White Plains railroad right-of-way, and two housing sites near La Plata and Waldorf in northern Charles County.

These areas are shown in Figures 3-2, 3-3 and 3-4, and are described in Table 3-1.

Acquisitions

All of the NOS land in the Indian Head area was obtained in five acquisitions that took place between 1890 and 1918. This area currently consists of about 2,009 acres including Hog Island, Marsh Island, and Thoroughfare Island.

The initial purchase was made in 1890 in the area then known as Cornwallis Neck. A total of 659 acres, in two parcels of 473 and 186 acres respectively, were acquired and the Naval Proving Ground was established on these tracts in the same year (see transactions 1 and 2, Indian Head Area, in Table 3-1). Another 222.75 acres, from a tract



INDIAN HEAD

Real Property

Source: NOS Public Works Engineering Division files, CHESDIV Real Estate Division files

LEGEND

Acquisitions (numbers are keyed to Table 3-1)

Disposals (numbers are keyed to Table 3-1)

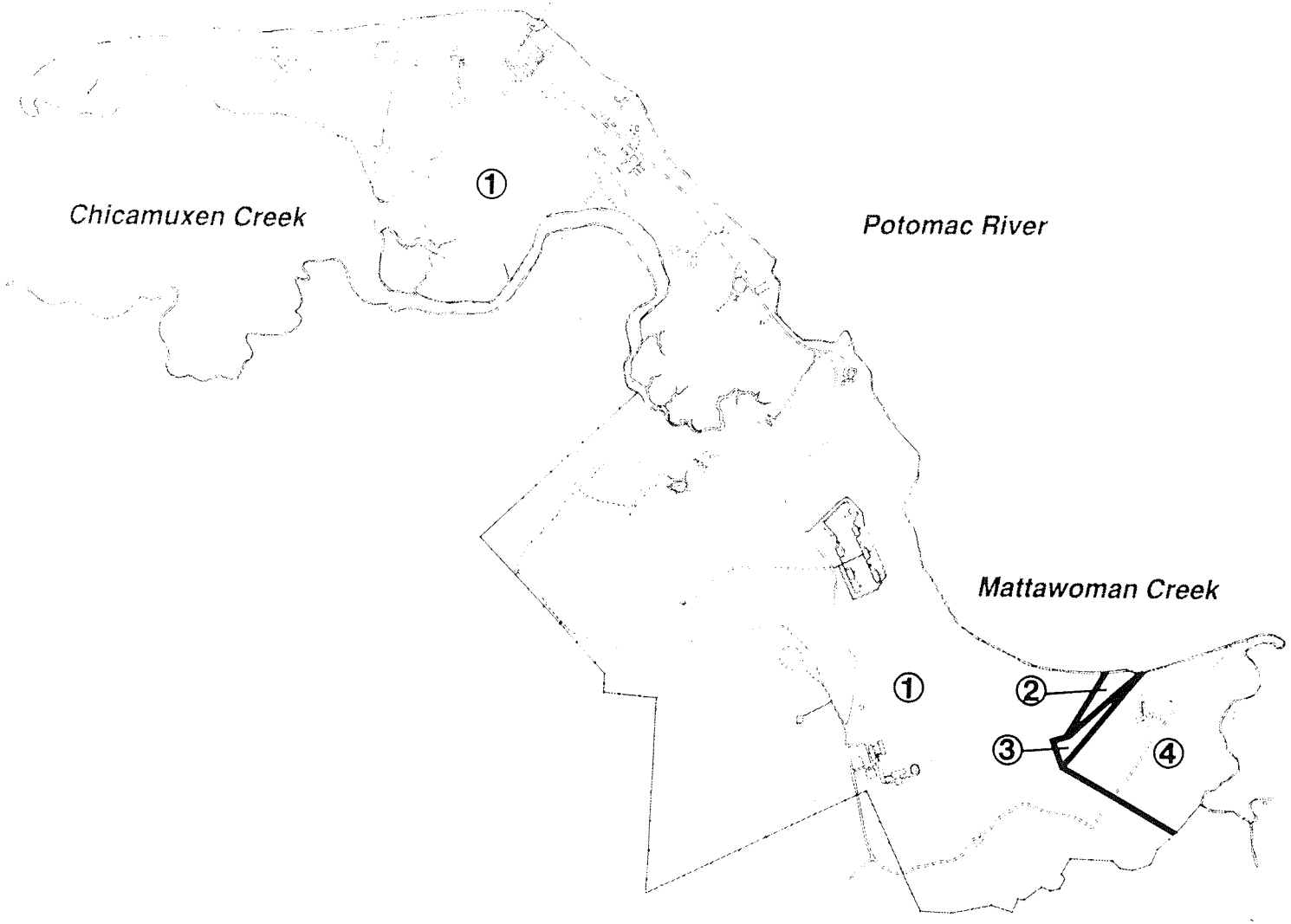
Transaction Boundary

Approximate Transaction Boundary

0 1000 2000 3000 4000 6000 Feet

Figure 3-2

Naval Ordnance Station, Indian Head



STUMP NECK

Real Property

Source: NOS Public Works Engineering Division files, CHESDIV Real Estate Division files

LEGEND

Acquisitions (numbers are keyed to Table 3-1)

Transaction Boundary

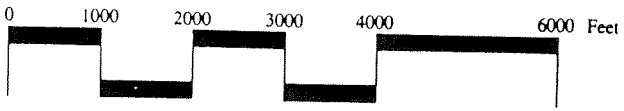
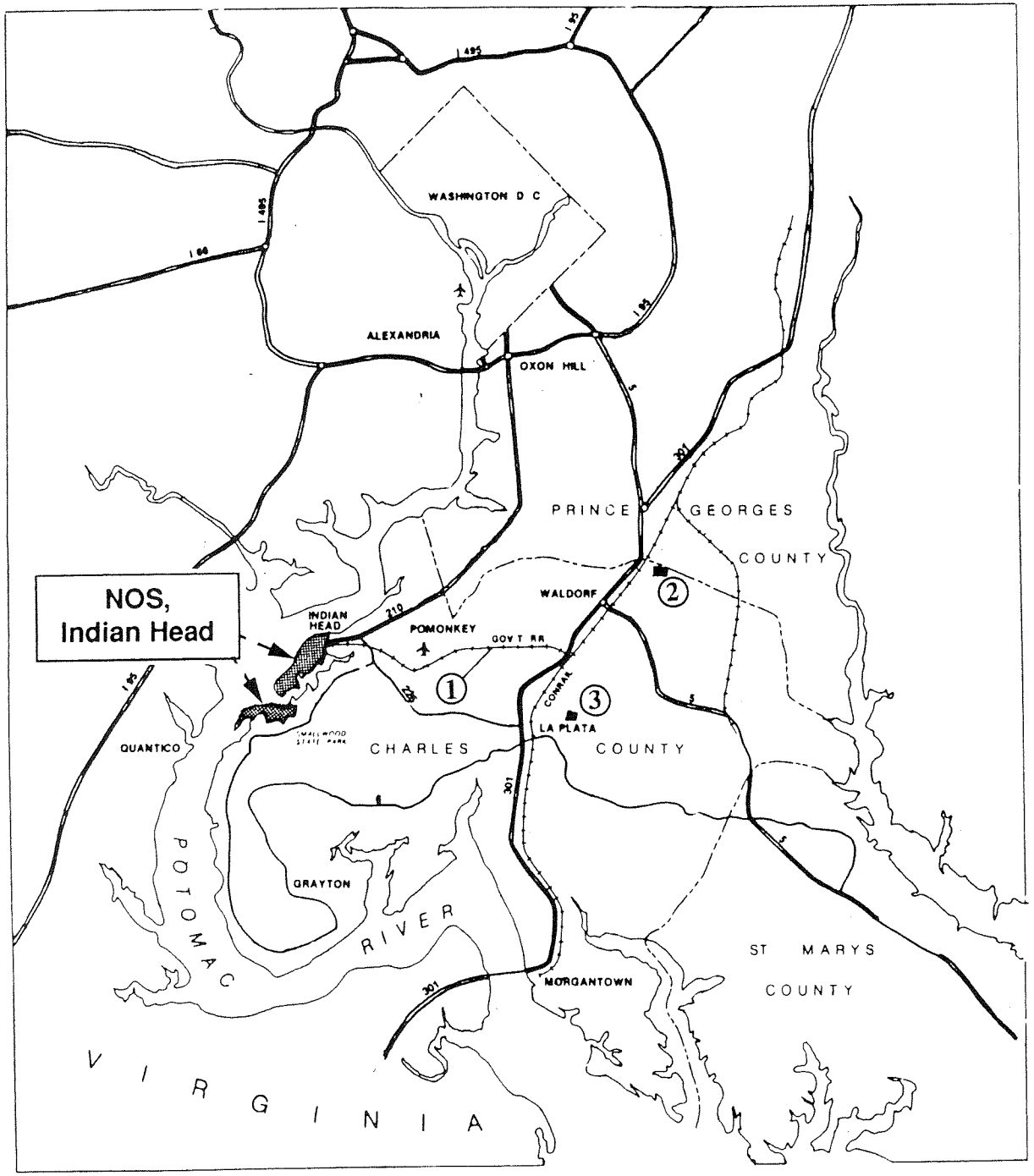


Figure 3-3

Naval Ordnance Station, Indian Head



REMOTE SITES:

1. White Plains RR
2. Waldorf Housing
3. La Plata Housing

0 5 10 15 miles

0 5 10 20 km

Figure 3-4
Real Property: Remote Sites

Table 3-1. Summary of Real Estate (Real Property) Acquisitions and Disposals (1)

GENERAL AREA and Specific Site	Transaction Number	Type	To or From	Original or Other Description of Tract	Date	Acres	
INDIAN HEAD AREA (2)							
Main Site	1	Acquisition	B. Cooley	Cornwallis Neck	May 14, 1890	473.00	
	2	Acquisition	K.U. Taylor	Cornwallis Neck	May 14, 1890	186.00	
	3	Acquisition	M.T. Irwin	Mount Pleasant Farm	Sep 15, 1891	222.75	
	4a	Acquisition	A. Reuter	Hopewell Farm	Apr 5, 1918	427.01	(3)
	5a (4)	Acquisition	Arundel Sand & Gravel		Jun 10, 1918	385.00	
		Acquisition	Mitchell, Mattingly	Fisher Tract	Jun 10, 1918	280.20	
		Acquisition	S.E. Mudd		Jun 10, 1918	66.70	
	6	Disposal	Charles County Schools	Indian Head Elementary School	Mar 15, 1955	-12.74	(5)
	12	Disposal	Town of Indian Head	New Post Office site	Apr 20, 1976	-1.00	
	13	Disposal	Town of Indian Head	Village Green/Summers Road	Mar 1, 1977	-20.14	
	14	Disposal	Charles County Schools	Fletcher Field, Diffenbach Court	Mar 6, 1978	-39.01	(6)
	15	Disposal	Town of Indian Head	Old NOS Post Office(Bldg 293)	Sep 11, 1985	-1.22	
				Main Indian Head Site, Subtotal Acres		1,966.55	
Hog Island	4b	Acquisition	A. Reuter	H. Grimes Island	Apr 5, 1918	6.90	(7)
Thoroughfare Island	5b	Acquisition	S.E. Mudd		Jun 10, 1918	25.00	
Marsh Island	5c	Acquisition	S.E. Mudd		Jun 10, 1918	10.30	
				INDIAN HEAD AREA, Subtotal Acres		2,008.75	
BULLETS NECK AREA (2)	7	Acquisition	W. Grinder		Oct 5, 1965	1.50	
	8	Acquisition	B. Grinder		Jan 26, 1966	35.57	
	9	Acquisition	S. Howard		Apr 14, 1966	0.75	
	10	Acquisition	G. Henderson		Apr 11, 1966	0.85	
	11	Acquisition	E. King, et al.		Jun 15, 1966	8.33	(8)
				BULLETS NECK AREA, Subtotal Acres		47.00	
STUMP NECK AREA (9)							
Main Site	1	Acquisition	Est. of B. Goffield	Mason's Enlargement	Aug 5, 1901	1,084.00	
	2	Acquisition	W. & E. Harlee		Nov 11, 1918	3.30	
	3	Acquisition	Est. of W. Harlee		Apr 25, 1966	3.30	
				Main Stump Neck site, Subtotal Acres		1,090.60	
Rum Point	4	Acquisition	E. King, et al.		Jun 15, 1966	80.00	
				STUMP NECK AREA, Subtotal Acres		1,170.60	
REMOTE SITES (10)							
White Plains RR	--	Acquisition	Various (11)	Government RR Right-of-Way	Aug 7, 1918	160.94	
				WHITE PLAINS RR, Subtotal Acres		160.94	
Waldorf Site	--	Acquisition	Dept. of the Army	Waldorf housing site	Mar 4, 1974	3.68	
La Plata site	--	Acquisition	Dept. of the Army	La Plata housing site	May 3, 1974	13.83	
				WALDORF & LA PLATA SITES, Subtotal Acres		17.51	
				TOTAL ACRES GOVERNMENT OWNED		3,404.80	(12)

Table 3-1 Notes:

(1) Transaction numbers in this table are keyed to each Real Property map. Tracts acquired in the same transaction but which are currently inventoried as separate entities, such as Thoroughfare Island and Rum Point, are listed individually with the acreage for each, but are given related transaction numbers (such as 4a and 4b).

(2) See Figure 3-2 (Real Property map, Indian Head Area).

(3) Hopewell Farm and Hog Island were acquired in the same transaction. Some documents show the acreage for both areas combined as one tract totalling 433.91 acres.

(4) Presidential Proclamation number 1458 authorized transactions 5a - 5c, which total 767.20 acres. Among the tracts acquired was a total of 102 acres purchased from the heirs of S.E. Mudd, including the areas now known as Thoroughfare and Marsh Islands. These are listed separately, as transactions 5b and 5c, for consistency with current inventories. Specific parcel boundaries within transaction 5a are not available in Navy files; hence only 5b and 5c are shown separately on the Real Property map (Figure 3-2).

(5) This parcel included the old Indian Head Elementary School building, as well as the land on which the new elementary school was later built.

(6) Disposal to Department of Health, Education and Welfare (HEW) in 1978; deeded by HEW to the Charles County Board of Education. All but about 7.5 acres of this parcel later reverted to the GSA and was auctioned in 1987 to the Cook Inlet Region Corporation.

(7) Originally known as H. Grimes Island, Hog Island was an island but is now appended to the main Indian Head peninsula (through siltation in the channel between the two). It was purchased in the same transaction with the Hopewell Farm as 6.0 acres. Later documents have defined Hog Island as a 6.90 acre area; for consistency with current inventories, the latter figure is used here.

(8) This 8.33 acre portion of Bullets Neck was purchased in the same transaction as the 80 acres at Rum Point; some documents will show them as one tract consisting of 88.33 acres.

(9) See Figure 3-3 (Real Property map, Stump Neck Area).

(10) See Figure 3-4 (Real Property: Remote Sites).

(11) Presidential Proclamation number 1472 authorized the taking of land for this right-of-way from about 70 individual owners.

(12) This total differs from that shown in the report, "Detailed Inventory of Naval Shore Facilities" (P-164) by 4.88 acres; apparently due to a discrepancy in the acreage for Bullets Neck and White Plains RR (acreage for some outgrants appears to have been added to the original total acreage in the P-164 totals).

SOURCES: NOS Public Works Engineering Division files; NAVFACENGCOM, Chesapeake Division, Real Estate files

known locally as the Mount Pleasant Farm, were added to the Indian Head site the following year (transaction 3).

World War I brought about a demand for increased powder production, which in turn brought about the next major acquisition of land in the Indian Head area. In April, 1918, Congress authorized an expansion of the Naval Proving Ground. The same month, the Hopewell Farm and Hog Island were purchased from one owner (transactions 4a and 4b).

Originally known as H. Grimes Island, Hog Island was at that time an islet in the Mattawoman Creek but has since become a part of the Indian Head peninsula.

In June 1918, President Wilson signed Presidential Proclamation number 1458 which authorized the taking of all remaining land on Cornwallis Neck in order to expand the Naval Proving Ground. As a result, three tracts totalling about 732 acres were acquired from different owners (transaction 5a). Marsh Island and Thoroughfare Island were also purchased at this time from the heirs of S.E. Mudd: (transactions 5b and 5c). Both islands are located in the marshy area of the Mattawoman Creek, between the main site and Stump Neck.

In August 1918, also as a result of World War I production needs, Presidential Proclamation 1472 authorized the acquisition of land for a railroad right-of-way, running from the Naval Proving Ground to the Pennsylvania Railroad junction at White Plains. Land was purchased from approximately 70 separate landowners, for a total of about 161 acres (transaction 1, Remote Sites), and a 13.8-mile railroad spur was laid.

The bulk of real estate in the Stump Neck Area was acquired in a single purchase of 1,084 acres in 1901, a property known locally as Mason's Enlargement (transaction 1, Stump Neck Area). Two small tracts of 3.30 acres each were acquired in 1918 and 1966, from the same original owner (transactions 2 and 3). Rum Point, an 80-acre promontory in the Mattawoman Creek closely related to the rest of the Stump Neck area, was acquired by condemnation in 1966 (transaction 4).

Bullets Neck, a separate 47-acre promontory in the Mattawoman Creek, was purchased in five small acquisitions (numbers 7 - 11, Indian Head Area) in 1965 and 1966. The primary consideration in acquiring this property, as in acquiring Rum Point, was one of safety and security arising from explosive safety quantity distance arcs for magazines on the Indian Head site across Mattawoman Creek.

In 1974, two residential housing sites in Waldorf and La Plata were acquired from the Department of the Army (transactions 2 and 3, Remote Sites). These sites total about 17 acres, and contain additional housing units for military dependents.

Disposals

All disposals of land by NOS have been from the Indian Head site in the area of the Town of Indian Head. All disposals are initially made to the General Services Administration (GSA) and thence to the ultimate recipients listed below.

In 1955, a 12.74-acre parcel including the old Indian Head Elementary School building, as well as the land on which the new elementary school was later built, was deeded to the Board of Education of Charles County (transaction 6).

A total of 22.35 acres was deeded to the Town of Indian Head in three separate disposal actions (transactions 12, 13, and 15) in 1976, 1977

and 1985. These parcels include the current site of the Town of Indian Head's Post Office, a water tower and the Village Green, as well as the old NOS Post Office (Bldg. 293) which is currently being used as a community center by the town.

The largest disposal was of a 39-acre tract deeded in 1978 to the Charles County Board of Education (via the Department of Health, Education and Welfare), on the condition that it be used for educational purposes (transaction 14). This parcel included a baseball field known as Fletcher Field, and the road called Diffenbach Court. As a result of the restrictions on use, the parcel (all except about 7.5 acres to the west of Stark Road and the old school building) was later returned to the GSA and was sold at auction by the GSA in 1987 to the Cook Inlet Region Corporation. This parcel has been rezoned to Commercial-General and is expected to be developed for future use as commercial/office space along with the old Indian Head Elementary school building, which was recently auctioned off by the Charles County Board of Education.

Outgrants

Included in the total acreage owned by NOS are approximately 70 acres on which about 40 easements or useage licenses have been granted. Several of these easements are on the main site; most are on the White Plains Railroad right-of-way. Easements are granted for varying periods of time and many cover very small areas (less than 1/10th of an acre).

The purposes of such easements have included rights-of-way for telephone cables, electric lines and other equipment, and to allow access across NOS-owned property to land owned by other parties. As part of the purchase agreements, several of the former owners of property on Bullets Neck were granted limited licenses for seasonal recreational use of those properties.

The most significant easement was to the State of Maryland in 1964 for the widening of Route 210 (Indian Head Highway). Other easements have been granted to Southern Maryland Electric Cooperative, C&P Telephone, the Town of Indian Head, the Veterans of Foreign Wars, the Charles County Sanitary District, and private landowners.

Since they are numerous and cover small areas, individual easements are not listed here. For detailed information on current easements, refer to the "White Plains Railroad Real Estate Summary Map" and other files held by the Facilities Acquisition Division of the Public Works Department at NOS.

The total acreage currently owned by NOS is about 3,405 acres.

Ingrants

The Naval Ordnance Station currently has two ingrants for a total of 23,750 SF. Both ingrants are located in the Town of Indian Head less than two miles from the Station.

Government Lease N6247787RP00018 provides approximately 14,000 SF of space used by the Station's Technical Information Department (Code 36), Instructional Resources Branch. It functions as an Applied Instruction Area for the Missle Propulsion Maintenance (MPM) School.

Government Lease N6247789RP00079 provides approximately 9,750 SF of space used by the Station's Weapons Simulation Department

(Code 64) as a Systems Laboratory for the Air and Sea Weapons Simulation Divisions.

Mission

The mission of the Naval Ordnance Station, Indian Head is to:

> "Provide quality and responsive technical, engineering, manufacturing, and material support to the Fleet and other operating forces for combat subsystems, equipment, and components in the areas of gun, rocket, and missile propulsion, energetic chemicals, missile weapon simulators and trainers, ordnance devices, aircrew escape propulsion systems, warheads, special weapons, and explosives and to perform other tasks as assigned by the Commander, Naval Sea Systems Command. Provide Naval station mission-essential services as assigned."

This mission is accomplished through an organization geared toward operations and engineering services, with administrative support provided to facilitate mission-related activities.

Base Loadings

The current (FY89) and projected (FY93) base loadings for the Naval Ordnance Station, including tenant activities, are shown in Table 3-2. The figures for NOS and NAVEODTECHCEN were established for the draft Basic Facilities Requirement report dated March 15, 1989, and are subject to approval by NAVSEA as NOS's major claimant. During that study, it was determined that the standard reported base loadings for NOS, perhaps due to NOS's Navy Industrial Funding (NIF) Status, showed nearly 1,000 fewer civilians than were currently on-board. As Table 3-2 shows, the number of civilian workers at NOS is expected to increase by about another 800 persons to meet projected workload increases. Military personnel are expected to remain the same. NAVEODTECHCEN expects a slight increase in military and a slightly larger increase in civilians (about 14 and 37 persons, respectively). Staffing levels for the other tenants are expected to remain fairly constant.

Organization

The Naval Ordnance Station is composed of the Commanding Officer and his staff, and 17 departments (see Figure 3-5). The Technical Director (TD) and the Executive Officer (XO) report directly to the Commanding Officer.

The staff departments and staff specialists report to either the Commander (Safety Department, Deputy EEO Officer and Command and Quality Review), the Executive Officer (Military Operations Department, Security Department, Chaplain and Public Affairs Officer) or the Technical Director (Comptroller and Legal Counsel). These departments' primary function is one of accountability for certain aspects of the Station's operations. All other departments report to one of the Technical Director's deputies.

The Director of Industrial Operations (TDO) oversees the departments responsible for carrying out the ordnance manufacturing portion of the Station's mission.

The Director of Product Support (TDE) directs the departments responsible for performing the technical, engineering and material support portions of the Station's mission.

Table 3-2. Current and Projected Base Loadings

	FY 1989			FY 1993			
	Civilian	Military	Total	Civilian	Military	Total	
NOS	2,515	44	2,559	3,225	44	3,269	(1)
Tenants: (2)							
NAVEODTECHCEN	234	90	324	271	104	375	(3)
NAVSCOLEOD	35	459	494	37	487	524	(4)
Branch Dental Clinic	0	4	4	0	4	4	
Branch Medical Clinic	5	23	28	5	23	28	
NPPSBO	6	0	6	6	0	6	
NSCT	2	23	25	0	0	0	(5)
NSWC Detachment	50	0	50	50	0	50	
NAVSEAADSA	185	0	185	185	0	185	
PSD	5	8	13	5	8	13	
Branch Navy Exchange	8	1	9	8	1	9	
Defense Reutilization Marketing	0	1	1	0	6	6	
Personal Property Office	1	0	1	1	0	1	
Tenants, subtotal:	530	608	1,138	575	627	1,202	
TOTALS	3,054	652	3,697	3,800	671	4,471	

(1) Source: FY 1989 -- Telecons, NOS Resources and Planning Department, 2/89; FY 1993 -- Departmental Strategic Plans or Staffing Plans and interviews, 11/88 - 2/89.

(2) Abbreviations:

NAVEODTECHCEN	Naval Explosive Ordnance Disposal Technology Center
NAVSCOLEOD	Naval School, Explosive Ordnance Disposal
NSWC	Naval Surface Warfare Center
PSD	Personnel Support Detachment
NAVSEAADSA	Naval Sea Systems Command Automated Data Systems Activity
NSCT	Naval Security Coordination Team
NPPSBO	Naval Publications & Printing Service Branch Office

(3) Source: Staffing Plan and interviews, 11/88 - 2/89.

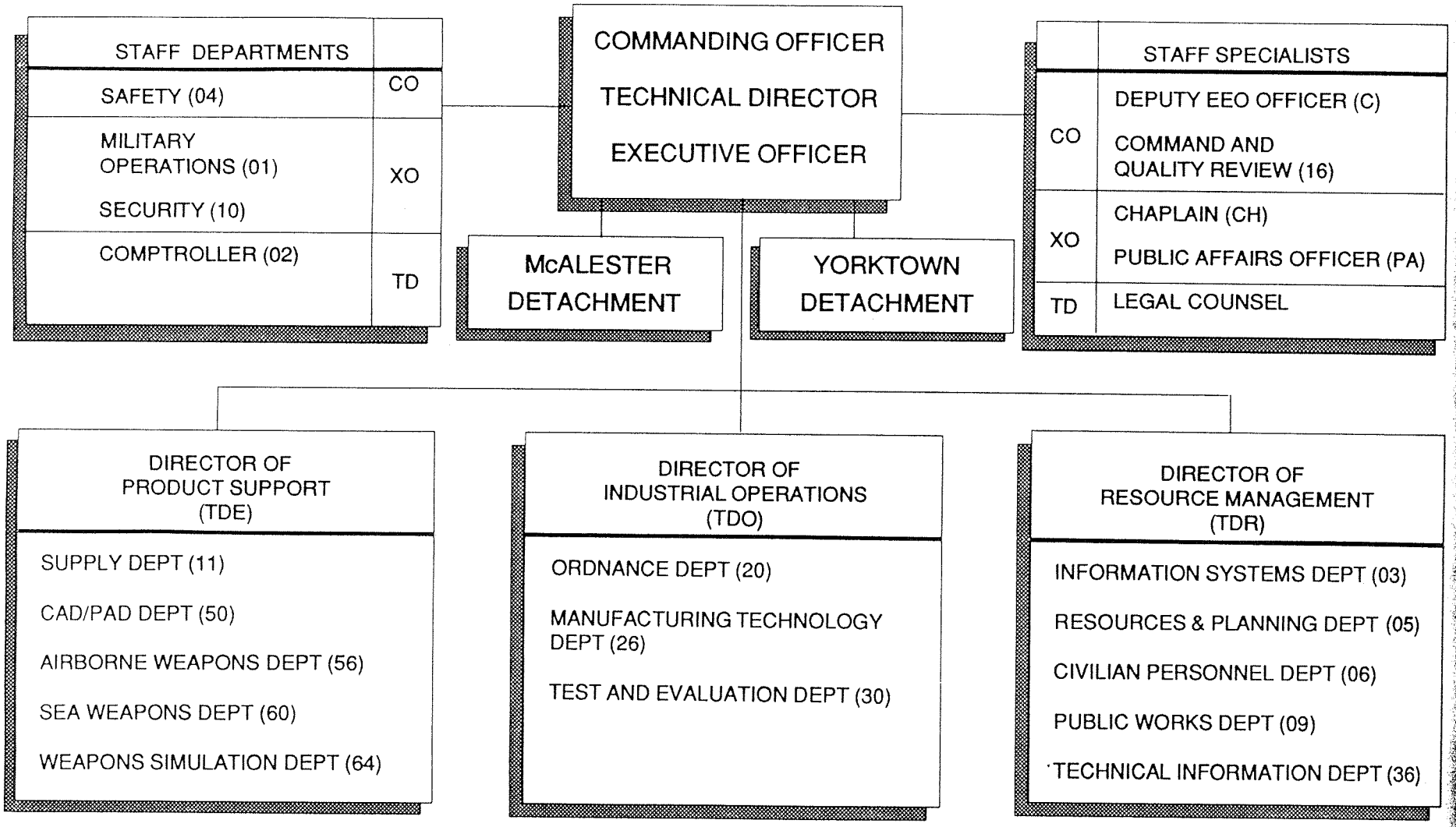
(4) Both FY89 and FY93 include FY89's average student on-board count of 283 military (30 officers, 253 enlisted) and 20 civilians. Source: telecons, NAVSCOLEOD N2 (R. Gettman), 8/16/89 and 9/5/89.

(5) NSCT relocated to NAB Little Creek, VA in August, 1989.

Figure 3-5

Organization

NOS, Indian Head



The Director of Resource Management (TDR) supervises those departments which, along with the staff departments, provide the working environment that allows the industrial operations and product support departments to function properly.

The following is a summary of the functions of the NOS departments.

Staff Departments

Code 01: Military Operations Department

Provides military support services for the Station and tenants. Manages the Consolidated Business Office, Clubs Division, Recreation Division, Bachelor Housing Division, Galley Division, and Familiy Housing.

Code 02: Comptroller

Responsible for the Station's financial management. Manages the Accounting, Disbursing, Budget and the Progress Analysis Divisions.

Code 04: Safety Department

A Naval Sea Systems Command (NAVSEASYSCOM) advisory field agency for propellant safety. Establishes safety guidelines and standards. Administers the Station's Environmental Protection, Explosive Safety and Navy Occupational Safety and Health (NAVOSH) Programs. Provides technical safety guidance and engineering for new buildings and alterations.

Code 10: Security Department

Provides physical security, information security and fire protection to Command and tenants. Manages the Station's security program. Conducts criminal and administrative investigations for Missing/Lost/Stolen/Recovered Government property and accidents. Keeps data on crimes and accidents.

Code 40: Quality Assurance Department

This department is being disestablished during FY89. Its functions are being realigned to Command and Quality Review (Code 16), Supply (Code 11) and Information Systems (Code 03). This deparment does not appear in Figure 3-5 (Organization).

Industrial Operations Departments

Code 20: Ordnance Department

Manufactures, loads, assembles, disassembles and reworks warheads, rockets, missiles, Cartridge Actuated Devices (CADs), Propellant Actuated Devices (PADs) and related components. Provides mechanical engineering design services to other departments. Administers a receipt, storage and inspection program as the Department of Defense (DOD) East Coast CAD Stock & Issue Point.

Code 26: Manufacturing Technology Department

Designs, develops, manufactures and loads pilot quantities and analyzes rocket motors, propellants, explosives, components, chemicals and igniters. Develops processes for design and pilot production of new explosives, propellants and chemicals.

Code 30: Test and Evaluation Department

Plans and conducts destructive and nondestructive tests and analyses, to evaluate propulsion systems produced at NOS. Evaluates raw materials and metal parts; performs special tests for engineering studies. Operates and maintains all testing facilities.

Product Support Departments

Code 11: Supply Department

Directs all supply functions, including procurement, shipping and receiving, issue, control and storage of material, equipment and services for NOS and its tenants. Conducts stock inventories. Responsible for Small Business/Labor Surplus Program and technical services.

Code 50: CAD/PAD Department

Performs design, development, quality evaluation, documentation, preproduction engineering, manufacture and rework of Cartridge Actuated Devices (CADs), Propellant Actuated Devices (PADs) and Aircrew Escape Propulsion Systems (AEPS) for DOD and the Navy. Cognizant Field Activity for the Naval Air Systems Command (NAVAIRSYSCOM) on CADs/PADs/AEPS. Serves as consultant to NOS, operating forces, Systems Command, DOD and others.

Code 56: Airborne Weapons Department

Plans and executes domestic and Foreign Military Sales, Fleet Support programs, including engineering, maintenance and logistical support, on airborne missiles and cruise missiles, rocket and JATO propulsion units and surface and underwater weapons. Navy Acquisition Agent and In-Service Engineering Agent for the above.

Code 60: Sea Weapons Department

Plans and administers design, engineering, procurement, fleet support and evaluation for gun propulsion systems, missile, surface and underwater weapons. Acts as Navy Acquisition Agent and In-service Engineering Agent for the above.

Code 64: Weapons Simulation Department

Provides engineering support in simulation development for Naval weapon systems, performs electronic design and technical support for NOS programs, and provides management and maintenance support for electronic equipment and missile training shapes. Designs, develops and fabricates missile training shapes and simulators. Provides design, development, and technical guidance to Station organizations and tenants for electronic systems and equipment. Installs and maintains the Station's security alarms.

Resource Management Departments

Code 03: Information Systems Department

Administers Station Automated Data Processing (ADP) Program for business, logistics, Quality Evaluation (QE) statistical and scientific applications. Provides technical leadership in acquiring and using ADP hardware (mainframe and personal/business computers), and guidance in developing and using the Station's computerized Management Information Systems. Manages the

Station's data communications network and databases. Serves as the development and test activity for NAVSEASYSCOM standard functional data systems.

Code 05: Resources and Planning Department

Provides management consultant and industrial engineering services to the Commander and the Station. Responsible for Corporate Planning, Productivity Improvement, Position Management, Modernization and Commercial Activities Programs. Develops Station-wide management systems.

Code 06: Civilian Personnel Department

Administers civilian Staffing and Placement, Training and Development, Employee/Labor Relations, and Services and Wage and Classification programs. Advises on personnel management and policies, as they relate to laws and regulations. Develops automated personnel systems for the Station.

Code 09: Public Works Department

Constructs, operates, and maintains all facilities and utilities, as well as transportation and engineering equipment. Administers all natural resource, land management, energy management, and master planning programs. Provides construction contract management services. Administers the NAVORDSTA Facilities Support and Contracting Program; prepares, inspects and administers all facilities/support service contracts. The Naval Facilities Engineering Command, Chesapeake Division (CHESDIV), Resident Officer in Charge of Construction (ROICC) and his staff work closely with the Public Works Department, inspecting and approving all facilities construction at NOS.

Code 36: Technical Information Department

Provides Technical Information support to NAVSEASYSCOM, NAVAIRSYSCOM and DOD, including engineering data, standards, documentation and publications. Operates the Technical Library and Missile Propulsion Maintenance School (Instructional Resources Branch). Administers NOS mail distribution, forms, paperwork and file management, and distributed copy equipment.

NOS Detachments

Code 90: Special Weapons Department -- NOS Detachment, McAlester, Oklahoma

A detachment of NOS located at the Army Ammunition Plant at McAlester, Oklahoma, operating as a tenant organization there and reporting to the Commanding Officer at NOS. Provides in-service engineering support for assigned nuclear weapons and technical liaison and direction for inventory control of all air-launched nuclear weapons, performs maintenance and repair on certain weapons, maintains technical documentation concerning nuclear weapons in the Fleet and performs proficiency and acceptance inspections. Facility planning concerns for the Special Weapons detachment are handled by the host organization at McAlester.

Code 46: Naval Explosive Development Engineering Department (NEDED) -- NOS Detachment, Yorktown, Virginia

A detachment of NOS, acquired in June 1988 and currently located as a tenant at Yorktown Naval Weapons Station, Yorktown, Virginia. NEDED is responsible for research and development studies of new explosive compositions and industrial processes for the Navy. The mission of NEDED is to provide quality and responsive engineering, technical and material support to the Fleet for combat subsystems, equipment and components, warheads, and explosive process development, as assigned by the Commander, Naval Sea Systems Command.

Tenant Activities

In addition to its own mission-related activities, NOS houses and provides support for two major and several smaller tenant organizations. The major tenants are the Naval Explosive Ordnance Disposal Technology Center (NAVEODTECHCEN), and the Naval School, Explosive Ordnance Disposal (NAVSCOLEOD).

The mission of the Naval Explosive Ordnance Disposal Technology Center is to:

"Conduct research, development, test, and evaluation in technical matters concerning explosive ordnance disposal and render safe procedures for conventional and special weapons, guided missiles, biological and chemical munitions, tools, equipment, and techniques as required to discharge the Navy's responsibility to the Department of Defense and to the Departments of the Army and the Air Force, and other agencies as well as other nations in matters relating to explosive ordnance disposal."

The mission of the Naval School, Explosive Ordnance Disposal is to:

"Train officers and enlisted personnel of the Navy, Army, Air Force, and Marines, both U.S. and foreign, and civilian officials, in the best methods and procedures for the recovery, evaluation, rendering safe and disposal of surface and underwater, conventional and nuclear, explosive ordnance employed by the U.S. and other nations."

Other tenant activities located at NOS are:

Branch Dental Clinic (DE)

An activity of the Naval Dental Center, Bethesda, MD. The clinic provides full dental treatment for active duty and retired military personnel, and oral hygiene and examination services for family members.

Branch Medical Clinic (ME)

A branch clinic of the Naval Medical Command, National Capital Region. In addition to providing medical services for active duty and retired military personnel and families, the clinic treats on-the-job injuries and performs physical and industrial health examinations for the Station's civilian work force, responds to emergencies, and provides disaster control and mass casualty services to Station personnel.

Naval Publications and Printing Service Branch Office (NPPSBO)

A branch of the Navy Publications and Printing Service Office, Naval District of Washington. Provides or procures all printing, large-volume reprographics, micrographics, automated publishing, and electronic page printing services to NOS and its tenant activities. The NPPSBO prints Station notices, technical documents, instructions, procurements, pamphlets, and the Station newsletter.

Naval Surface Warfare Center (NSWC)

A detachment of NSWC, White Oak Laboratory, representing its Research and Technology Department's Energetic Materials Division. Conducts basic and applied research in the fields of high-energy chemistry. Consulting services are also provided to other Navy and DOD activities as requested. Works closely with NOS's Ordnance, Manufacturing Technology, Test & Evaluation, Airborne and Sea Weapons Departments. The NSWC detachment is expected to be relocated away from NOS sometime within the next 10 years, but will still continue to interact with the above-mentioned NOS industrial operations and product support departments after that relocation.

NAVSEASYSCOM Automated Data Systems Activity (SEAADSA)

A field activity of the Naval Sea Systems Command (NAVSEASYSCOM), providing 16 NAVSEA organizations, including NOS, with support in the development and maintenance of automated systems. The activity designs, tests and assists in the implementation of management information and data processing systems to support Navy military industrial activities.

Personnel Support Activity Detachment (PSD)

A branch of the Personnel Support Activity, Naval District of Washington, which administers active duty military pay and personnel functions, issues identification cards for military families, and arranges passenger transportation for Navy-sponsored travel.

Navy Exchange, NAVORDSTA Branch (EXCH)

A branch of the Navy Exchange, Patuxent River Naval Air Station, Patuxent River, MD, which operates a retail store at NOS.

4

Regional and Local Conditions

REGIONAL AND LOCAL CONDITIONS

Climate

NOS, Indian Head is midway between the rigorous climate of the north and the mild climate of the south. Since the Station is located in the middle latitudes where the general atmospheric flow is from west to east across North America, it has a continental-type of climate with four well-defined seasons. However, the proximity of the Potomac River and its tributaries have a considerable modifying effect on the climate, especially in moderating extreme temperatures.

Climate data from the Naval Weather Service Detachment from the period of 1945-1982 were assessed to characterize conditions at Indian Head. The closest weather station to Indian Head is located on the Patuxent River. Summary climate data are presented in Table 4-1.

Generally, the coldest period of the year is late January and early February when the early morning temperature averages 29°F. The warmest period is late July when the afternoon maximum temperature averages 85°F. The highest temperature recorded between 1945-1982 in the Indian Head region was 103°F, recorded in July 1980, while the lowest was -3°F recorded in January 1977. Precipitation is somewhat evenly distributed through the year with either July or August being the wettest month, and February, April or October the driest. The heaviest precipitation during the colder half of the year is generally the result of low pressure systems moving northeastward along the Atlantic coast; in summer it occurs as thunderstorms. The highest official one-day precipitation recorded during 1945-1982 was 5.88 inches, which occurred on August, 1969. The greatest accumulation of snow occurred in February 1979, with 11.7 inches.

Prevailing surface winds are from the north-northwest to northwest except during the warm months of the year when they become more southerly. The most windy period is late winter and early spring when the wind speeds average more than 3 mph.

Table 4-1. Climate Summary

Mean Daily Extremes for Rainfall (inches)

J	F	M	A	M	J	J	A	S	O	N	D
2.14 (1962)	3.06 (1979)	2.66 (1980)	1.93 (1946)	.68 (1971)	3.06 (1963)	4.61 (1960)	5.88 (1969)	3.89 (1960)	3.55 (1966)	4.22 (1956)	1.91 (1975)

Mean Daily Extremes for Snowfall (inches)

J	F	M	A	M	J	J	A	S	O	N	D
11.2 (1954)	11.7 (1979)	9.4 (1960)	0.3 (1972)	-	-	-	-	-	0.1 (1979)	7.1 (1967)	8.0 (1966)

Natural Conditions

Charles County is located within the inner Potomac Coastal Plain geologic province. The soils in this area are derived from unconsolidated marine sediments that vary from sandy to clayey in texture and from excessively well drained to poorly drained. High water tables, severe erosion, earthslides and hardpans are common.

The topography near Indian Head and Stump Neck is gently rolling, for the most part. The area includes many drainage swales and streams, and the shoreline areas are generally steeply sloped. The most important hydrological feature in the area is the Potomac River. It is a continuous, slow-moving, tidal tributary of the Chesapeake Bay. Mattawoman Creek and Chicamuxen Creek are also

important waterways. They both have large floodplains and contain large expanses of tidal wetlands and swamps. The area is crossed by many small streams, most of which drain directly into one of the three major waterways.

NOS is bordered by and contains large tracts of both tidal and non-tidal wetlands. Wetlands and floodplains are valuable habitat for wildlife, important groundwater recharge areas, and filters for surface water runoff, thus minimizing siltation and erosion. They are also important aesthetic buffers, recreational areas (in some cases), and scientific resources.

The land around both Indian Head and Stump Neck is heavily vegetated. Most of the forested land is either second or third growth; little, if any, virgin forest remains. The most abundant trees are Virginia pine, sweet gum, red oak, and yellow poplar.

Local Development History

The Town of Indian Head had its origins as housing built by the Navy for its employees. The road now known as Indian Head Highway was built during the early part of World War II to service the Station, and was later deeded to the state.

The area around NOS, Indian Head, outside of the town, traditionally has been a tobacco producing region and has remained very rural until recently. Development has clustered along the major highways in Charles County, which include Routes 210, 301 and 5. Both residential and commercial strip development along these routes tend to be clustered, with undeveloped land between developed areas.

In the last two decades, the proximity of Charles County to Washington, DC, and the intense development and rising cost of land in the closer-in counties has caused the population to grow and urbanization to increase in the county. However, the majority of land in Charles County, approximately 90% of the county's total 299,488 acres, is still open land, primarily agricultural and forested.

Although the acreage of developed land is still a small percentage of the total land in the county, it has increased substantially in the 12-year period 1973-1985. The increase from 5.5 to 8.1% during that period represents a 47% growth rate.

Future development in the county is expected to center in the northern part of the county, still along the major highways (including the proposed Eastern Bypass) for new residents commuting to employment centers in Washington, DC and its Maryland suburbs, and along the waterfront in the southern part of the county, for vacation and retirement housing markets. The primary constraints will be availability of water and sewer service and adequate local roads.

Land Use

The south side of Route 210 extending from the Station's main gate to the Town boundary consists of a variety of commercial, retail, and institutional land uses. The area adjacent to NOS along its boundary with the town south of Route 210 to the Mattawoman Creek is occupied by single family detached housing and a Town boat ramp located on the Creek at the Station boundary.

The north side of Route 210 encompassing the area between the main gate and Summers Road and extending northward to the Station

boundary was formerly owned by the Navy. This area was annexed by the Town several years ago. Land uses here include a public park and open space, and both the existing and abandoned Indian Head elementary school buildings. Commercial uses are not present along the north side of Route 210 until east of its intersection with Summers Road, although the old Indian Head elementary school and the area near it are expected to be developed as commercial/office space. The strip immediately adjacent to the north side of Route 210 extending from Summers Road east to the Town boundary contains a variety of commercial and retail uses.

The primary activity on the land adjacent to Stump Neck is agriculture, interspersed by scattered, low density residential development. The residential development intensity averages less than one dwelling unit per three acres.

The General Smallwood State Park lies immediately to the east of Stump Neck. This park contains six boat launching ramps, five boating piers, restrooms, and a concession facility. A pedestrian foot bridge provides access to a day-use picnic area. The state is currently planning to improve the Park facilities, including construction of 200 boat slips.

The state has been purchasing properties along the southern edge of Mattawoman Creek east of the park. At the present time, they own much of the of waterfront acreage between Stump Neck and Route 225. These purchases ensure that this land will remain as a natural area and open space. Additional information on nearby land use is contained in the Land Use Compatibility Study (1987).

Population

The population of Charles County is increasingly part of an expanding metropolitan Washington area. Both Charles County as a whole and the Town of Indian Head in particular have undergone substantial increases in population over the last three decades.

Charles County's population grew by over 46% between 1960 and 1970, and by about another 53% between 1970 and 1980, to a total of 72,751 residents. This growth has been more evenly distributed over time than that of neighboring Prince George's County, which grew an explosive 85% between 1950 and 1960 and again between 1960 and 1970, then dropped off sharply to less than 1% between 1970 and 1980. By contrast with both counties, the population of Maryland as a whole rose by approximately 27% between 1960 and 1970, and by 7.5% during the period 1970 to 1980.

While the bulk of Charles County's growth occurred in the more urbanized areas of Waldorf, including the "new town" of St. Charles, and La Plata (up by nearly 60% from 1970 - 1980), the Town of Indian Head and the election districts of Pomonkey and Marbury have also grown steadily since 1980.

The population of Indian Head increased by 2.3% from 1970 to 1980 according to 1980 Census figures, and increased by about 16% between 1980 and 1986, rising from 1,381 to 1,603. Other estimates put the 1986 Indian Head population closer to 2,300, counting gains from annexation as well as actual residential development within the Town.

By 1990, Charles County's population is expected to have increased by nearly 30%, to around 94,500 people. The Department of State

Planning projects that Charles County will have a population of about 119,250 by 2005, which the Charles County proposed Comprehensive Plan translates into a need for more than 18,500 additional residences in the entire county by that year.

Economy

According to state employment projections, the largest group of workers in Charles County is employed in wholesale and retail trade: about 7,000 in 1985, projected to rise to over 10,000 by the year 2005. Employment in manufacturing accounts for the lowest number, or about 300 in projections for 1985. Employment in agriculture, including forestry and fishery, is projected to be between 1,100 and 1,200 over the next 20 years. Around 3,700 employees in Charles County are estimated to have worked (as civilians) for the Federal government in 1985. State and local government combined are projected to employ close to 3,500 people consistently over the next two decades. There is net out-commuting from Charles County, as approximately 5,000 more employed persons reside in the county than the number of persons working in the county.

NOS remains the largest single employer within Charles County, with about 2,500 civilian workers in 1988, of which about 65% to 70% were county residents. An additional 500 civilian workers were employed by NOS tenants.

Utilities

Sewers

The Town of Indian Head has its own wastewater treatment system, which does not receive wastewater from NOS. The design capacity of the plant is .5 million gallons per day (mgd), and the average daily flow in 1988 was .3 mgd.

Water System

The Town of Indian Head relies on groundwater for its drinking water. Five wells are used, with a total daily flow of .2 mgd. There are two storage tanks with capacities of 100,000 and 200,000 gallons per day. The Town plans to add more storage capacity in FY91. The distribution system in more than half the town was replaced in 1980.

As evidenced by several recent water supply planning studies for Charles County and the Town of indian Head, water supply is becoming a significant issue and a possible constraint on development. Both the town and NOS, Indian Head draw their groundwater from the same aquifer, with the Navy using approximately 1 mgd. Salt water intrusion into the aquifer is becoming a problem.

Transportation

Maryland Route 210 is a four lane, divided highway with limited access for most of its length from the District of Columbia line to NOS, Indian Head. Access is controlled through limitations on the

type and number of at-grade intersections permitted along the highway. The access limitations placed on Route 210 do not restrict the construction of either overpasses or underpasses.

Access limitations are strongest in the Prince Georges County segment of the road, and less restrictive along the road segment in Charles County. Development on parcels immediately adjacent to the highway from just north of Route 227 to the entrance of the Station may provide access directly onto the highway, while development further north must use either a nearby public road or a parallel access road.

Community Facilities

Fire Protection

The Indian Head and the Potomac Heights volunteer fire departments provide fire protection services in the vicinity of the Town of Indian Head. The Marbury volunteer department provides fire protection for the Stump Neck area. NOS, Indian Head provides its own fire protection services for the Station; all fire companies assist each other when needed.

Police Protection

The Charles County Sheriff's Office provides the law enforcement services for the Town of Indian Head and the portion of Charles County surrounding the Stump Neck facility. Federal and local police have concurrent jurisdiction over the La Plata and Waldorf housing sites. NOS has exclusive jurisdiction over the off-station railroad right-of-way.

Education

The Indian Head elementary school (K-6) is part of the Charles County School System. The total enrollment in this school was 585 students as of September, 1989. Approximately 100 children of military personnel stationed at NOS, Indian Head attended the Indian Head Elementary school during the 1989/90 school year.

There are no commercial day care facilities in the Town of Indian Head.

Emergency Medical Services

The Indian Head Volunteer Rescue Squad provides emergency medical assistance and ambulance service for the residents of the Town of Indian Head. The closest hospital is Physicians Memorial Hospital located in La Plata. Because on-station emergency medical services are available, NOS, Indian Head does not rely upon these community services.

Solid Waste Disposal

The Town of Indian Head provides solid waste disposal services for residents and businesses located in the municipality. All residents and businesses are required to use the collection service. The town owns 2 packer trucks which collect the waste and transport it to the Charles County landfill in Pisgah. This service is not extended to NOS, Indian Head, which has a service contract for waste removal.

Encroachment

The Land Use Compatibility Study (1987) addresses encroachment issues in detail. The conclusions of that study are summarized here.

- Environmental features near the Station protect NOS from encroachment. For example, surrounding water bodies limit the potential for conflicting adjacent land uses, while the presence of endangered species may limit the likelihood of major roadway construction (and attendant population growth) near the Station.

- Several small developments in the 210 corridor and in the town of Indian Head are not expected to have any discernible impact on NOS. However, larger developments may have an impact to the extent that they result in increased boat traffic in the vicinity and consumption of potable water resources.

- NOS activities can have off-station consequences. Areas of concern that could affect or limit NOS activity are:
  - Noise
  - Transportation of hazardous materials
  - Groundwater withdrawals by NOS in competition with civilian users
  - Surface or groundwater contamination from on-site spills or disposal of toxic or hazardous materials
  - Transient boat use of areas within ESQD arcs or the navigation danger zone.

- The State of Maryland is projecting an increased rate of growth in Charles County over the next decade.

5

NOS Environmental Features

NOS ENVIRONMENTAL FEATURES

As a Federal facility, NOS Indian Head has a responsibility and a commitment to protect the natural resources within its jurisdiction, and to prevent off-site impacts resulting from on-station activities. To help meet this commitment, the NOS Natural Resource Manager (Code 097D) is available to consult with Station personnel who must incorporate resource protection into project design and other activities. Additional support is available through the Natural Resources and Land Management Branch (Code 243) of CHESDIV. Code 243 provides guidance and assistance in the management of forests, fish and wildlife, outdoor recreation opportunities, and soil and water conservation efforts. Emphasis is being directed to the support of the Chesapeake Bay Initiatives and reducing non-point source pollution, especially from shoreline erosion and erosion from new construction. In addition, technical assistance in evaluating project sites for the presence of wetlands is available from Code 243. A summary of the Station's natural resources and their implications for land use planning is presented in the following sections.

Geology

Indian Head and Stump Neck lie within the Potomac River Basin in the Coastal Plain, which was formed over 500 million years ago. The deposits beneath the area are composed of gravel, sand, silt, and clay. These materials were transported by streams from the Appalachian and Piedmont region, west and north of the region, and deposited in the form of alluvial fans, deltas, and as estuarine and marine layers. The deposits are chiefly of Cretaceous, Tertiary, and Quanternary age resting on dense, hard, crystalline metamorphic, and igneous rocks of Precambrian or Cambrian age. Bedrock is usually found at an average depth of 600 feet below the surface. It is primarily crystalline in nature and composed of quartz, chlorite, mica and kaolonite.

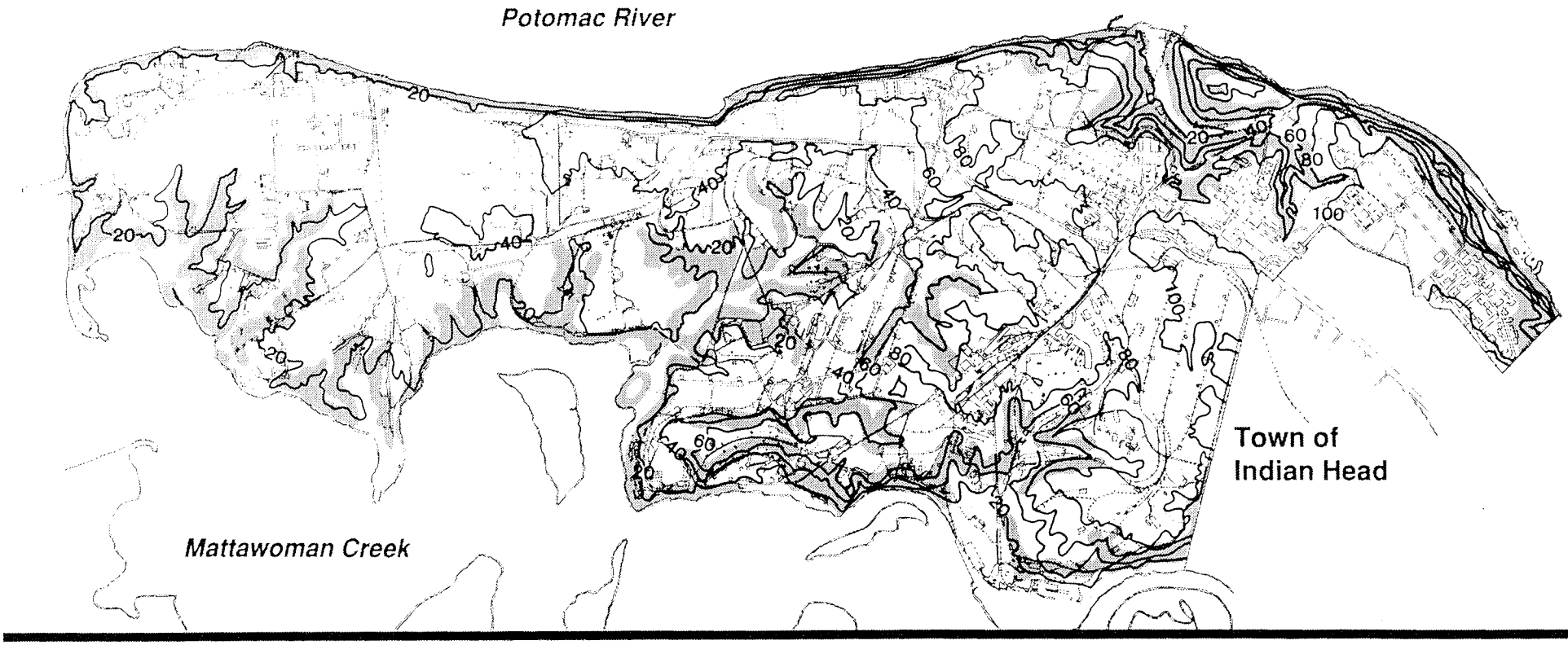
Topography

Both Stump Neck and Indian Head are located on peninsulas adjacent to the Potomac River. Indian Head is bordered by Mattawoman Creek to the southeast, while Stump Neck is bordered to the southeast by Chicamuxen Creek. Both land forms have very low elevation profiles typical of the Coastal Plain region. Indian Head decreases in elevation from north to south, with its highest elevation being 100 feet above sea level (Figure 5-1). Stump Neck decreases in elevation from east to west and has a maximum elevation of 110 feet above sea level (Figure 5-2). The overall terrain on both peninsulas is rolling and is marked by many drainage swales and streams.

The Potomac River shoreline of Indian Head and, to a lesser degree, Stump Neck is marked by steep slopes, most in excess of 15 percent. Facilities in this area are in danger of being undermined due to continuing wave undercutting and groundwater freeze-thaw processes.

While Mattawoman and Chicamuxen Creeks also have some areas of steep slopes, the majority of their shoreline area is composed of wetlands, swamps and floodplains. These act as buffers against continual wave action and groundwater erosion along the shore.

Because they pose structural hazards, and because development will exacerbate soil erosion, causing increased sedimentation of the river, steep slopes (see Figures 5-1 and 5-2) should be avoided for all construction. Specific erosion problems on these slopes, and plans for



INDIAN HEAD

Topography

Source: Master Plan Update (1982)

LEGEND

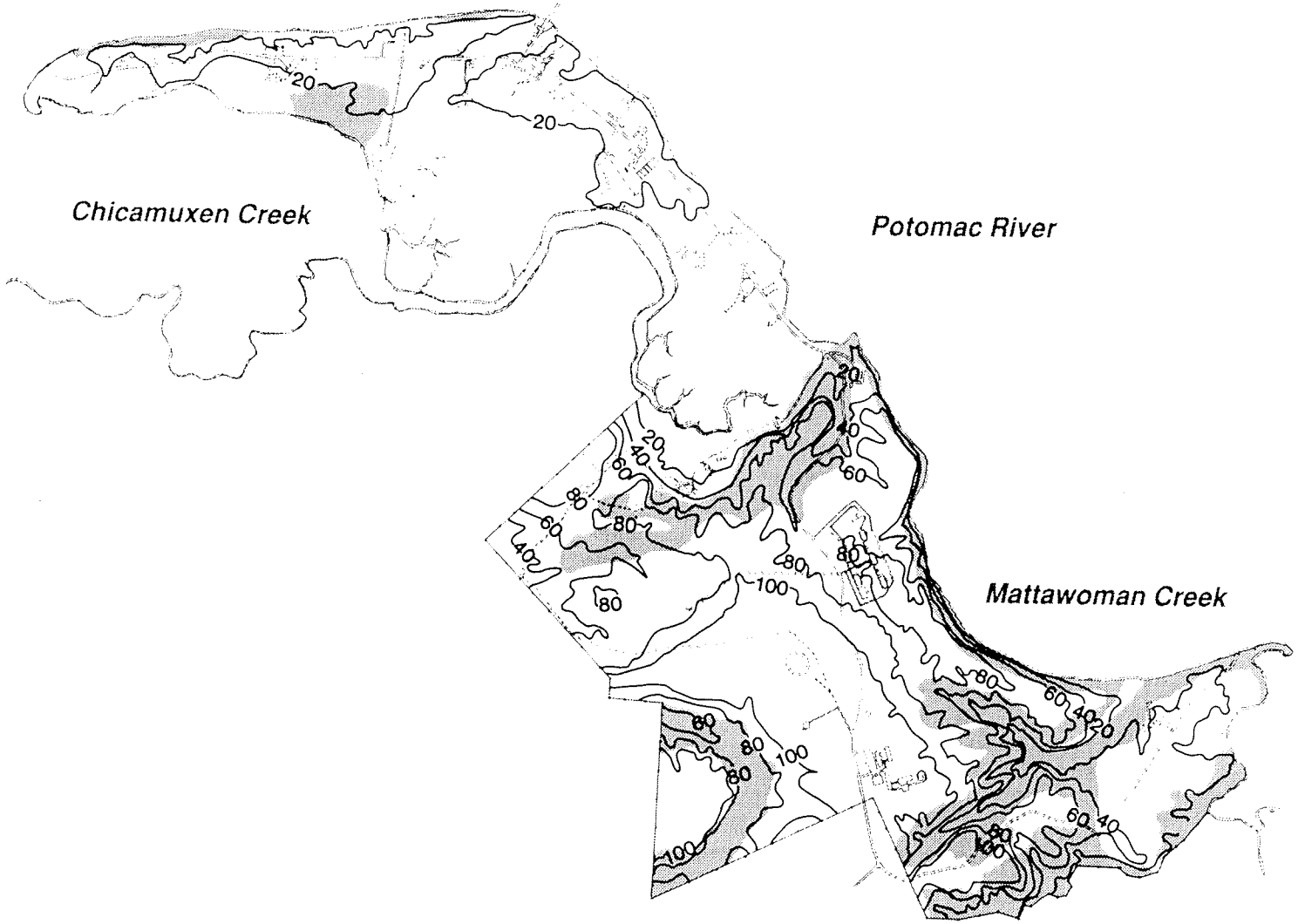
Steep Slope

20' Contour Line

Figure 5-1

0 1000 2000 3000 4000 6000 Feet

Naval Ordnance Station, Indian Head



STUMP NECK

Topography

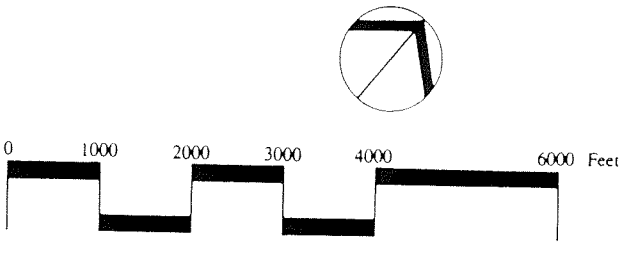
Source: Master Plan Update (1982)

LEGEND

Steep Slope

(20) Contour Line

Figure 5-2



Naval Ordnance Station, Indian Head

controlling erosion, are contained in the Naval Installations Erosion Control Study, prepared by the Army Corps of Engineers (1985).

Soils

The soils of Indian Head and Stump Neck were mapped by the U.S. Department of Agriculture, as recorded in the Soil Survey of Charles County (1974). Many of the soil types have severe load bearing capacity limitations caused by severe erodability and high water table conditions. More detailed information about these soils can be found in the Charles County Soil Survey.

Soils with high water tables (including hydric, or wet soils) at Indian Head and Stump Neck have been mapped in Figures 5-3 and 5-4. These areas should be avoided where possible due to construction limitations. Erodible soils have not been mapped, as avoidance of steep slopes (shown in Figures 5-1 and 5-2) will minimize impacts associated with construction on erodible soils.

In addition to construction limitations, soils may also present limitations on the use of septic systems. A review of the soils on Stump Neck, where no central sanitary sewer system is present, shows that the majority of the remaining undisturbed soils may not be considered acceptable for septic system use (see Figure 5-5). The Maryland Department of Environment follows the USDA guidelines in the Soil Survey of Charles County to determine soil suitability and limitations. Soils listed in the survey as hydric or as having a water table within 3 feet of the soil surface at least 9 months per year cannot be used for septic systems. Other soils listed as having perched, seasonally high or high water tables must be checked during the months of February, March or April to determine if waivers can be granted. Percolation tests done at any other time are not considered valid or acceptable.

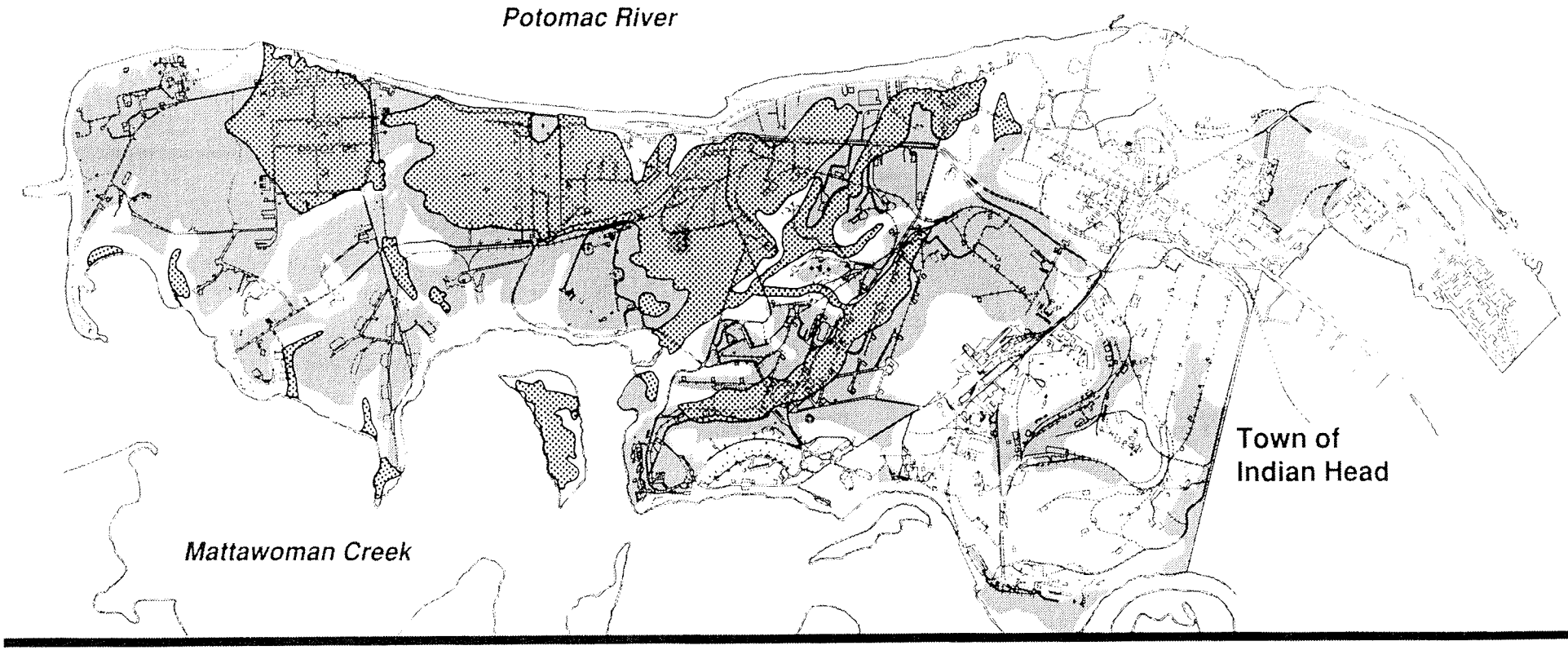
Surface Water

Due to its rolling topography and its proximity to water bodies, NOS, Indian Head is intimately involved in the surface water systems of the region. Wetlands serve to maintain surface water quality. Natural drainage channels on-station quickly transport surface runoff to the Potomac River or its tributaries, but can also carry pollutants such as sediment and toxics. Due to the sensitive location of the Station vis-a-vis surface water, care must be taken to prevent water quality impacts from occurring. There are several Federal and State programs designed to prevent these impacts. These programs, and the resources they are designed to protect, are discussed below.

Wetlands

Wetlands are defined by the Corps of Engineers and the U.S. Environmental Protection Agency (EPA) as areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

Identification and delineation of wetlands is based on the "Three Parameter Approach" developed by the Corps of Engineers. An area is considered a wetland if (1) the prevalent vegetation consists of species specifically adapted to areas having hydrological and soil conditions described above, (2) the soils are classified as hydric or possess characteristics that are associated with saturated conditions



INDIAN HEAD

Soil Constraints

Source: Soil Survey of Charles County (1974)

LEGEND

Hydric Soils

Seasonal High Water Table

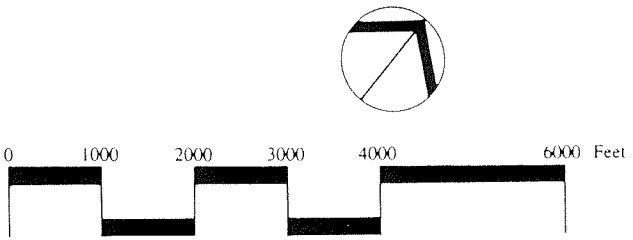
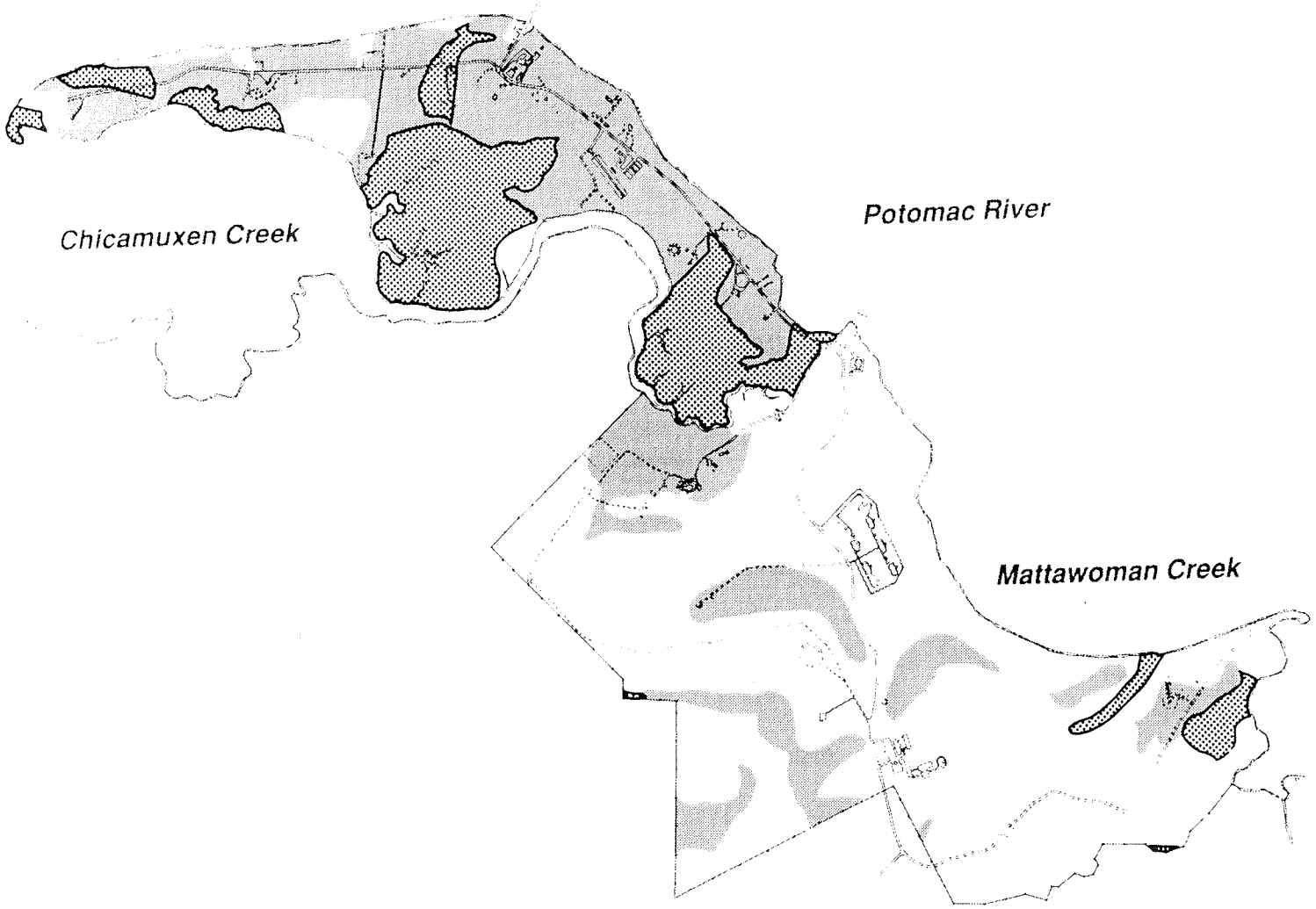


Figure 5-3

Naval Ordnance Station, Indian Head



STUMP NECK

Soil Constraints

Source: Soil Survey of Charles County (1974)

LEGEND

Hydric Soils

Seasonal High Water Table

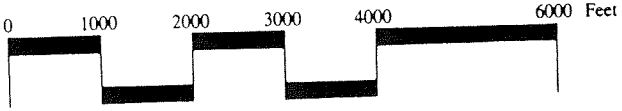
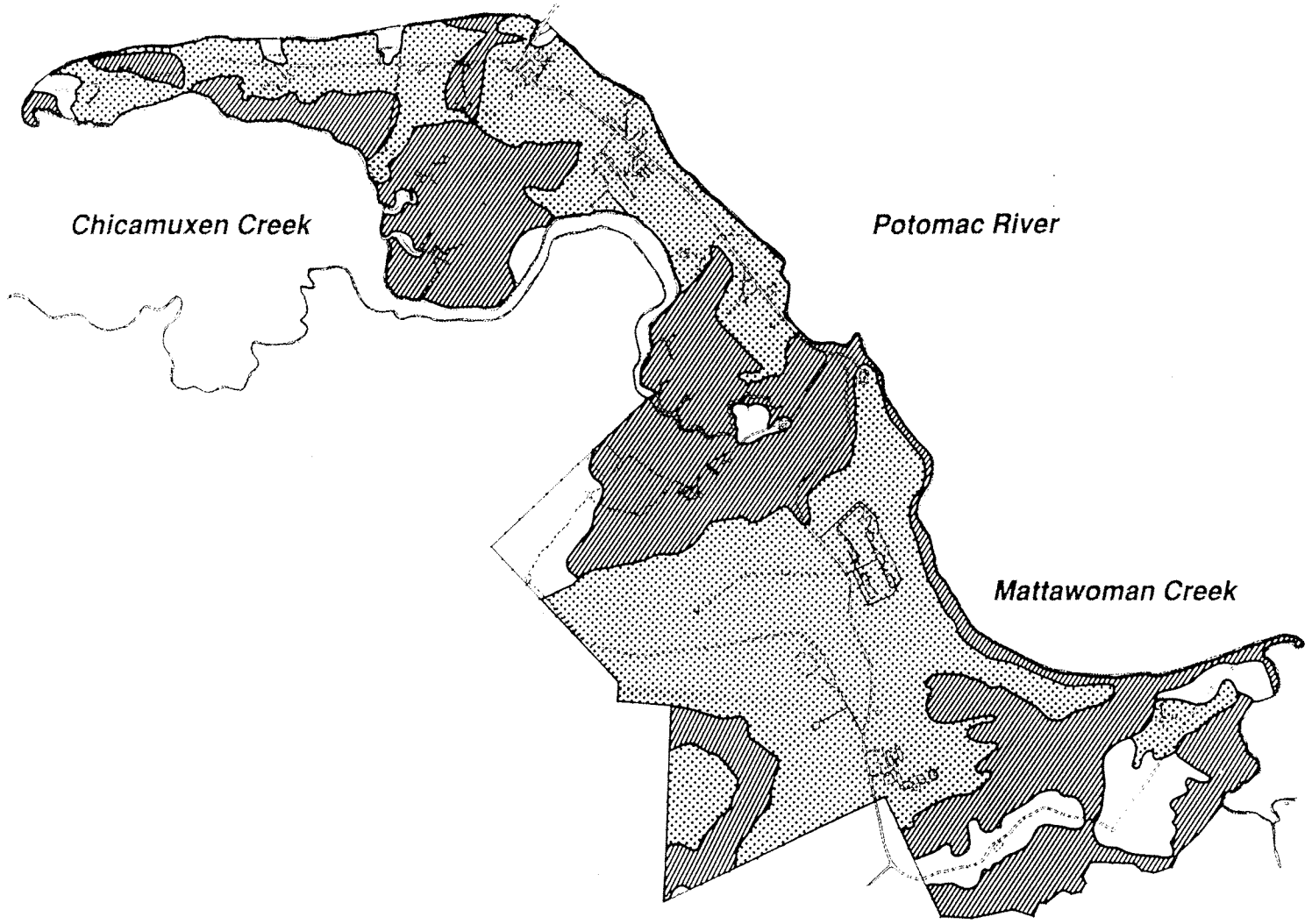


Figure 5-4

Naval Ordnance Station, Indian Head



STUMP NECK

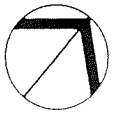
Septic Limitations

Source: Soil Survey of Charles County (1974)

LEGEND

Septic Systems Prohibited

Waiver Required for Septic Systems



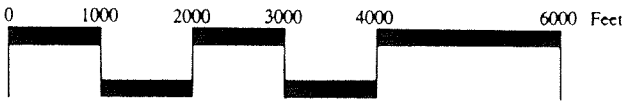


Figure 5-5

Naval Ordnance Station, Indian Head

(e.g., gleying, mottling) and (3) the area is inundated permanently or periodically, or the soil is saturated to the surface at some time during the growing season of the prevalent vegetation (Corps of Engineers Wetlands Delineation Manual, 1987).

Wetlands are important to NOS for several reasons. Aside from their significance as plant and wildlife habitat, and as buffers and filters for maintaining water quality, wetlands are protected by Executive Order (E.O.) 11990. E.O. 11990 requires that all agencies avoid construction in wetlands unless the head of the agency finds that (1) there is no practicable alternative to the construction and (2) all practicable measures will be taken to minimize impacts to the wetlands. Water dependent uses (e.g. docks, intake structures) are examples of facilities for which there are no practicable alternatives. When construction in a wetland is unavoidable, early review of the proposed action must be provided to the public.

Wetlands also fall under the jurisdiction of Section 404 of the Clean Water Act and, to some extent, Section 10 of the Rivers and Harbors Act. As a result, a "Section 404/10" permit must be obtained from the Corps of Engineers prior to the start of any work in a wetland, including all open waters and intermittent streams. The Corps solicits comments from the USFWS, EPA, NMFS, MD-DNR and MD-DOE. In response to recommendations from these agencies, the Corps may require mitigation in the form of wetland creation. The costs involved with creating wetlands can reach $50,000 or more per acre, not including the cost of the upland property to be altered.

Figures 5-6 and 5-7 indicate the approximate extent of nontidal wetlands on both Indian Head and Stump Neck (wetland map symbols are explained in Table 5-1). The areas shown in the figures should be avoided whenever possible. When projects are sited near mapped wetlands, CHESDIV (Code 243) should be consulted to verify the wetland boundary.

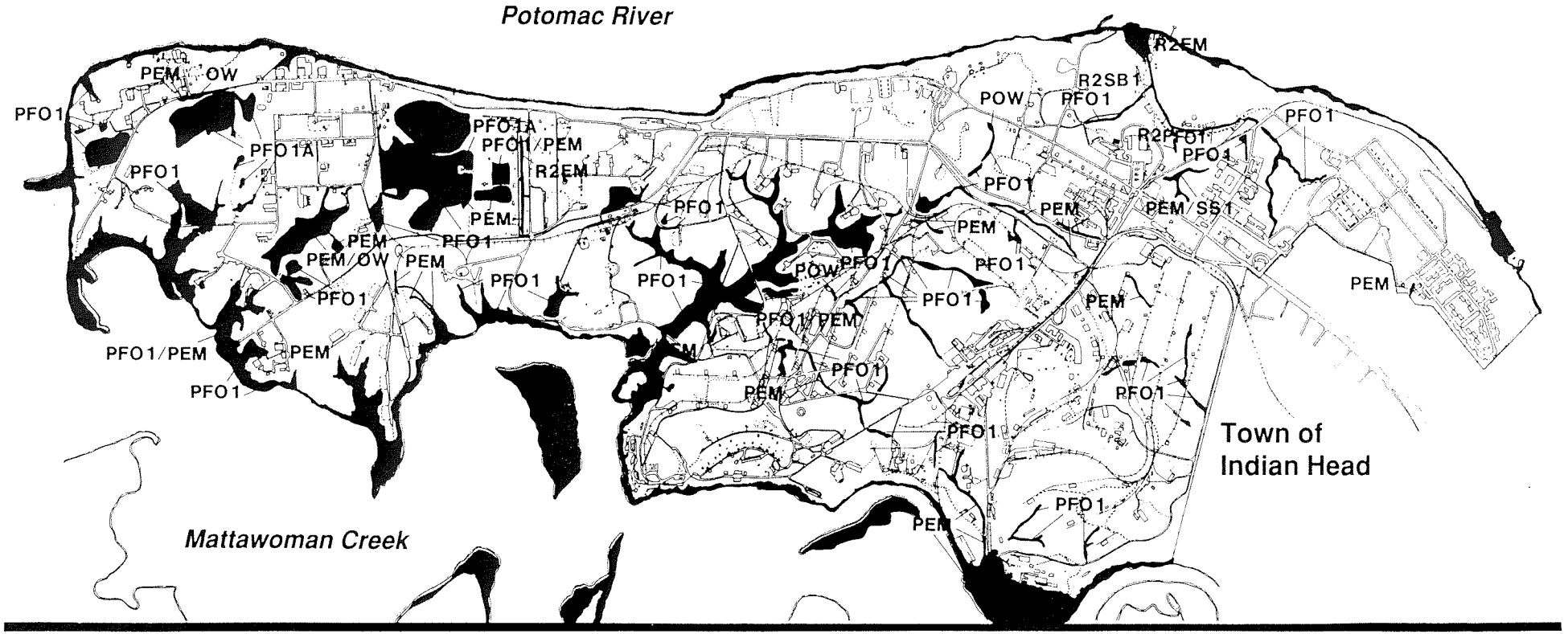
Table 5-1. Key to Wetland Symbols (Figures 5-6 and 5-7)

Wetland Symbol	Wetland Type
OW	Open water
PEM	Palustrine emergent wetland
PEM/OW	Palustrine emergent/open water wetland
PEM/SS1	Palustrine emergent/broad-leaved deciduous scrub-shrub wetland
PFO1	Palustrine forested broad-leaved deciduous wetland
PFO1A	Palustrine forested broad-leaved deciduous temporarily flooded wetland
PFO1/PEM	Palustrine forested broad-leaved deciduous/palustrine emergent wetland
POW	Palustrine open water wetland (unknown bottom)
R2EM	Lower perennial riverine emergent wetland
R2/PFO1	Lower perennial riverine/palustrine forested broad-leaved deciduous wetland
R2SB1	Lower perennial riverine bedrock streambed wetland

Floodplains

A floodplain is defined as land subject to flooding. Floodplains are typically described as an area likely to be inundated by a particular flood. For example, a flood that has a 1% chance of occurring in any one year (i.e., a 1-in-100 chance) is the 100-year floodplain. The 100-year floodplain includes some land areas that are flooded by small, and often dry water courses. The 100-year floodplain at Indian Head and Stump Neck is shown in Figures 5-6 and 5-7.

Executive Order 11988 restricts development within the 100-year floodplain to water dependent activities. Under this Executive Order, each Federal agency must review its action to determine if any part of it will occur within a floodplain. Potential effects of the action within the floodplain, and project alternatives, must be evaluated. Any construction within the floodplain must be in accordance with the



INDIAN HEAD

Hydrology

Source: Draft Wetland Delineation (1989)

LEGEND

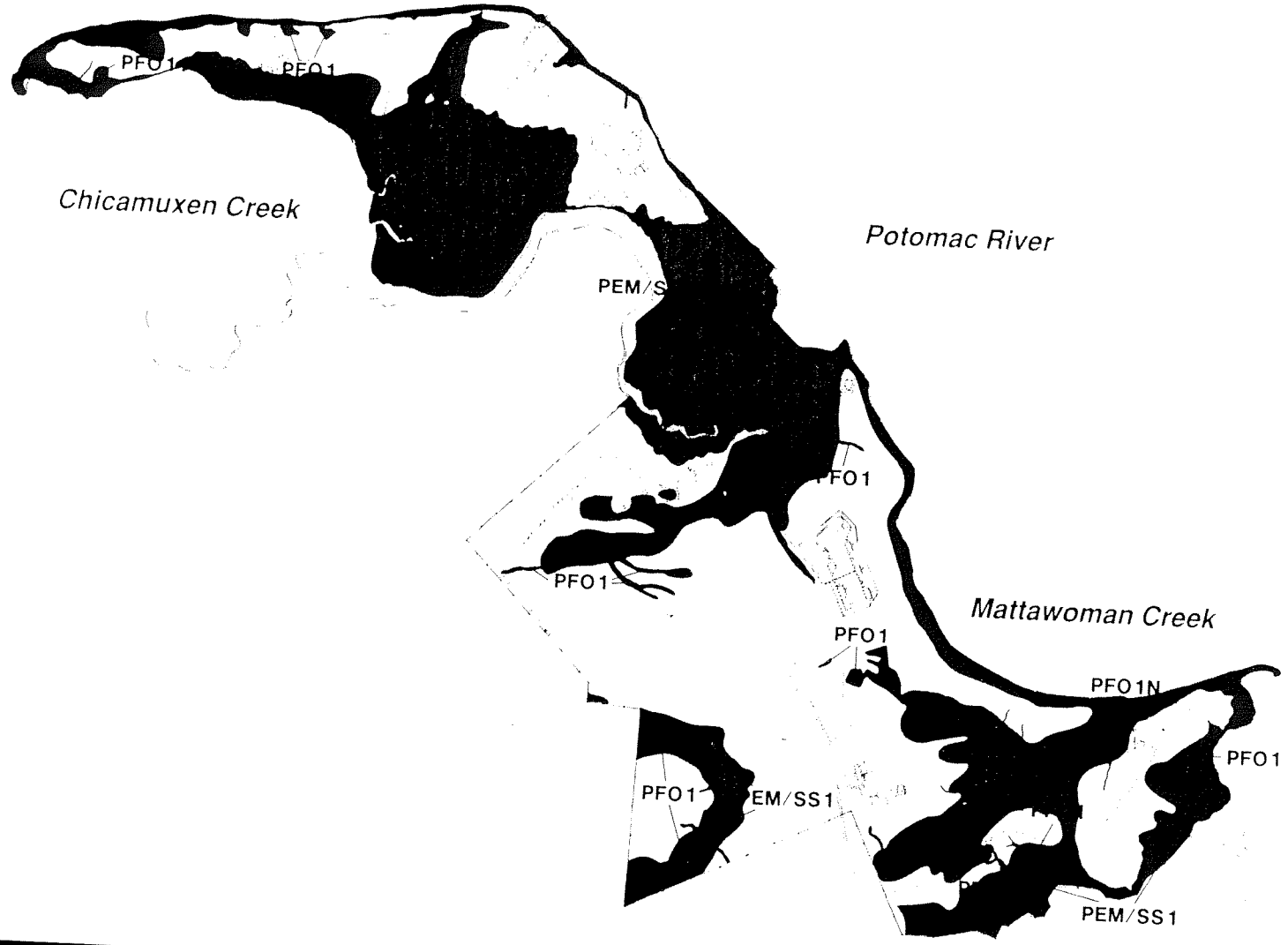
Wetland (See Table 5-1; boundaries between classes of wetlands not shown)

100-Year Floodplain

0 1000 2000 3000 4000 6000 Feet

Figure 5-6

Naval Ordnance Station, Indian Head



STUMP NECK

Hydrology

Source: Draft Wetland Delineation (1989)

LEGEND

Wetland (See Table 5-1; boundaries between classes of wetlands not shown)

100-Year Floodplain

0 1000 2000 3000 4000 6000 Feet

Figure 5-7

regulations promulgated by the Federal Insurance Administration pursuant to the National Flood Insurance Act of 1968. Permits for construction within the 100-year floodplain are also required, and are administered by the Waterway Permits Division (MD-DNR) through the joint Federal/State application process for the alteration of any Floodplain, waterway, tidal or non-tidal wetland in Maryland.

The Potomac River floodplain for both Indian Head and Stump Neck is limited by the steep slopes on the northwest shoreline of both peninsulas. The floodplains for both Mattawoman and Chicamuxen Creeks are more extensive because of the flatter topography associated with their shorelines.

The Coastal Zone

Maryland's Coastal Zone program consists of ensuring compliance with all state requirements that can affect actions in the coastal zone. The program is coordinated by the Department of Natural Resources.

The Coastal Zone of Maryland includes all land and water lying within coastal counties, one of which is Charles County. Based on Executive Order 12372 (Intergovernmental Review of Federal Programs), any federal action (and therefore, any action at NOS, Indian Head) is required to undergo a Coastal Zone Consistency Review. If a federal permit is required (e.g., Section 404/10 permit), the federal permit application will automatically be forwarded to the Maryland Tidewater Administration. If a federal permit is not required, CHESDIV will coordinate with the Tidewater Administration to request a Federal Consistency Determination. Either the permit application or direct contact with the state must include a certification that the proposed action is, to the maximum extent practicable, consistent with the state's coastal zone management program.

The Critical Area. Within the Coastal Zone, Maryland has defined an area within which strict land use management is needed to protect the Chesapeake Bay. This is the Critical Area, defined as a 1,000-foot wide strip of land surrounding the Bay and its tidal tributaries. Requirements for development are extensive, and include the following:

- Prohibition of most construction within 100 feet of the Mean High Water Line. This area is called the Buffer, and it may be wider if steep slopes, hydric soils, or erodible soils are adjacent to the Buffer.

- Prohibition of most construction within wetlands, and within a minimum 25-foot buffer around the wetlands.

- Limitations on impervious surface and clearing, and required re-forestation.

The Critical Area Law and Criteria (i.e., the specific requirements) have been adopted by amendment into Maryland's Coastal Zone Management program. All new facility designs submitted to the state for a Federal Consistency Determination will be reviewed for consistency with the Critical Area Criteria as well.

The Chesapeake Bay Program. The Department of the Defense (DOD) first became involved in the Chesapeake Bay Program in September 1984, when the Secretary of DOD signed a Joint Resolution with the Environmental Protection Agency (EPA). This agreement called for DOD to give priority consideration to funding projects, studies, and review programs to support the Bay clean-up effort.

The 1984 agreement prompted a two-year study by DOD to survey installations in the Chesapeake Bay drainage area, identify those with the greatest potential impacts, and make recommendations to improve water quality. Subsequently, NOS, Indian Head was identified as having potential for significant impacts on water quality in the Bay. Even before the recommendations of the DOD study were published, NOS was implementing projects and programs to reduce adverse impacts on the Bay such as sewage system improvements, development of new technology for treatment of ordnance and explosive wastewater, and implementation of "Best Management Practices" to minimize non-point source pollution.

In December of 1987, DOD signed The Chesapeake Bay Agreement which further defined and expanded its role in the clean-up effort with the District of Columbia, the State of Maryland, and the Commonwealths of Virginia and Pennsylvania. In June of 1988 the Commander, Naval Base, Norfolk, Virginia was appointed as Navy Coordinator for the Chesapeake Bay program. The COMNAVBASE Norfolk will ensure that the Navy supports the specific goals of the 1987 Agreement. Accordingly, NOS is developing a progressive program to support various projects being implemented by the Governor of Maryland to clean up the Bay and promote the 1987 Agreement.

Groundwater

The groundwater in Charles County and NOS, Indian Head is recharged chiefly by precipitation. The water filters through soil and is held primarily in sandy/gravelly formations. The Patuxent Formation is the main aquifer supplying Indian Head. Currently NOS is approaching its maximum contractual level of withdrawal from the aquifer (this issue is discussed further in Chapter 7). The continuous use of the aquifer has made brackish contamination a real possibility.

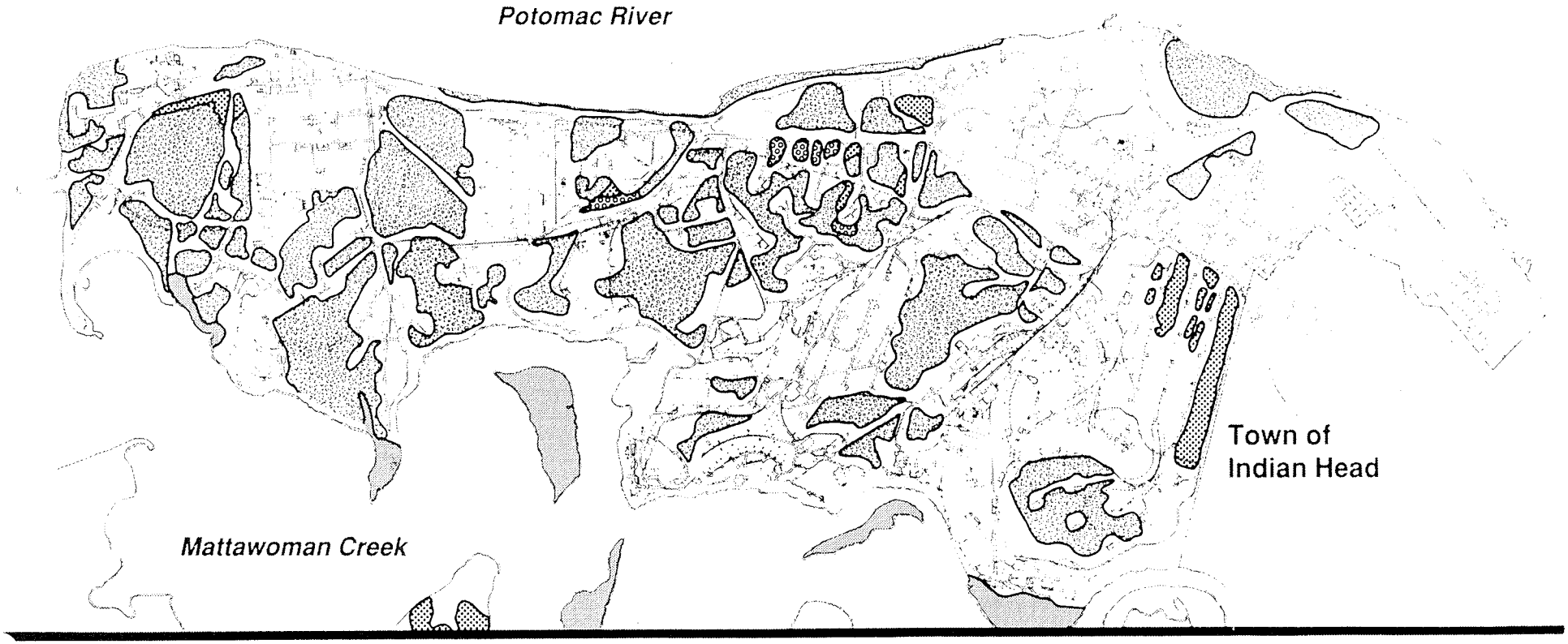
Vegetation

A Forest Management Plan for NOS, Indian Head (1982) has been prepared to provide for the long-term management of forest resources on-station. The plan includes a detailed inventory of existing resources, and recommendations for timber harvest, reforestation, and other management techniques.

There are five basic vegetative cover types on NOS: pine, hardwood, pine-hardwood mix, tidal and non-tidal wetlands, and urban landscape. Both the hardwood category and the pine-hardwood mix category can be further subdivided into upland and wetland divisions. Vegetative cover types are shown in Figures 5-8 and 5-9.

The pine cover areas account for approximately 91 acres on NOS. Of that, pure Virginia pine stands comprise approximately 17 acres. The remaining acreage (approximately 74 acres) is devoted to loblolly pine plantations.

The hardwood forest portion of NOS is approximately 1,078 acres. Approximately 98% of this is mature or overmature hardwood. Recommendations in the Forest Management Plan are designed to eventually balance the age distribution of all forest land to provide for a sustained yield of forest products. Species commonly found in the upland portions of hardwood forests include red oak, white oak, chestnut oak, tulip poplar, and hickories. Red maple, sweet gum, green ash and American sycamore often comprise the wetland acreage.



INDIAN HEAD
Vegetation

Source: NOS Master Plan Update (1982)

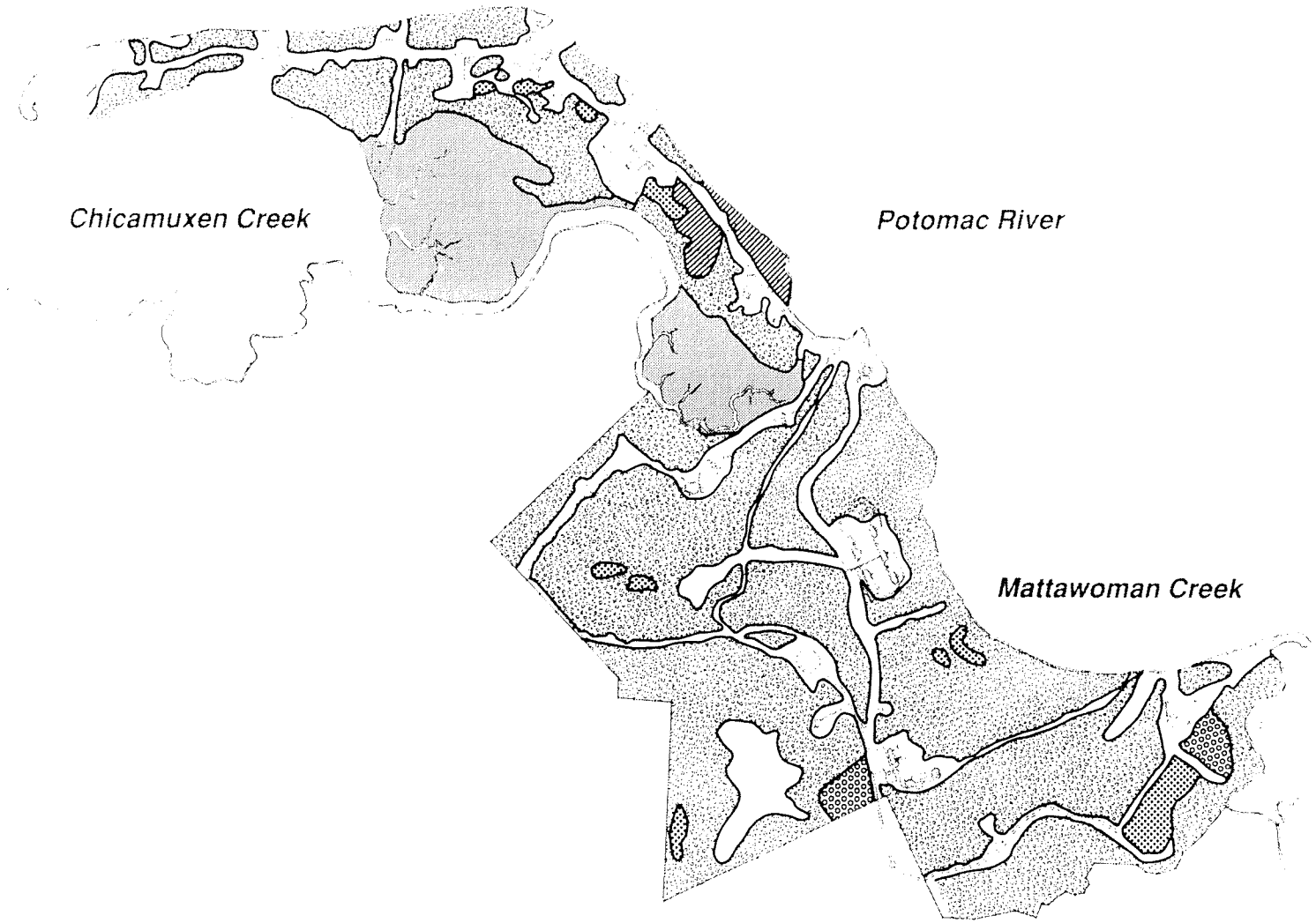
LEGEND

- Pine Forest
- Pine / Hardwood Forest
- Hardwood Forest
- Marsh
- Developed / Other

0 1000 2000 3000 4000 6000 Feet

Figure 5-8

Naval Ordnance Station, Indian Head



STUMP NECK

Vegetation

Source: NOS Master Plan Update (1982)

LEGEND

- Pine Forest
- Pine / Hardwood Forest
- Hardwood Forest
- Marsh
- Open Field
- Developed / Other

0 1000 2000 3000 4000 6000 Feet

Figure 5-9

Naval Ordnance Station, Indian Head

Virginia pine, red oak, white oak, and chestnut oak comprise the pine-hardwood forest areas. These areas occupy approximately 29 acres at NOS. Most of the trees in these stands are well over 50 years old.

The developed areas include those areas around buildings that have been landscaped after development. They are composed primarily of grasses and ornamental plantings.

Wildlife

The NOS Wildlife Management Plan was updated in 1987. The primary objectives of the wildlife management program are to:

- Provide sufficient suitable habitat to meet or exceed population maintenance requirements for threatened, endangered, or sensitive species inhabiting the installation.

- Improve and maintain habitat to provide a sustained yield of game animals for hunters and fishermen and a variety of non-game animals for the nonconsumptive user.

In an effort to implement these objectives it will first be necessary to control the white tailed deer population. As the deer population increases, strain is placed on the existing habitat which then adversely affects populations of numerous other animals as well as the habitat itself. Due to the absence of natural predators (wolf, bobcat, black bear) and lack of hunting, the deer population will continue to rise until carrying capacity is exceeded. The existing habitat will become so overused that a large deer die-off will occur and the value of remaining habitat will be marginal.

The Southeastern Cooperative Wildlife Disease Study Division of the Department of parasitology, College of Veterinary Medicine, University of Georgia, conducted a herd health check on the NOS deer population in 1982. Based on the findings of this study, the Department concluded that there is a good likelihood that the deer population exceeds the habitat carrying capacity, the herd is experiencing parasitism problems (lungworm pneumonia and heavy tick infestations), and evidence suggests that the majority of the animals are susceptible to infection by hemorrhagic disease-causing virus. To avoid excessive malnutrition and heavy parasitism in the near future, it was recommended that herd growth to be stopped and consideration given to herd reduction.

Another field survey conducted in March 1982 by the Regional Forester (Maryland Forest and Park Services), the Project Forester for Charles county, and the Base Forester revealed significant deer browsing which was severe in some areas. The Regional Forester concluded that any attempts at afforestation or reforestation would be wasted unless intensive management of the deer herd is initiated. Trees would be stunted, deformed, or killed under present circumstances.

Based on these studies and as recommended in the 1987 Wildlife Management Plan, the deer population should be reduced soon. A deer control program in accordance with the Cooperative Agreement for Wildlife Management between NOS, the Maryland Department of Natural Resources, and the U.S. Fish and Wildlife Service should be initiated. Initial control measures should be conducted by the NOS Natural Resources Manager. Maintaining the deer population within carrying capacity can be accomplished through a bow hunting season. Bow hunting is not unusual on ordnance stations. A bow season can be easily tailored to NOS requirements with assistance from the Maryland Department of Natural Resources.

The remote and diverse natural conditions of NOS offer an exceptional opportunity to contribute to the conservation of fish and wildlife resources. The species richness of the area is depicted in the list of species that are considered to be common or abundant in Charles County (Table 5-2). Of particular note is the opportunity to conserve wetlands and waterfowl by supporting the North American Waterfowl Management Plan.

Endangered Species

The Endangered Species Act of 1973 requires a federal agency to ensure that its actions and those of its contractors will not jeopardize the continued existence of any threatened or endangered species or result in the destruction or adverse modification of its critical habitat.

There are four endangered species located within the boundaries of NOS. All are located on Stump Neck. Three of the species are now federally protected: the American bald eagle, rainbow snake, and sensitive joint-vetch. The fourth species, the scaly blazing-star is a species of special concern in the State of Maryland.

Cultural Resources

A survey of archaeological resources at NOS, Indian Head was conducted in 1985. The results of that survey are recorded in the Preliminary Archaeological Reconnaissance Survey of the Naval Ordnance Station, Indian Head Maryland. The survey resulted in the discovery of 45 sites representing prehistoric time periods from the Early Archaic through the Late Woodland/Contact transition period. Four of these sites were considered to be eligible for nomination to the National Register of Historic Places as containing "categories of information that will help to further the discipline of archeology." An additional eight sites might be eligible but need further investigation. The entire region of Bullets Neck, with five sites identified and several other potential sites, was considered to be eligible for registration as a prehistoric site district which should be preserved as a unit pending more detailed study. In addition to the prehistoric sites, three 19th century sites and one 19th/20th century site were identified.

Precise location of archaelogocal and historic sites are not included as part of the Master Plan. This has been done to help prevent vandalism and disruption of the sites. Complete information regarding the archaeological sites is available in the draft of the Archaeological Survey which is available through CHESDIV.

The Contact period site, which contains the remains of a small Potomac Creek Indian village, is located near the north bank of Mattawoman Creek (northwest of Marsh Island), off Noble Road. This site was considered especially important, in that there are very few such sites known in Maryland. This site promises information on the introduction of European trade goods into the aboriginal culture and resultant culture changes. The other three sites eligible for nomination to the National Register of Historic Places are in the general vicinity of the first, north of Marsh Island.

In addition to the sites discovered, the draft archeological report described several related areas likely to be archaeologically significant, which were not completely surveyed; an archeological reconnaissance should be undertaken as part of the planning for any improvements in these areas. Development near or on sites described above will require at a minimum that a Phase II archaeological study be completed to determine the exact nature and extent of the artifacts, and whether the site can be developed after all artifacts are extracted

Table 5-2. Common or Abundant Wildlife in Charles County, Maryland.

AMPHIBIANS

northern two-lined salamander
upland chorus frog
green frog
pickerel frog
northern red salamander
American toad
northern cricket frog
northern spring peeper
bullfrog
southern leaopard frog
red-backed salamander
northern dusky salamander
Fowler's toad

REPTILES

northern fence lizard
five-lined skink
eastern hognose snake
rough green snake
northern water snake
eastern garter snake
snapping turtle
six-lined racerunner
eastern worm snake
black rat snake
eastern king snake
northern brown snake
eastern mud turtle
eastern box turtle

BIRDS

horned grebe
great blue heron
green-backed heron
whistling swan
Canada goose
mallard
black duck
American wigeon
wood duck
canvasback
common goldeneye
bufflehead
ruddy duck
common merganser
red-breasted merganser
turkey vulture
red-tailed hawk
red-shouldered hawk
barred owl
whip-poor-will
chimney swift
common flicker
red-bellied woodpecker
downy woodpecker
eastern kingbird
eastern phoebe
acadian flycatcher
eastern wood peewee
tree swallow
barn swallow
purple martin
blue jay
Carolina chickadee
tufted titmouse
white-breasted nuthatch
brown creeper

BIRDS (contd.)

osprey
American kestrel
bobwhite
killdeer
common snipe
herring gull
lauging gull
ring-billed gull
mourning dove
yellow-billed cuckoo
scarlet tanager
indigo bunting
rufous-sided towhee
chipping sparrow
white-throated sparrow
ovenbird
blue-gray gnatcatcher
ruby-crowned kinglet
starling
red-eyed vireo
yellow-rumped warbler
prarie warbler
house sparrow
Carolina wren
mockingbird
catbird
brown thrasher
eastern meadowlark
red-winged blackbird
common grackle
American robin
wood thrush
estern bluebird
cardinal
American goldfinch
dark-eyed junco
field sparrow
song sparrow
American redstart
golden-crowned kinglet
cedar waxwing
white-eyed vireo
northern parula warbler
blackpoll
common yellowthroat

MAMMALS

opossum
eastern mole
little brown myotis
silver-haired bat
red bat
gray squirrel
white-footed mouse
pine vole
Norway rat
meadow jumping mouse
raccoon
fox
least shrew
star-nosed mole
Keen's myotis
eastern pipistrelle
woodchuck
southern flying squirrel
meadow vole
muskrat
house mouse
eastern cottontail
white tailed deer
skunk

by professional archaeologists, or whether it should be made part of the National Register of Historic Places to preserve its value.

An historic survey of NOS buildings was also conducted, and found remnants dating back to the Civil War. In the ravine leading up from the original Potomac River landing area, remnants were found of the original guns tested there, as well as metal plates dating back to the late 19th century. The single base line (single base powder production area), a series of buildings located at the top of the ridge, dates from 1899, as does the water tower, the original power plant, and some administrative and residential buildings (Victorian officers' quarters and the surgeon's house).

The issue of National Register eligibility has not been addressed yet (an upcoming draft historical survey report will include that), but individual buildings and complexes are expected to qualify. These are buildings 101, 103, 111 and 113. Other buildings may also be eligible for the Register. Most significant is the role played by the Station in the industrial history of the development of munitions, and in Naval history. In that sense, the Station as a whole may be considered to be historically significant.

Once buildings are determined to be eligible, impacts of proposed activities must be assessed in accordance with Advisory Council on Historic Preservation regulations (36 CFR 800). One potential conflict posed by the historicity of the production facilities, especially the single base line, is that many of the buildings are stripped to shells, contaminated, and have of necessity been demolished for safety reasons. Also, any renovation of salvageable WWI or WWII facilities, while desirable for reasons of safety and efficiency, would reduce the historical value of those buildings.

Outdoor Recreation

The primary goal of the NOS Outdoor Recreation Program as detailed in the 1988 Outdoor Recreation Plan is to provide a full spectrum of recreation opportunities which complement the existing recreation programs and are consistent with the NOS mission. To meet this goal the following objectives should be promoted:

- Provide for the physical and social well being of military and civilian personnel by providing outdoor recreation opportunities not currently available on the installation or within the surrounding community.
- Provide recreation opportunities in locations convenient to users and compatible with master planning.
- Provide a physical environment in a safe setting that enhances outdoor recreation experiences.
- Provide community outreach programs to foster a "good neighbor" relationship.
- Implement the Outdoor Recreation Plan and Cooperative Agreement to help to ensure that the quality of life for installation employees is improved.

Summary

NOS is taking major steps to manage the natural resources under its stewardship. Notable accomplishments should be documented for participation in the next (1991) DOD Natural Resources Conservation Awards Program. Continued Command support for the Natural Resources Management Program will help to ensure placement in the competition.

6

Environmental Management

ENVIRONMENTAL MANAGEMENT

It is Navy policy, as stated in OPNAVINST 5090.1, to comply with the intent of all federal and state environmental directives. The NAVORDSTA Environmental Handbook serves as a convenient reference to the myriad environmental regulations and requirements that govern waste management, environmental releases, personnel training and related environmental concerns at the Station. The scope and implications of environmental management requirements are described below.

Air Quality

Charles County is currently classified as an air quality attainment area. This status excludes NOS from many air quality regulations. However, Maryland has proposed strict regulations to govern volatile organic compounds (VOC's), which are precursors to ozone. If and when enacted, these regulations will require NOS to reduce VOC emissions and implement a strict monitoring and control program. It also appears likely that Charles County will be reclassified as non-attainment for ozone because of its proximity to the Washington DC metropolitan area. If this happens, air quality standards for new and existing sources will be even more stringent.

Only the power house and thermal treatment area currently require air emission permits. The permit for the power house is issued by the Maryland State Department of the Environment. The thermal treatment area (burn point) is regulated by two permits, one issued by the State of Maryland Department of Health and Mental Hygiene and the second by the Charles County Health Department. The proposed VOC regulations would, however, require permits for many of the other activities currently at NOS, as well as for many proposed activities. To obtain permits, NOS will have to show that the activity in question will not degrade ambient air quality beyond the limits set by new regulations. Activities that may require permitting in the future include boilers, incinerators, petroleum storage tanks, fueling operations, open burning sites, activities that allow solvents to evaporate into the atmosphere, and industrial processes such as spray painting, curing and drying.

Wastewater

NOS operates under an Industrial Wastewater Discharge permit issued by the State of Maryland and EPA. At present, many wastewater streams undergo primary treatment prior to discharge. However, in order to meet a compliance schedule placed in their discharge permit, NOS is constructing treatment facilities at various sites. Phase I (MILCON P-963), programmed for FY91, will provide a collection system and additional treatment facilities for nitration plant wastewaters. It will also include sewer connections to connect selected industrial wastewaters to the NOS domestic sewage treatment plant. Phase II (MILCON P-106), programmed for FY92, will provide holding tanks and sewer connections for the remaining industrial wastewater sources. The Best Management Practices Plan for NOS presents a plan for managing and treating all industrial wastewater at the NOS.

NOS also operates under a Sanitary Wastewater Discharge permit issued by the State of Maryland and EPA. All sanitary sewage on Indian Head is currently treated at the existing treatment plant. Sanitary sewage on Stump Neck is managed by 17 septic fields. Of these, five are surface outfall systems operated under permits issued

by the State of Maryland. Currently, these septic outfalls do not always meet standards. The five surface systems will be upgraded by NOS in FY90.

Stormwater and Sediment Control

Stormwater is an environmental management issue because it can carry surface pollutants and eroded soil (i.e., sediment) to nearby surface waters. Stormwater at NOS is typically handled by allowing the water to collect in ditches from which it eventually discharges directly to the Potomac River or the Mattawoman or Chicamuxen Creek. In many cases these culverts have developed leaks, cracks and breaks which allow water to seep directly out through the cliff face, contributing to existing erosion problems. This overland system of stormwater management has also resulted in increased erosion (and therefore, increased generation of sediment) in many of the drainage swales and ditches.

Stormwater runoff is governed by regulations enforced by the Maryland Water Resources Administration. The adoption of the Chesapeake Bay Agreement will serve to strengthen these regulations, because sediment control is an important aspect of Bay water quality control. Construction of new projects requires analysis of post-development stormwater runoff and a plan for maintaining predevelopment runoff levels. The Maryland Standards and Specifications for Erosion and Sediment Control outlines specific measures to be taken to control sedimentation and erosion as well as suggestions for managing stormwater. Supplemental guidance for preparing stormwater management reports has been prepared by Code 114 (Environmental Engineering Branch) and Code 405 (Civil Engineering, Design Branch), CHESDIV. These sources should be consulted during the design phase of any action requiring disturbance of soil. Stormwater Management and Sediment Control Plans are coordinated by the Public Works Facilities Acquisition Division (Code 092).

Hazardous Waste

Hazardous wastes are defined by EPA as substances that exhibit ignitability, corrosivity or toxicity. Hazardous wastes include spent solvents, heavy metals, and explosive scrap.

The Clean Air Act, the Clean Water Act, and the Resource Conservation and Recovery Act (RCRA) all regulate the release of hazardous wastes. The U.S. Department of Transportation (DOT) regulates the transport of hazardous materials. NAVORDSTAINST 5090.2 specifies the procedures for use at NOS, Indian Head during handling, turn-in, storage, and treatment of hazardous waste.
NOS has a permit that allows storage of hazardous wastes beyond the 90-day limit (RCRA Part B Permit), and a permit allowing the storage and delivery of oil (Oil Operations Permit). Non-compliance with these permits can result in the revocation or suspension of these permits as well as fines to the responsible parties or individuals. Wastes other than explosive wastes are delivered to the central storage facility (Building 455) for off-station disposal. Explosive wastes on NOS are disposed of by burning at one of two active burn points. This is conducted under "interim status" (i.e., a final permit has not yet been issued).

All naval installations are required by 1992 to reduce their hazardous waste production to one half the level produced in 1987. For this

reason, it is unlikely that new hazardous waste storage facilities will be funded by DOD, despite the current shortage of space.

An Initial Assessment Study of the Station (NEESA 13-021), completed in 1983, identified 38 potential hazardous and non-hazardous waste sites on NOS. Most of the sites are historic and many were subject to clean-up prior to the study. Of the sites, only one, a mercury deposition site in a wetland near Building 766, is currently undergoing review for cleanup due to potential impacts to human health and the environment. However, the locations of certain other sites that do not currently pose a threat to human health or environment in their current use should be noted (see Figures 6-1 and 6-2). The sites in Figures 6-1 and 6-2 may present constraints for future development, although data to characterize the sites are insufficient. If these sites are considered for future use or disturbance of any type, site surveys should be conducted to evaluate actual risks that may be incurred. The sites are described below. Site numbers correspond to those assigned in the Initial Assessment Study.

Site No. 1 -- Thorium Spill

This spill site is the area near the Special Weapons Disposal Building (Building 900). Although some cleanup took place, there are no records available to indicate the success or extent of cleanup of thorium-contaminated soil. A thorough survey should be made prior to any excavation or change in land use in the vicinity of Building 900.

Site No. 5 -- Grain Manufacture and X-Ray Building, Open Drain

This open ditch was formerly used to discharge wastewater. Silver compounds, which are toxic to marine life, may have deposited along the sidewalls and bottom of the ditch. Further study of the site is recommended to determine whether earthwork associated with future activities may result in migration of contaminants to surface water.

Site No. 7 -- HMX Spill

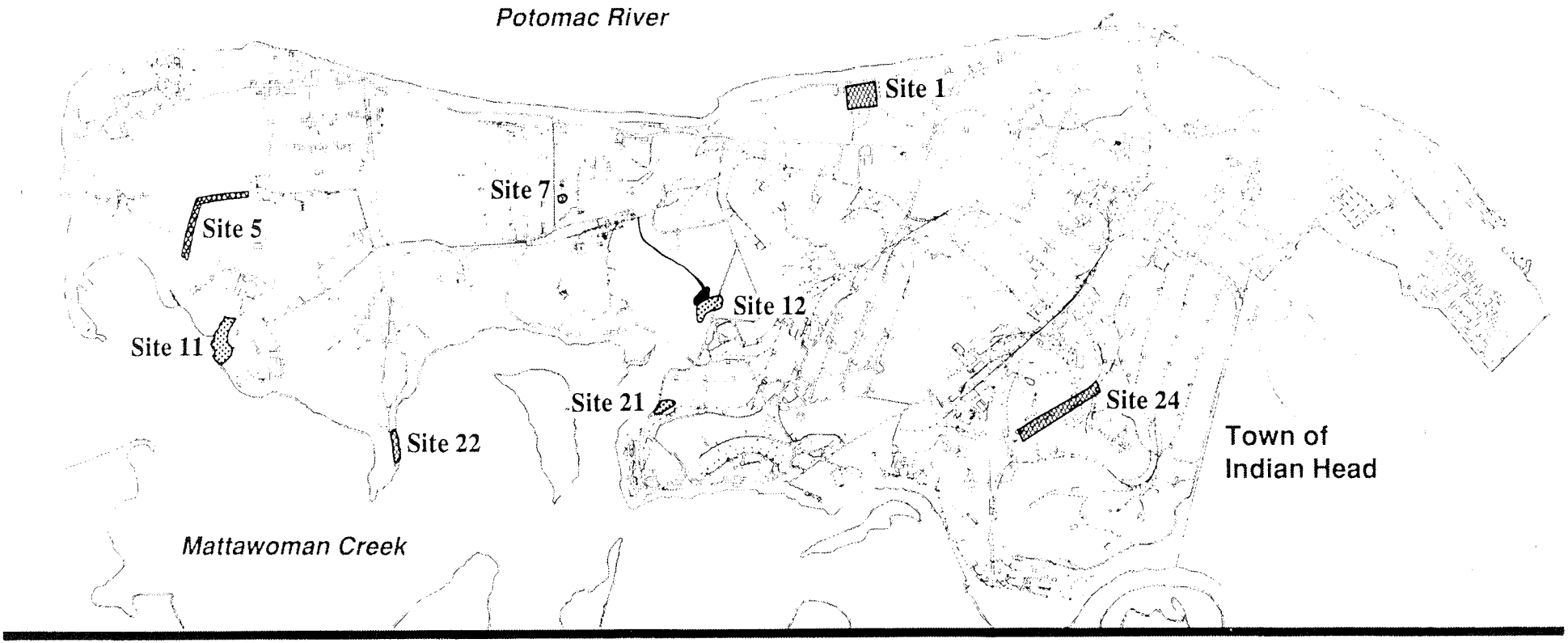
This spill is the area around the Slurry Mix Building (Building 682). HMX was discharged in the area around Building 682, and HMX and lead were discharged into an open storm ditch (no. IW10). It is probable that HMX and lead remain in the vicinity of Building 682. Therefore, precautions should be taken during future earthwork activities in this area.

Site No. 11 -- Caffee Road Landfill

This site is a formerly used disposal site for trash, bulk items and other undetermined materials. Physical characteristics of the site have not been evaluated. Due to the uncontrolled nature of disposal operations, this site should be avoided for future development due to potential for stability and contamination problems.

Site No. 12 -- Town Gut

This site was used for disposal of landscaping waste, fill material and rubble, and may have been used for unauthorized trash disposal, including paints and varnish. Further study of the site is recommended to determine nature and extent of contamination.



INDIAN HEAD
Former Waste Disposal Sites

Source: Initial Assessment Study, 1983

LEGEND

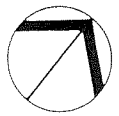
Closed Landfills

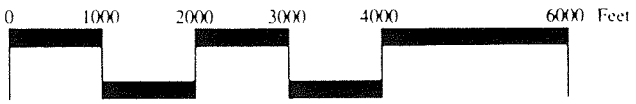
Other Waste Sites

Mercury Deposits

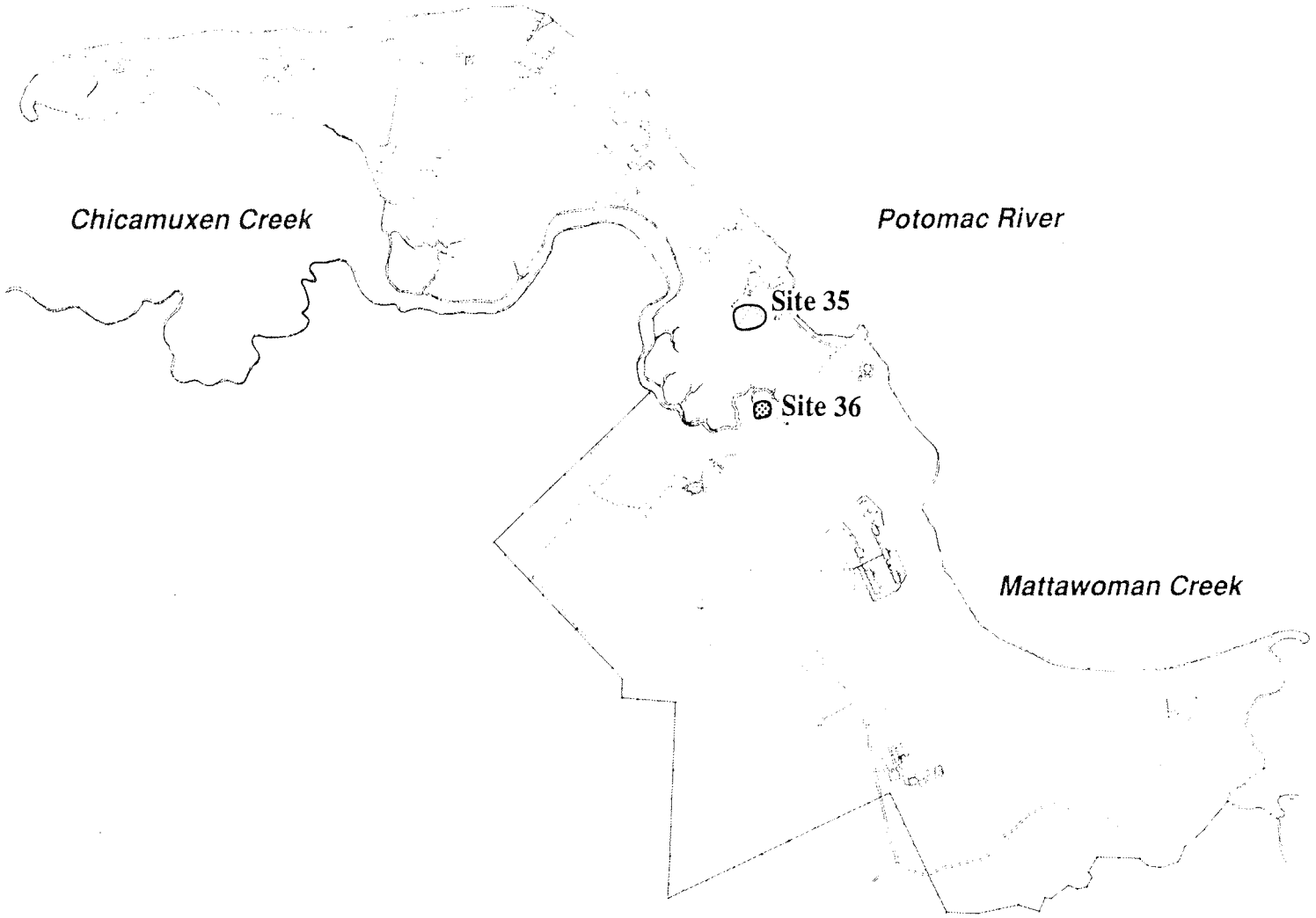
All boundaries are approximate

Figure 6-1





Naval Ordnance Station, Indian Head



STUMP NECK
Former Waste Disposal Sites

Source: Initial Assessment Study, 1983

LEGEND

Closed Landfill

Buried Torpedoes

All boundaries are approximate

0 1000 2000 3000 4000 6000 Feet

Figure 6-2

Naval Ordnance Station, Indian Head

Site No. 21 -- Bronson Road Landfill

This site is the location of a two-acre abandoned gravel mining pit. This site was used for disposal of trash, paint sludges, bagged asbestos, and unauthorized materials. Due to the site's use for disposal operations, the site should be avoided for future development due to potential for stability and contamination problems.

Site No. 22 -- NG Slums Burning Site

This site was formerly used as a burning ground for NG slums generated by the nitroglycerin plant. Explosive hazards should be considered prior to the use of this site.

Site No. 24 -- Abandoned Drain Lines

This site is the location of the abandoned nitrocellulose production facilities. There is some concern that nitrocellulose may have deposited in abandoned drain lines located near the old plant site. Due to its explosive characteristics, this potential safety hazard should be factored into any future development plans, especially earthwork activities in the vicinity of the old plant and abandoned drain lines.

Site No. 35 (Stump Neck) -- Buried Torpedoes

This unconfirmed site is believed to contain buried torpedoes, including parts that were not rendered safe. This site should not be disturbed due to the potential safety hazard.

Site No. 36 (Stump Neck) -- Closed Landfill

This site is believed to contain metal casings such as mines, bombs, and torpedoes. The contents are claimed to have been certified inert and did not contain explosives or chemicals when buried. However, the site should be avoided due to potential stability problems.

EPA has conducted a RCRA facility assessment (RFA) of NOS, Indian Head. The RFA is an inventory of all solid waste management units at NOS. Based on review of available documents and a visual inspection of NOS, EPA has identified a total of 78 solid waste management units and 13 areas of concern. The latter are areas where the potential for contamination exists, such as former spill sites. EPA, through its authority under the 1984 amendments to RCRA, can require remedial action for unregulated releases from any of these units or areas.

Non-Hazardous Solid Waste

NOS disposes of non-hazardous solid waste by contract. The waste is taken to the Charles County landfill.

7

Man-Made Features

MAN-MADE FEATURES

The built environment at NOS presents opportunities and constraints for future use in much the same way that natural features do. Existing land use patterns are described, and will serve as the starting point from which development patterns will evolve. An analysis of facilities is included as an input to the facilities planning process. Information on infrastructure is also provided, as these features will determine, to some degree, the ability of existing systems to support additional growth or redevelopment.

Land Use

Current land use patterns, based primarily on assigned category codes, are shown in Figures 7-1 (Indian Head) and 7-2 (Stump Neck). Category codes for specific facilities are as contained in the NOS Engineering Evaluation data base, in which category codes are assigned to facilities according to the system established in Department of the Navy Facility Category Codes, April 1984 (NAVFAC P-72).

The land use classifications shown in Figures 7-1 and 7-2 were derived according to the following rules:

Operations/Training - Facilities coded in the 100 series. These are typically occupied by or under the cognizance of organizations whose mission is related to explosive ordnance disposal technology and training.

Production - Facilities coded in the 200 series, excluding facilities under the cognizance of the Public Works Department. These are facilities used to produce ordnance and other products.

Maintenance/Utilities - Facilities coded in the 800 series, and facilities coded in the 200 series and under the cognizance of the Public Works Department. These facilities are related to the supply of power, water, waste treatment, and facility and equipment construction and maintenance.

RDT&E - Facilities coded in the 300 series. These are facilities associated with product research and development, testing and evaluation.

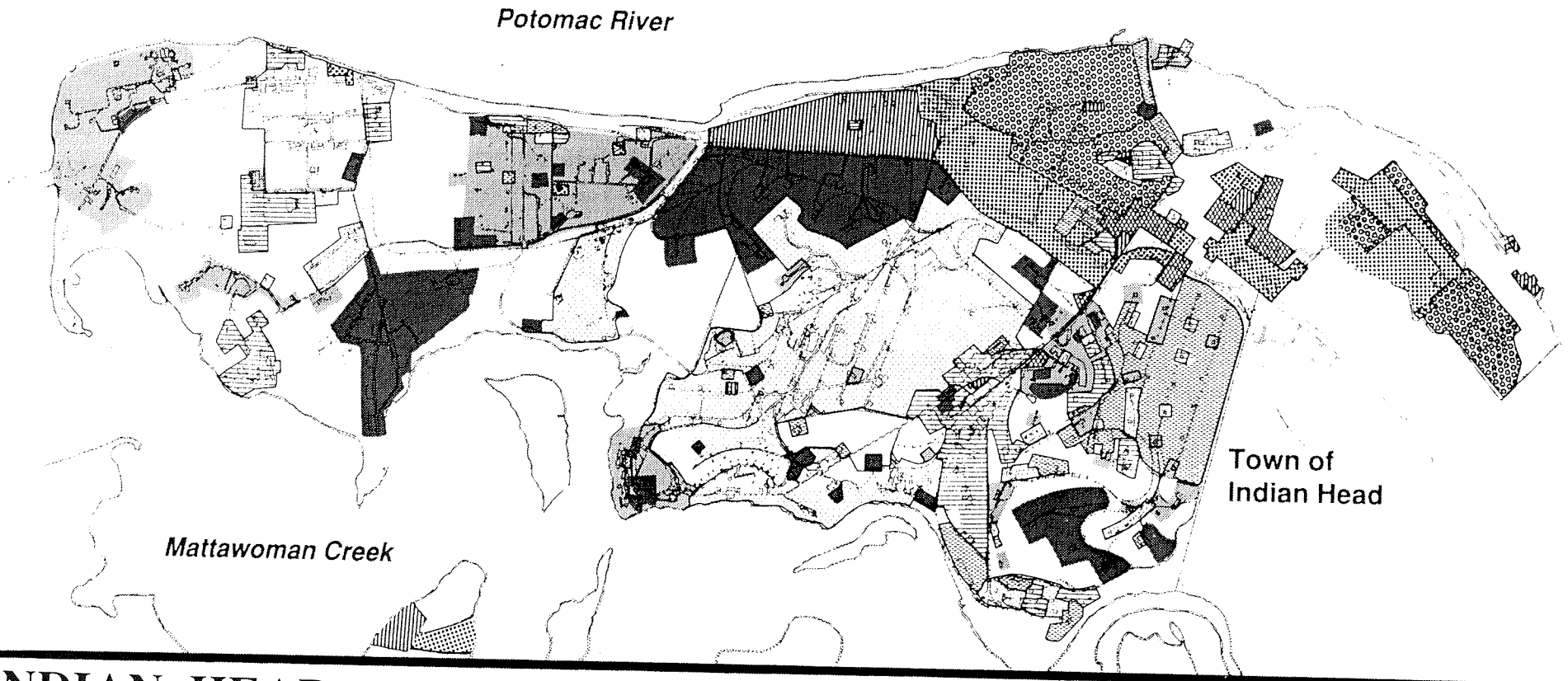
Explosives Storage - Facilities coded in the 420 series. These are storage facilities that generate an explosive safety quantity distance arc.

Supply/Non-explosive Storage - Facilities coded in the 400 (excluding 420) series. These are typically storage and other facilities under the cognizance of the Supply Department.

Administration - Facilities coded in the 600 series. These facilities provide work space for personnel whose job is to support production and RDT&E functions.

Community Facilities and Services - Facilities coded in the 500 and 700 series, excluding 710 and 720. These facilities provide services related to the non-professional needs of the on-station community (e.g., medical, recreational, security).

Housing - Facilities coded as 710 and 720 (residential and related buildings).



INDIAN HEAD
Existing Land Use

Source: Engineering Evaluation (1988)

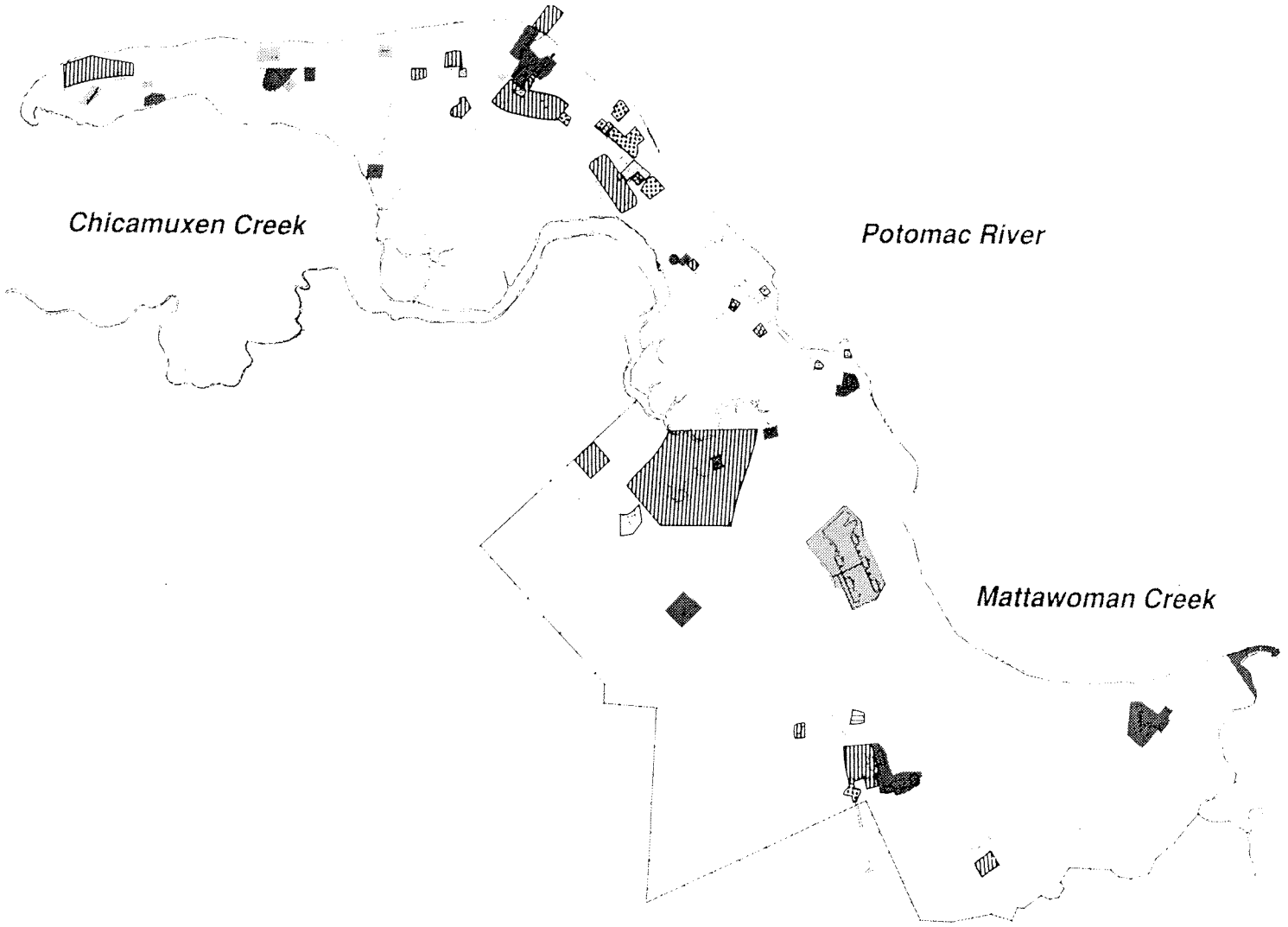
LEGEND

- Operations / Training
- Production
- Maintenance / Utilities
- RDT&E
- Explosives Storage
- Supply / Non-Explosive Storage
- Open Space
- Administration
- Community Facilities and Services
- Housing

0 1000 2000 3000 4000 6000 Feet

Figure 7-1

Naval Ordnance Station, Indian Head



STUMP NECK

Existing Land Use

Source: Engineering Evaluation (1988), NOS Public Works Engineering Division Files

LEGEND

- Operations / Training
- RDT & E
- Production
- Maintenance / Utilities
- Explosive Storage
- Supply / Non-Explosive Storage
- Administration
- Community Facilities and Services
- Open Space

0 1000 2000 3000 4000 6000 Feet

Figure 7-2

Naval Ordnance Station, Indian Head

The development pattern at Indian Head has evolved over the years, resulting from continual changes in workload that have occurred in response to the Navy's requirements. The Station has had to gear up for new tasks, vacating some structures and adding others as required for a particular need. Vacated structures are quickly used for other purposes when possible, resulting in a seemingly scattered and unorganized land use pattern. This pattern and process of land development and use has created functional as well as operational inefficiencies within some organizations.

Production is the largest single land use at Indian Head. The production area has been established over many years of development at NOS and consists of three major areas: The Cast Plant, Nitration Plant, and Intermediates Manufacturing. Two smaller production facilities include Extruded Products and CAD/PAD manufacturing. Safety requirements prohibit dense development of these facilities, and require them to be located within the security fence.

The second major land use at Indian Head is RDT&E, also located within the security fence. Major areas are the test areas near Hog Island and near the Old Burn Point, the manufacturing technology area between Strauss Avenue and Caffee Road, and smaller areas along Mattawoman Creek and just within the secure area gate.

Explosives storage occurs in a few large clusters, providing for better control and safety, while non-explosive storage and supply is widely scattered throughout Indian Head to better serve the needs of Station activities. The major exception to this is use of the old dry houses near Benson Road, by the Supply Department.

Most other uses at Indian Head, with the exception of Maintenance, are located outside of the security fence. Maintenance functions are scattered, with major areas occurring along Patterson Road within the security fence, and along the Potomac waterfront (in "the Valley") outside of the security fence.

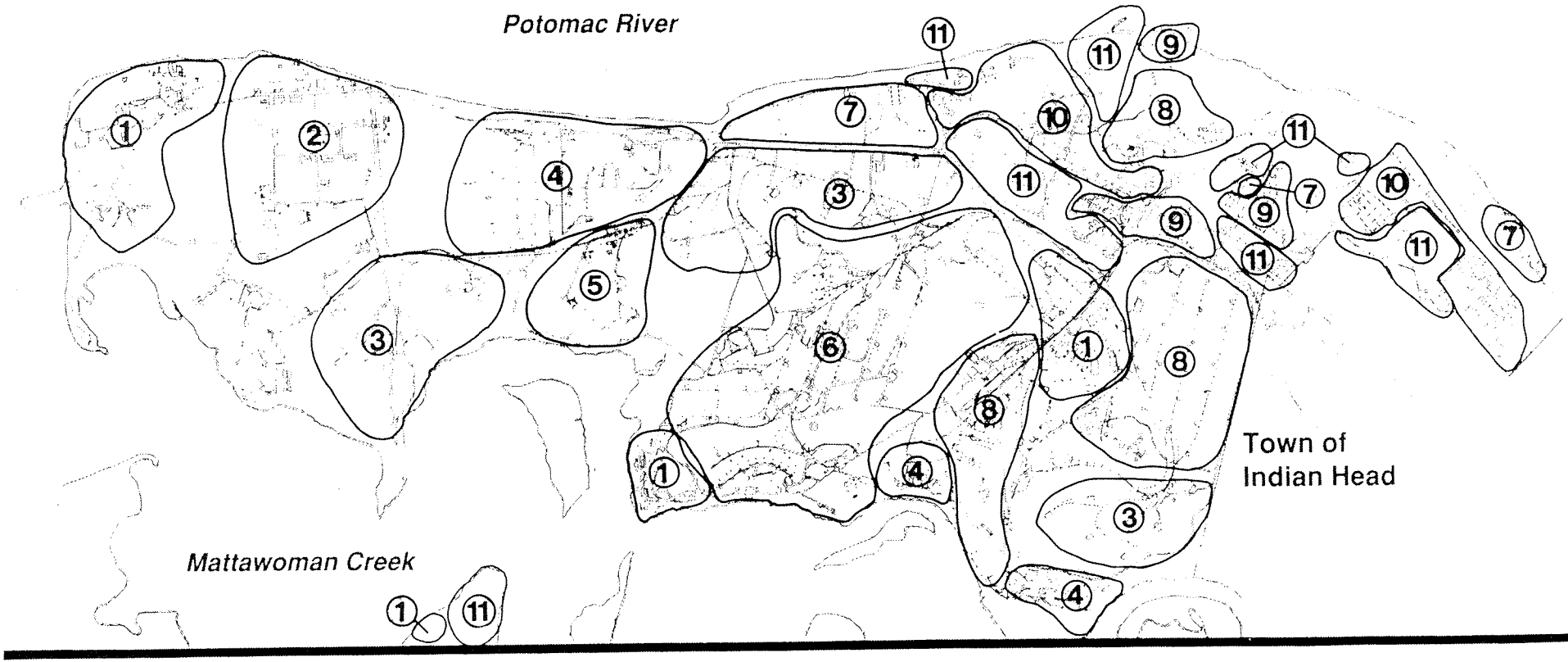
At Stump Neck, a variety of land uses occur, but there are fewer use categories, and use areas are much smaller than on Indian Head. This is primarily due to the development constraints and safety requirements of the site. Stump Neck is the primary location of the Naval Explosive Ordnance Disposal Technical Center, and most uses located at Stump Neck are related to the needs of that organization. In addition, the Naval Ordnance Station conducts some testing and evaluation and operational training at Stump Neck.

At Bullets Neck, plans for a natural Resources/Environmental Education Center and a Weather/Air Quality Monitoring Facility are being implemented.

The land use patterns at Indian Head and, to a lesser degree, Stump Neck, appear quite complicated. However, close examination reveals that land uses fall into several distinct functional areas, based on the use that predominates in each location. These functional areas are shown in Figures 7-3 and 7-4. Consideration of these functional areas will be an important factor in planning for future land uses. To the extent that like functions can be clustered (as permissable within operational needs and constraints), overall Station efficiency will be improved.

Facilities

In support of the Station's mission approximately 1,057 buildings, totalling nearly 2.9 million square feet, have been constructed at NOS. Of these buildings, 80 are located at the Stump Neck and Rum Point



INDIAN HEAD

Functional Areas

Source: 1989 Master Plan Update

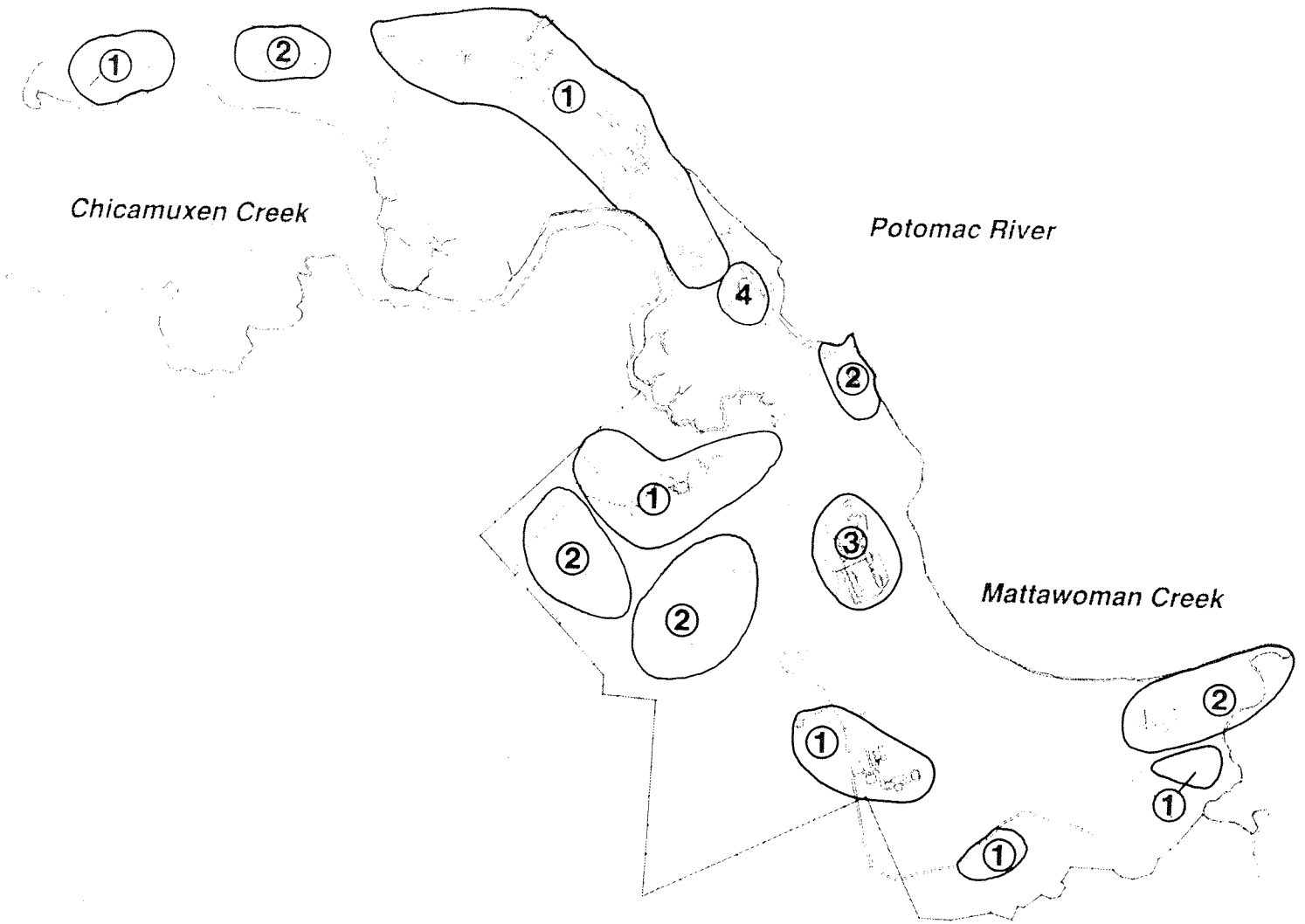
LEGEND

1 Test and Evaluation
2 Cast Production
3 Explosives Storage
4 Manufacturing Technology
5 Nitration
6 Ordnance
7 Training
8 Support (Public Works / Supply)
9 Administration
10 Housing
11 Community Facilities and Services

0 1(000) 2(000) 3(000) 4(000) 6(000) Feet

Figure 7-3

Naval Ordnance Station, Indian Head



STUMP NECK

Functional Areas

Source: 1989 Master Plan Update

LEGEND

1 Training
2 Test and Evaluation
3 Explosives Storage
4 Facilities Maintenance

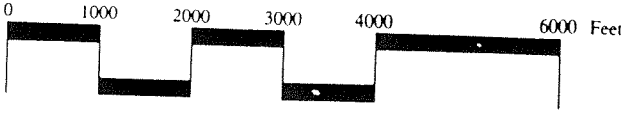


Figure 7-4

Naval Ordnance Station, Indian Head

sites, 4 buildings (3 of which contain residential units) are located at Waldorf, 4 buildings are located at at LaPlata, and 1 building is located on Bullets Neck (a former residence, pre-dating the land acquisition by NOS). The remaining buildings are located on the main Indian Head site.

Many of the structures at NOS were constructed to support the Station's efforts related to World War I, World War II, and the Korean conflict. Several date back to the Station's turn of the century origins, and approximately 25 buildings are old enough to be of possible historical significance.

Most of the older buildings are production buildings, many with unusual configurations related to their original function. There are also a large number of magazines among the structures at NOS. Construction materials used in the buildings at NOS vary from very large masonry and steel structures to small metal or wooden structures. Magazines are typically of concrete or brick; many have been further hardened (made better able to contain explosive forces) by being partially enclosed by earthen berms.

Facilities Analysis

Table 7-1 summarizes the buildings at NOS by their general type of construction, which is defined in the Shore Facilities Planning Manual (NAVFACINST 11010.44E) as follows:

Permanent: a building constructed with a highly durable exterior, structural framing of substantial building materials such as masonry, concrete, or steel, finished interior (where normally applicable), and expected to be useful for its designed function with minimum maintenance for a period of at least 50 years.

Semi-Permanent: a building constructed with a moderately durable exterior, structural framing of substantial building materials such as masonry, concrete, or steel, interior finished or unfinished, and expected to be useful for its designed function with moderate or high maintenance for a period of at least 25 years, but not less than 10 years.

Temporary: a building constructed with a nondurable exterior, structural framing of lesser grades such as wood or light gauge steel, low grade or nonexistent interior finishes, and expected to provide minimum facilities for five years without regard to the degree of maintenance.

Table 7-1. Facilities Construction

Type of Construction	Number of Buildings	Percent of Buildings	Square Footage	Percent
Permanent	546	52%	1,921,785	67%
Semi-Permanent	301	28%	779,047	27%
Temporary	210	20%	163,482	6%
Totals[1]	1,057	100%	2,864,314	100%

Note:

(1) Structures not normally measured in terms of square feet (such as wharfs, liquid fuel storage facilities, and open storage areas) are not included in these totals.

Source: NAVFAC report P-164 -- Detailed Inventory of Naval Shore Facilities, 30 September 1988.

As Table 7-1 shows, permanent and semi-permanent buildings comprise 80% of the total number of buildings and 94% of the total space (gross square footage) at NOS today. The use of temporary buildings has declined somewhat since 1982, when temporary buildings made up 25% of the total (1982 Master Plan Update). Permanent buildings make up 5% more of the total now than in 1982.

The terms "permanent", "semi-permanent" and "temporary", by definition, apply only to buildings. A number of vital structures (such as magazines, wharfs, liquid fuel, and other storage facilities, and open storage areas) are not normally measured in terms of square feet. Measures such as cubic feet, gallons, berthing feet, outlets, square yards, etc. are used instead. Such facilities are not summarized by type of construction or number of structures on the P-164, and thus can not be included in these totals. Most such structures could be considered as "permanent", albeit in a more general sense than that of the NAVFACINST 11010.44E definitions.

As ordnance technology has evolved, production facilities that could be adapted were renovated to accommodate new technology and production methods, and to meet the Navy's and the Station's changing needs. However, certain buildings, because of their configurations and specialized equipment, were not adaptable to new production technologies. Such buildings were replaced by new facilities, and their only subsequent use, if any, has been for purposes other than production. For example, a number of the older dryhouses, no longer needed in that function, have been renovated for general storage or office space.

Most ordnance production facilities must be decontaminated and extensively renovated before they can be used for other purposes. Since this process can be prohibitively expensive, a number of the outmoded production buildings have been demolished, when decontamination is impractical, or abandoned when are not available for renovation.

Table 7-2 (Facilities Usage Summary), summarizes the facilities at NOS by their general type of function using data from the most recent Engineering Evaluation (Assets Evaluation) of NOS facilities. Functions correspond to the category codes assigned to individual facilities, as defined in Department of the Navy Facility Category Codes (NAVFAC P-72).

Table 7-2. Facilities Usage Summary

Category	CCN	Number of Facilities[1]	Percent	Gross Feet	Percent
Operations & Training	100	56	4%	276,573	10%
Maintenance & Production	200	398	30%	767,839	27%
RDT&E	300	277	21%	384,975	13%
Supply	400	76	6%	355,613	12%
Magazines	420	174	13%	242,868	8%
Medical/Dental	500	2	<1%	9,525	<1%
Administrative	600	45	3%	252,495	9%
Family Housing	710	92	7%	422,715	9%
"Bachelor" Housing (UPH)	720	16	1%	111,205	3%
Community Facilities	700	58	4%	124,894	4%
Utilities	800	129	10%	120,138	4%
TOTALS:		1,323	100%	3,068,840	100%

Note: (1) Facilities not normally measured in terms of square feet (such as runways, wharfs, liquid fuel storage facilities, and open storage areas) are not included in these totals. Magazines are included in these totals, although only some magazine types are normally totalled by square footage as "buildings" (vs. "structures"), totalled by cubic feet.

Source: Engineering Evaluation, Naval Ordnance Station, May 1988.

A "facility" as included in this table, and as defined in NAVFAC P-72, may be an entire building or other structure, or may be only part of a building, in cases where a building is used for more than one function (category code). For example, part of a building may be used for administrative office space and part for a locker room (change/relief house). Such buildings are referred to as "multi-user buildings."

The building in the preceding example would be counted *both* under the total Number of Facilities for administration (category 600) and *again* under maintenance and production (category 200, under which the detailed category code for change/relief house falls). However, the square footage used for *each function* is counted *separately* under

each appropriate category code. Because the totals in the Facilities Usage Summary (Table 7-2) are for facilities, not buildings, the overall totals will not match those in Table 7-1 (Facilities Construction), which are for buildings.

As Table 7-2 shows, maintenance and production functions together occupy about 398 facilities (30% of total facilities) and about 768,000 square feet (SF), or about 27% of total SF. Approximately 277 facilities, representing about 21% of all facilities and 13% of total SF, are used for research, development, testing and evaluation (RDT&E) activities. These two operational categories account for about 51% of all facilities and 40% of all space (SF) at NOS.

About 174 facilities (13% of total facilities), representing 8% of total SF, are used for explosives storage. Other types of storage and supply functions occupy about 76 facilities and 12% of SF. (A relatively low number of supply facilities account for a substantial proportion of the total SF because many are warehouses, which tend to be relatively large individual buildings, especially as compared to magazines, which are numerous but tend to be small structures.) Administrative uses account for about 45 facilities, and close to 9% of SF.

Community facilities, including NOS's medical/dental clinic and a variety of recreational and other support facilities, occupy about 60 facilities and 5% of total SF, in addition to the non-structural facilities such as ball fields and picnic areas which are not listed here. About 129 facilities and 4% of total SF are facilities related to Station utilities (power, steam, water, sewer), in addition to the many utility-related facilities which are not normally measured in SF (transformer stations, waste treatment units, steam lines, fuel tanks, sewage treatment tanks and basins, etc).

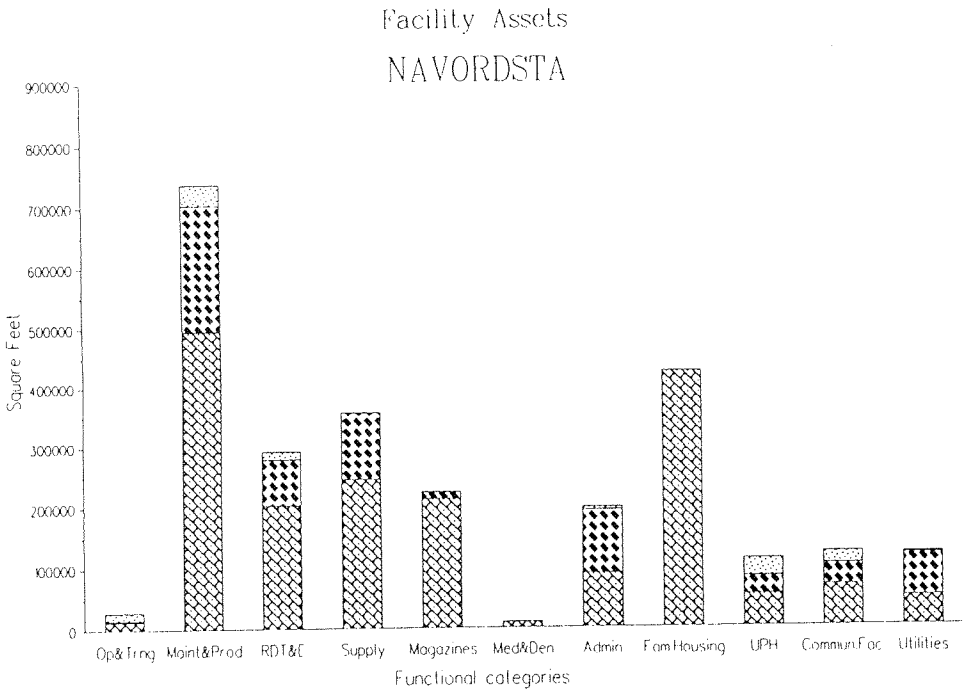
Housing provided by NOS for military personnel with families accounts for about 92 facilities (housing, garages, and storage buildings) and 9% of SF, including the 7 housing buildings and one related storage building at the Waldorf and LaPlata housing sites. Many of the family housing units are detached houses which are fairly old, but are in relatively good condition; the Station's multifamily units tend to be of more recent construction, and are also in relatively good condition overall. NOS also maintains a number of sites that are used for tenant-owned trailers. Including the trailer sites, NOS can provide housing for about 300 families. About 16 residential facilities are housing and mess facilities for Unaccompanied Enlisted Personnel Housing ("bachelor" quarters, or UEPH).

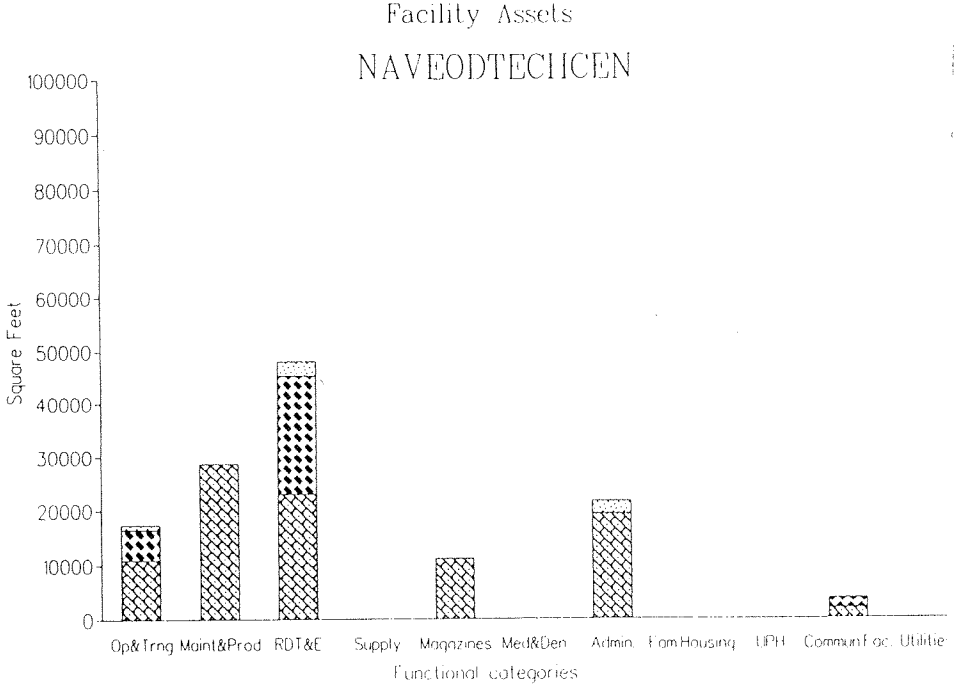
Condition of Facility Assets

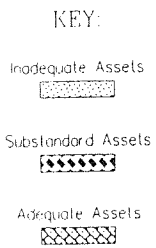
Figure 7-5 (Facility Assets) illustrates the condition of the assets at NOS used by NAVORDSTA and its two major tenant activities, the Naval Explosive Ordnance Disposal Technology Center (NAVEODTECHCEN) and the Naval School, Explosive Ordnance Disposal (NAVSCOLEOD).

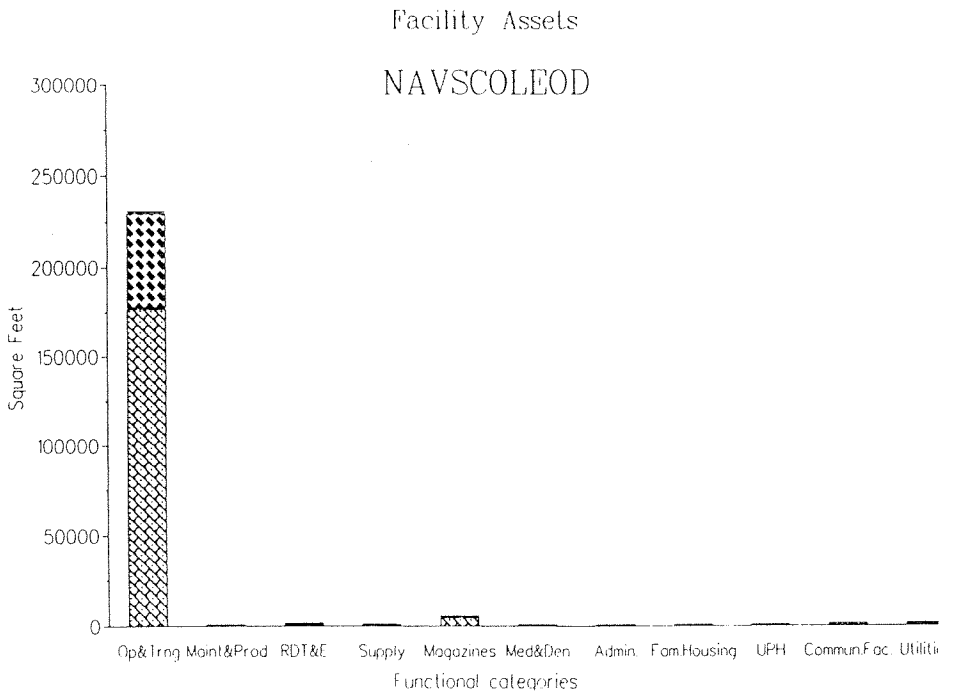
This summary is provided for general planning purposes only, and is not intended to replace the latest Facility Planning Document (FPD). As an overview, this figure and discussion show adequate, substandard and inadequate assets at the most general level of functional categories, whereas the FPD analyzes them at the level of detailed category codes and individual facilities, including requirements.

Requirements are based on analysis of the NOS mission, base loading and other relevant information, resulting in a minimum requirement for space (assets) needed in each category code relevant to the Station's mission. In the FPD, this requirement is compared with









Facility Assets

Figure 7-5

existing assets, and specific actions are proposed for resolution of deficiencies and/or surpluses in each category code. For detailed information on Basic Facility Requirements, contact the Facilities Acquisition Division (Code 092) of the Public Works Department at NOS.

Facilities (assets) are categorized as either adequate, substandard, or inadequate spaces, as defined in the Shore Facilities Planning Manual (NAVFACINST 11010.44E), December 1987, and summarized below:

Adequate: facilities which are fully capable of supporting their current use without modification or repairs that normally require approval and funding beyond the authority of the activity's Commanding Officer; such facilities should be within the limits and restrictions of planning criteria, satisfy structural and mechanical criteria, and do not conflict with operational or safety requirements; facilities that are acceptable but barely satisfactory are considered adequate.

Substandard: facilities which are capable of supporting their current use, but require modifications or repairs which normally require approval and funding beyond the authority of the activity's Commanding Officer to make them adequate; such facilities can be converted to another functional use for which they would be adequate, if economically justifiable.

Inadequate: facilities that cannot be made adequate for their present use through "economically justifiable means"; inadequate facilities may be made adequate or substandard for a use other than the current one. (The difference between substandard and inadequate is essentially economic: in general, a facility requiring repairs that would cost more than 75 percent of the cost for equivalent new construction should be considered substandard.)

A deficiency is defined as the difference between the approved requirement in a given category code, and existing adequate assets within a category code. Substandard facilities should be upgraded to adequate status wherever possible, or converted to another use for which they would be adequate. Inadequate facilities should be converted to another use or disposed of.

As the Basic Facility Requirements for NOS is under revision, an analysis of assets versus requirements cannot be presented here. Contact the Public Works Facilities Acquisition Division (Code 092) for further information.

There is a prevailing shortage of space at NOS. One result of this situation is that vacant buildings are quickly made use of by a different function, when buildings become no longer useable for their original functions due to changing technology or changes in mission. The changing uses of facilities as they become available often result in substandard or inadequate configurations for the new uses. For example, former production or storage buildings may have inadequate overhead space or cramped floor layouts for administrative or engineering office space; dryhouses formerly loaded from a boxcar loading dock, converted to storage for rocket motors and now loaded by forklift, may not provide good access.

Projects currently planned to correct deficiencies, for NOS as well as its two major tenants, are described in the Capital Improvements Plan.

Transportation

Vehicular access to NOS is from MD 210, a four lane divided highway which extends south from I-95 to the entrance gate to Indian Head. The highway was constructed by the Federal government to assure good access to NOS production and storage facilities. The main gate at the edge of the Town of Indian Head is the only open road access to the Station. At the main gate, MD 210 narrows to two lanes and becomes Strauss Avenue. On an average day, more than 1,250 vehicles pass through the gate. A small guard house provides the only transition between the Town and the Station. Guards depend on signs to slow traffic approaching the gate. Primary and secondary traffic routes and primary traffic destinations are shown in Figure 7-6.

During the morning rush hour, most of the traffic entering the front gate bears left and follows Farnum Road and turns left on Patterson Road to pass through a second security gate to the restricted area. The restricted area gate is a choke point for traffic on the Station. Much of this traffic is headed to the Public Works and Supply area. Other destinations include supply, engineering offices, and other functions that are not required to be in the restricted area. The rest of the organizations within the restricted area are widely dispersed.

The remainder of the traffic follows Strauss Avenue into the non-restricted area. The work centers include Central Administration, the EOD School and Training Facilities, SEAADSA, personnel and administrative facilities. In addition, all traffic to the housing area in the northeast corner of the Station must use Jackson Road to Patterson and Earle Roads.

During the evening rush hours, the traffic pattern reverses with the majority of the traffic exiting the installation from the restricted area. This traffic uses Patterson Road, then Farnum Road through the main gate.

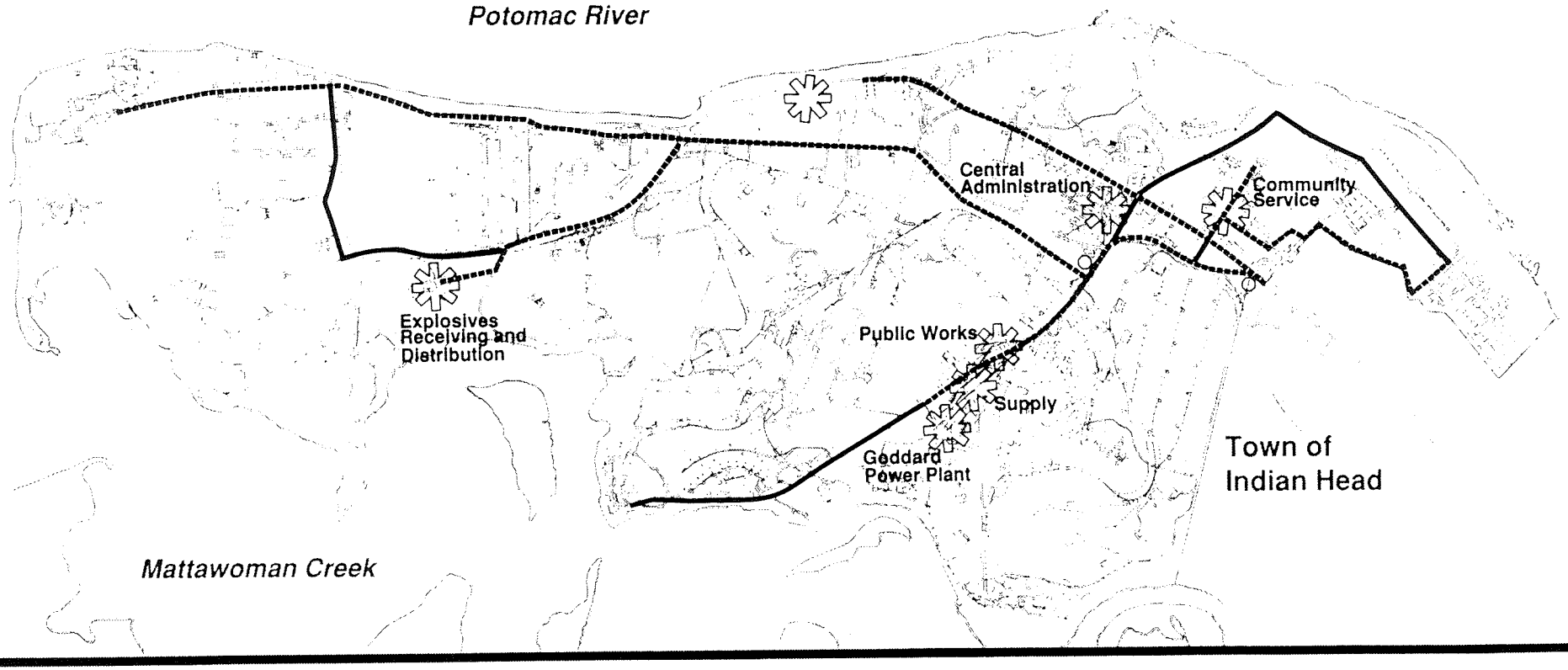
Studies by the Military Traffic Management Command have identified intersections that need to be improved for safety reasons. The intersection of Strauss Avenue and Jackson Road is one of several intersections that will be reconfigured to assure safe traffic flow.

Parking is available in sufficient quantity throughout the Station. In many cases however, this is on-street parking or it conflicts with service access. Both of these situations create serious circulation and safety problems. The worst example of this is the supply building loading dock (Building 116). This one area includes service access for tractor trailers, employee parking, and pedestrian traffic moving between buildings. In general, on-street parking should be eliminated from primary roads and loading area access points, and reduced where possible on other roads.

Patterson Road has parallel parking and 90-degree parking between Farnum Road and Strauss Avenue. This arrangement adds confusion to an area located between two of the three busiest intersections on Station. Adding to the confusion is a service drive extending from Building D-323 to the intersection of Strauss and Patterson.

Parking also creates a hazard on Patterson Road near Buildings 351, 503, and 551. Perpendicular spaces create a situation where cars back out on to a busy road. Heavy traffic at rush hours makes the situation even worse.

Visitors to NOS must register at the Pass Office (Building 872) outside the front gate. Badges are issued here during daytime business hours (7:00 a.m. to 4:00 p.m.). After business hours, visitors are issued a temporary pass at the gate and then must go to Security



INDIAN HEAD

Existing Circulation

Source: Physical Security Division (Dept. 10), Traffic Engineering Study (1984), Master Plan Update (1982), Facilities Planning Branch (Dept. 09)

LEGEND

----- Primary Traffic Routes

Primary Traffic Destinations

— Secondary Traffic Routes

○ Security Gate

0 1000 2000 3000 4000 6000 Feet

Figure 7-6

Naval Ordnance Station, Indian Head

Police Headquarters (Building D339) to be issued a badge. All visitors entering the Station are subject to inspection by security police. There is no designated area for inspections and most take place at the gate. Vehicle inspections cause traffic to back up, particularly at rush hours. Trucks are not allowed on Station until 8 a.m.

Over 100 delivery trucks a day pass through the main gate at Indian Head. Most of this traffic is headed to the supply warehouse or munitions unloading area. Both of these facilities are located in the restricted area. Each of these vehicles must make three stops: pass office, front gate, and the restricted area gate. The supply warehouse has no requirement to be in the restricted area, but all traffic going there must follow the required security procedures.

The transportation system at Stump Neck (Figure 7-7) is much simpler than at Indian Head. Archer Road is the primary traffic route, and leads from the main gate westward through the middle of the site. Access to Rum Point is currently unrestricted; visitors do not have to pass through the security gate to reach that destination.

A Traffic Management Group has been established to review traffic impacts of all projects and to oversee improvements related to vehicular traffic and safety.

Pedestrian Circulation

Most work centers in the non-restricted area have sidewalks connecting buildings within that area. However, there is very little pedestrian access between work centers. On-station traffic could be reduced by the development of a well-defined pedestrian circulation system. NOS is small, but distances between work centers are perceived as being greater because there is no definite pedestrian link.

Where pedestrian walkways do exist, they are limited in scope. Important pedestrian connections are:

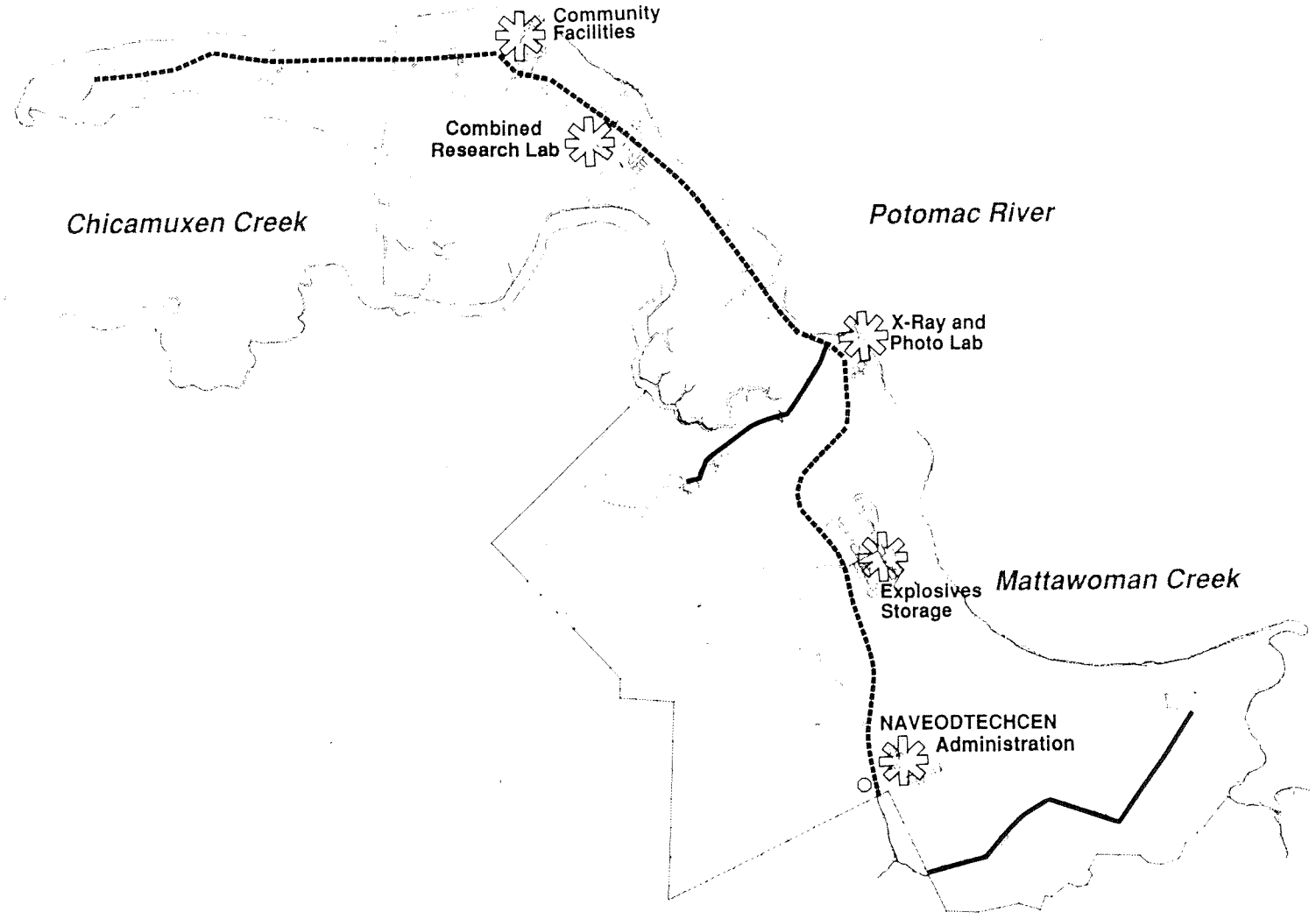
1. Housing--Swimming Pool--Recreation
2. EOD School--Bachelor Housing
3. Administration--Community Facilities and Services--Housing
4. Public Works--Maintenance/Utilities

Production and RDT&E facilities are widely dispersed to meet ESQD requirements. Pedestrian circulation has been developed within general building clusters; this practice should be continued.

Rail System

NOS Indian Head has a rail system (Figures 7-8 and 7-9) that serves the restricted area of the Station with a connecting spur that extends to the CONRAIL junction at White Plains, MD. This unique capability is considered by the Station to be a valuable asset for meeting mobilization requirements. Although the rail system is currently inactive, the Station intends to maintain it for specialized transportation of materials to and from Indian Head. To this end, a railroad operations master plan and instructions are in progress. Use of the rail system will be determined by the comparative cost and convenience of other modes of transportation. Many oversized objects or heavy loads are better delivered by rail.

There are 20.5 miles of track on station; of these, 5.3 miles are active. Facilities served by this portion of the rail system include: coal storage for the Goddard Power Plant, the machine shop (Building 268), supply warehouse (Building 116), packing house #3 (Building 313), the Biazzi plant, and barricaded transfer stations (Buildings 1103 and 1105). While use of this track has been temporarily suspended, the overall condition is good. The suspension is to allow for repair,



STUMP NECK

Existing Circulation

Source: Physical Security Division (Dept. 10), Traffic Engineering Study (1984), Master Plan Update (1982), Facilities Planning Branch (Dept. 09)

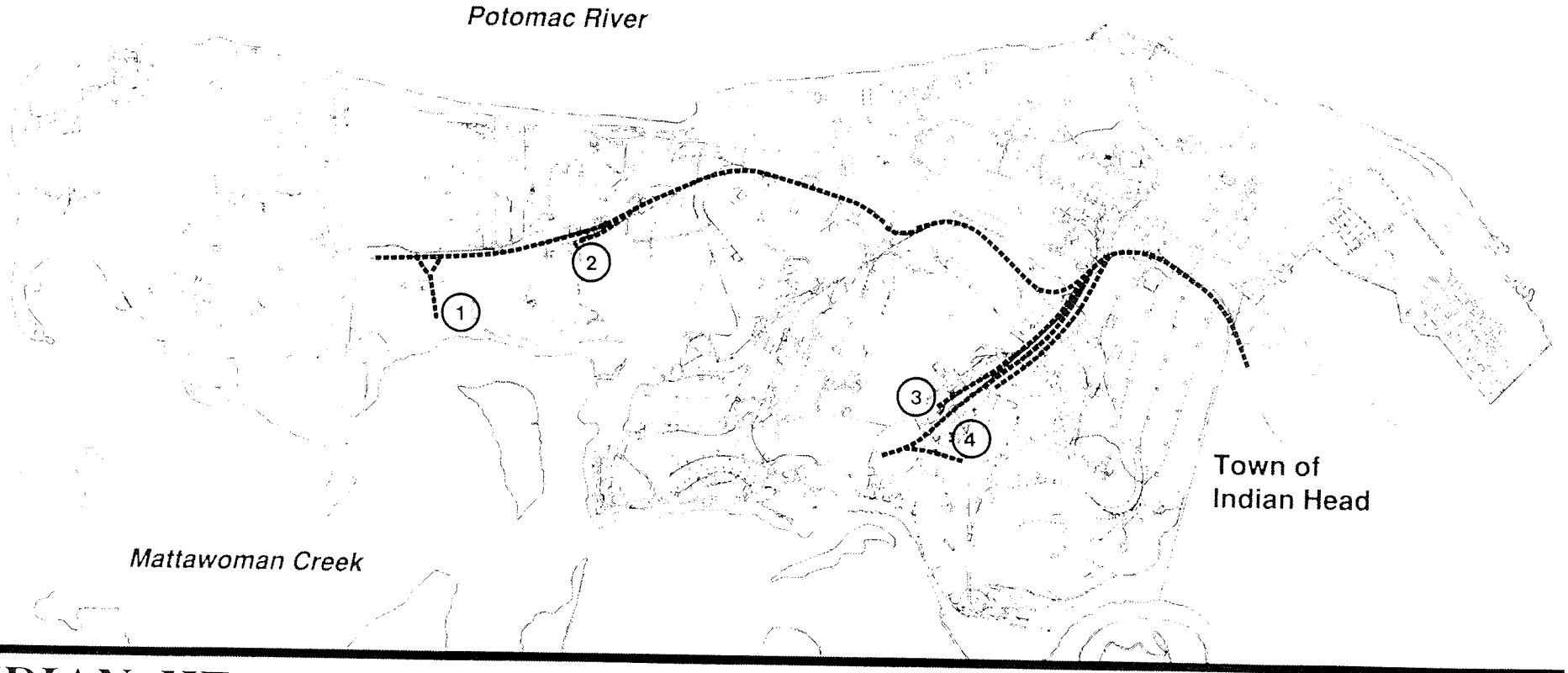
LEGEND

- ..... Primary Traffic Route
- — Secondary Traffic Route
- Primary Traffic Destinations
- ○ Security Gate

0 1000 2000 3000 4000 6000 Feet

Figure 7-7

Naval Ordnance Station, Indian Head



INDIAN HEAD

Rail System

Source: Government Railroad Survey Report (1988), Map - Active Railroad Track Requiring Maintenance (1982)

LEGEND

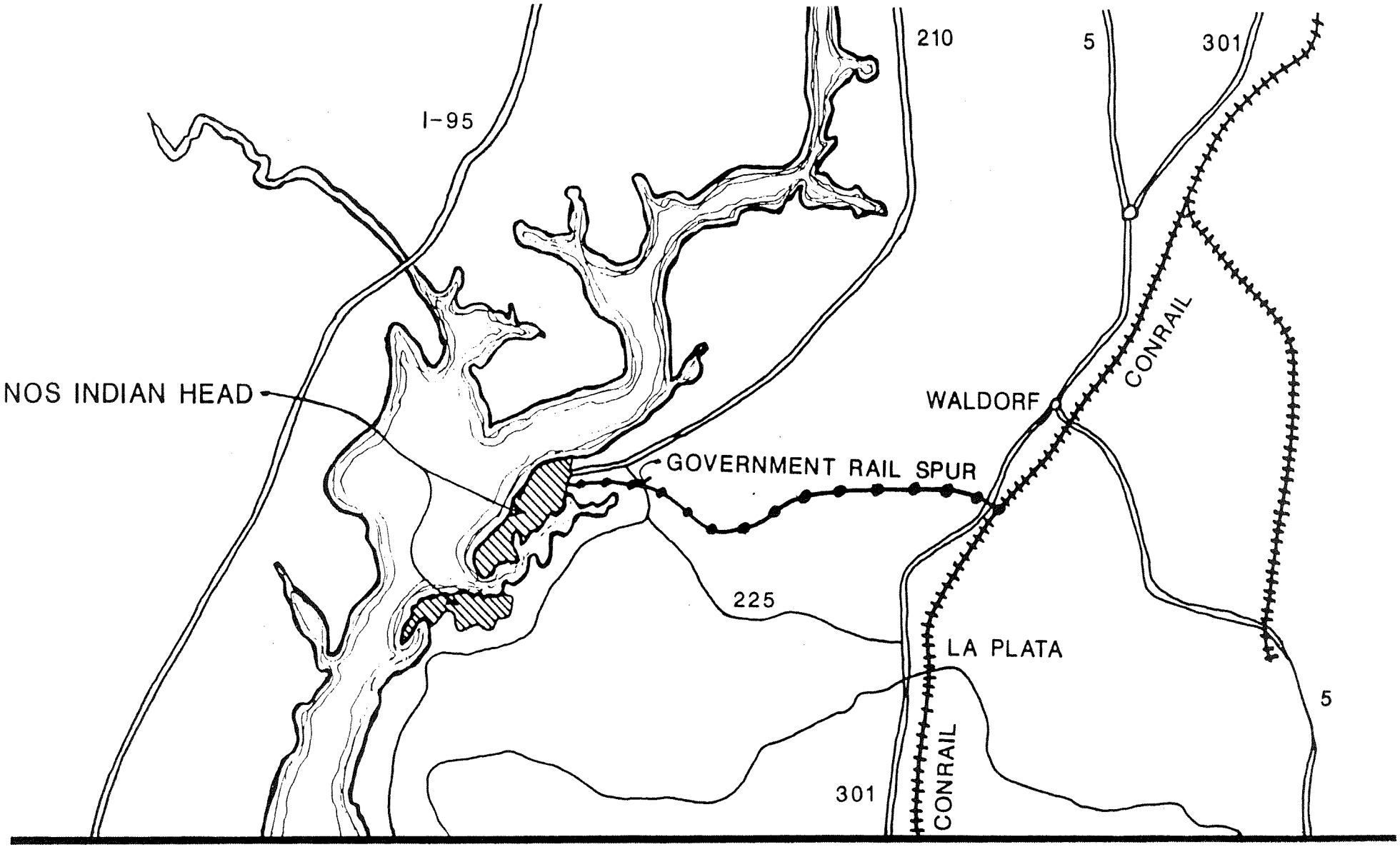
----- Active Rail Line

(1) Supply and Explosives Scales
(2) Biazzi Plant
(3) Rail Yard
(4) Goddard Power Plant

0 1000 2000 3000 4000 6000 Feet

Figure 7-8

Naval Ordnance Station, Indian Head



INDIAN HEAD

Government Rail Spur

Source: Government Railroad Survey Report (1988) Land use Compatibility Study (1987)

Figure 7-9

NOT TO SCALE

testing, and recertification of portions of the track. Most of the current repairs are on the section of track between the industrial spur and the power plant. Upon completion of this work and recertification of the track, use will be resumed.

The remaining 15.2 miles of on-station track are inactive. This portion of the rail network extends throughout the restricted area. The condition of this track has deteriorated to the point that the Station has abandoned it in place. All switches to the inactive track have been spiked to prevent inadvertent access.

The off-station portion of the rail system is a 14.4 mile connecting spur extending through Charles County. Between the Station fence and the White Plains CONRAIL junction, the 100-foot right-of-way contains approximately 164 acres. Over this distance there are 13 public and 6 private grade crossings. Additionally, these are 48 utility crossings, and two utility lines running parallel to the track. Before reactivation of the rail system, the track and crossings will be evaluated to assure compliance with all applicable regulations.

NOS has established a railway management team to ensure that all aspects of the railway system are properly managed and maintained. The team is responsible for the management of the White Plains right of way, and the maintenance, inspection, and operation of the NOS rail system. They will establish standard operating procedures for the system prior to the activation of the system.

A recent review of right-of-way records conducted for the draft Railroad Operations Master Plan (January 1989) has found that there is encroachment pressure on the railroad right-of-way. An annual update of property records, based on physical inspection of the property, has been initiated to protect the Navy's interest.

Utilities

A Utility System Assessment (USA) was completed by CHESDIV in FY89. This document should be used with the Master Plan when planning for new or remodeled facilities at NOS. The USA provides an in-depth look at the condition and expansion capabilities of existing infrastructure.

Electrical System

Electrical power requirements at Indian Head are met by a co-generation facility working in parallel with a commercial electric utility. The government owned and operated Goddard Power Plant produces 50% of the power used at NOS. The remainder is purchased from Potomac Electric Power Company (PEPCO). All power at the Stump Neck site is purchased from Southern Maryland Electric Cooperative (SMECO).

The Goddard Power Plant uses two 5000kW steam driven electric turbine generators. These generators, numbers 1 and 2, are connected to 13.2kV buses A and B, respectively. They are run on a rotating basis for six month periods. During down-time each generator undergoes maintenance or is kept on stand-by. Both generators run in parallel with PEPCO service through main buses A and B. A normally closed bus-tie breaker connects the two buses.

The PEPCO feeder enters NOS near the front gate, parallels the fence and then runs to the Goddard Substation. The PEPCO line is metered at 69kV before terminating at two government owned 7,500 kVA transformers at the Goddard Substation. The 13.2kV transformer secondaries are tied to both buses A and B in the Goddard Plant. This arrangement allows the use of commercial power to supplement either

of the NOS generators. Because of contract limitations between PEPCO and SMECO, the Station can only purchase 10,000 Kw (10 Megawatts) at power from PEPCO in conjunction with the generating capacity at 5,000 kW.

The existing emergency diesel generator at the Goddard Plant is out of service. This generator served as a back-up power source for electrically driven boiler auxiliaries and power plant control systems. Currently the emergency power requirement is being met by a 1500kW generator being leased from the Naval Energy and Environmental Support Activity through FY91. At that time, a new generator must be in place or the loan extended.

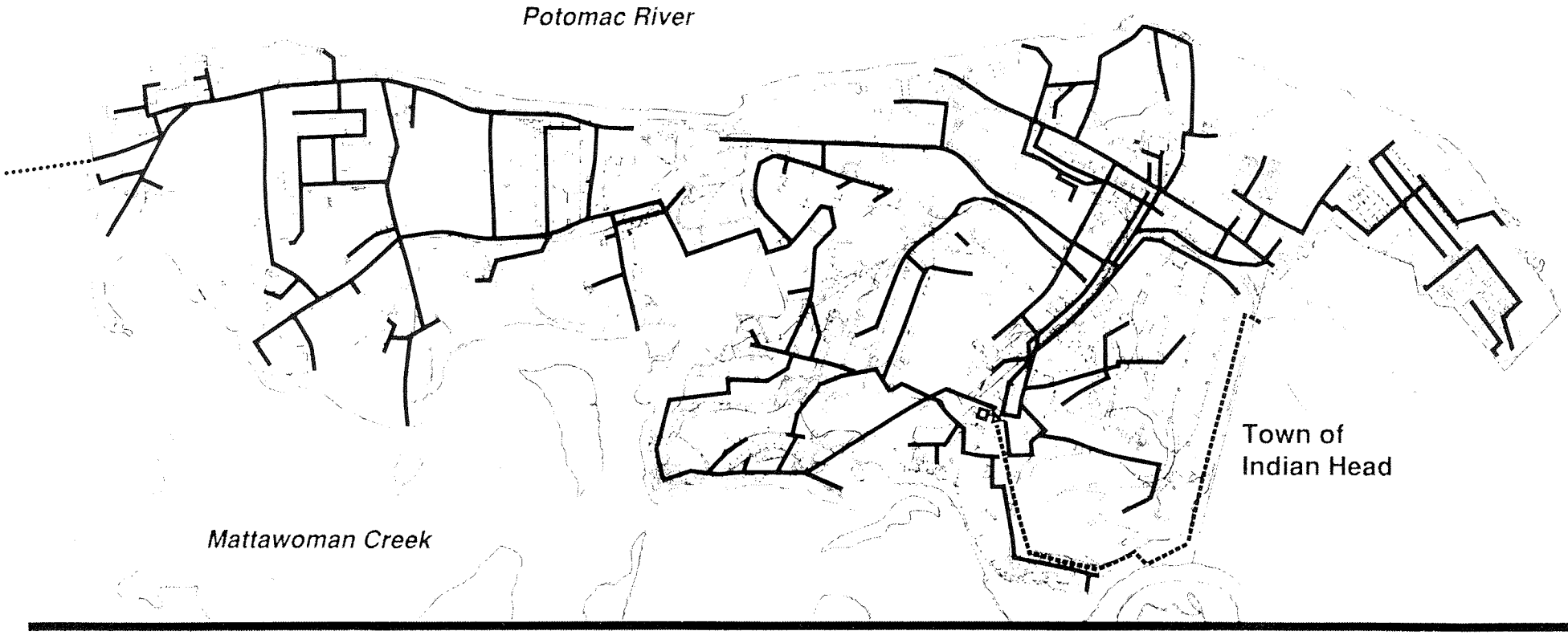
The facility will consist of a new generator, transformer substation, diesel fuel pumping system, and associated electrical synchronization equipment. It will provide the ability to restart the steam boiler plant within thirty minutes of a power failure. Normal boiler operation is required to provide the steam pressure necessary to maintain service to essential facilities. Without the emergency power, a cold restart of the power plant is impossible.

The electrical distribution system (shown in Figure 7-10) consists of eight 13.2kV feeders extending from buses A and B. The distribution network is a simple radial configuration. Each branch operates independently, but has an interconnect to another branch to provide an alternate feed in the event of an outage. A total of eight substations and several individual facilities are served by the feeders. From the substations, 2.3kV distribution lines serve each facility.

Electrical use at Indian Head has steadily increased over the last several years. During the summer of 1988 the peak load was 10,900kW, double the capacity of the power plant during normal, single generator operation. The additional power was purchased from PEPCO. Running both generators would require the use of two boilers and create a steam load of 250,000 lbs/hr. During the summer months, normal steam usage is 100,000 lbs/hr. Operation of the second generator would create a steam surplus of 150,000 lbs/hr. Condenser capacity at the plant is only 40,000 lbs/hr.

Demand for electrical service is beginning to exceed the system capacity at the west end of Indian Head. The cast plant area is where the problem is most critical, followed by the extrusion, housing, and administration areas. This additional demand is due to the increased requirement for air conditioned computer rooms. Another factor is the installation of Integrated Dehumidification Systems (IDS) in the production area. IDS is required for many of the processes in operation at Indian Head. MILCON project P-059, Mix, Assemble and Cure Facility includes a new Transmission line from the Goddard Plant to the cast plant area. This improvement is expected to fill the power requirements in the area of highest demand on NOS.

The distribution system typically consists of weatherproofed single copper conductors mounted on conventional wooden utility poles. A 4,600 foot submarine cable connects feeder 7-D with a 2500kVA substation in the Stump Neck area. This cable is now abandoned and, because it is damaged in its submerged section, cannot be economically repaired. Essentially there is no backup feeder. Due to load growth at NOS, the Stump Neck demand was removed from the network to allow the expansion of electrical service at Indian Head. Electrical service at Stump Neck is provided by a feeder from SMECO to a 1500kVA substation, where it is reduced to 2.4 kVA for distribution throughout the area (see Figure 7-11). The feeder enters Stump Neck as an overhead line and follows Archer Avenue to the intersection with Howard Road, where it becomes a buried cable and continues along Archer Avenue to the substation. A May, 1988 study



INDIAN HEAD

Electrical System

Source: Master Plan Update (1982), Power Generation and Distribution Branch and Engineering Design Branch (Dept. 09)

LEGEND

- Goddard Power Plant
- Goddard Substation
- Pepco Feeder
- Primary Circuit
- Submarine Cable

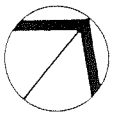
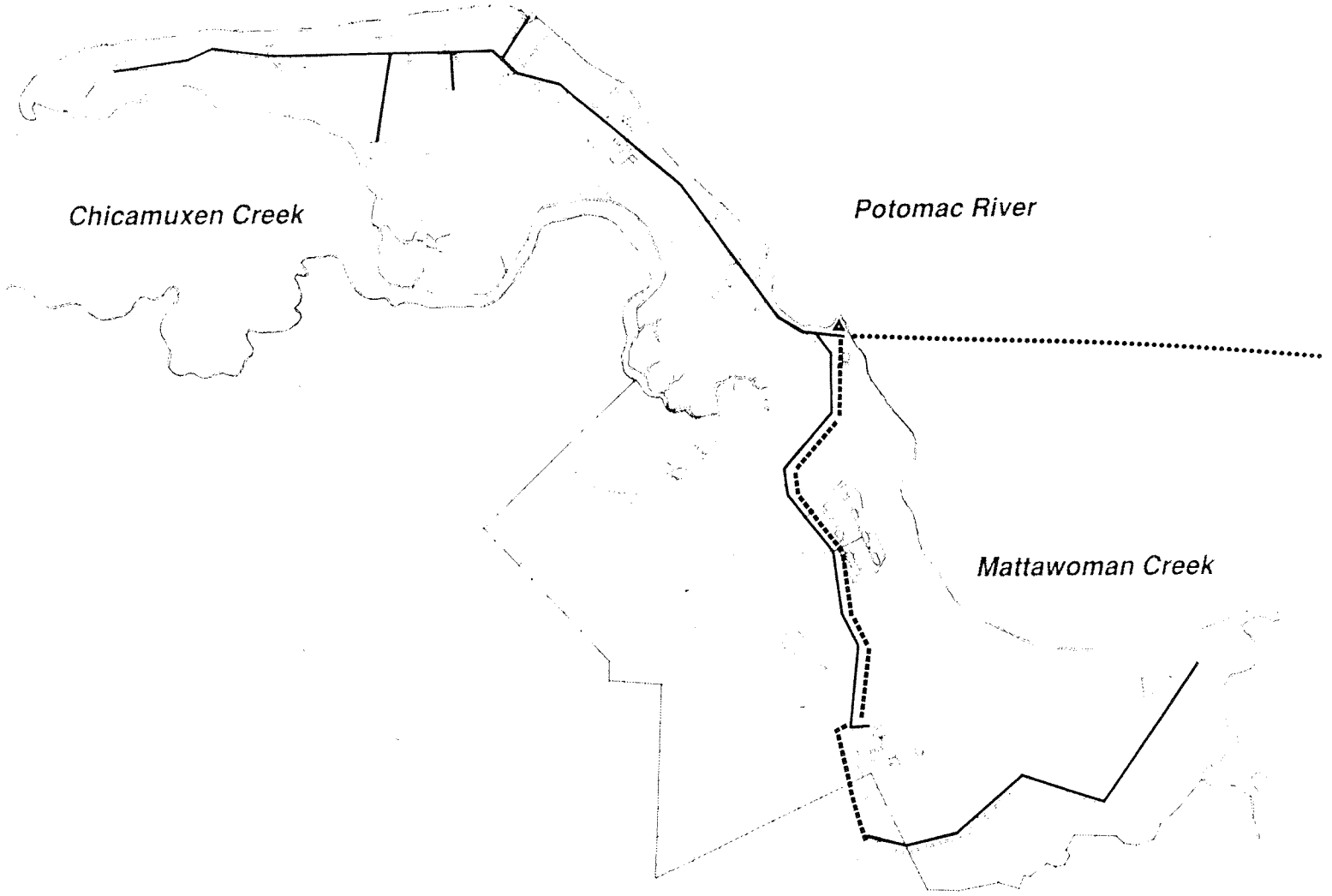


Figure 7-10

Naval Ordnance Station, Indian Head



STUMP NECK
Electrical System

Source: **Master Plan Update (1982), Power Generation and Distribution Branch and Engineering Design Branch (Dept. 09)**

LEGEND

— Main Distribution Line

..... Submarine Cable

----- SMECO Feeder

▲ Main Substation

0 1000 2000 3000 4000 6000 Feet

Figure 7-11

Naval Ordnance Station, Indian Head

indicated a peak demand of 1077 kVA; a 72% loading of the existing Transformer substation served by SMECO.

The Rum Point area is fed separately by a second SMECO feeder. The last section of this feeder is only single phase.

Potable Water Supply

Water supply is one of the more critical issues facing NOS. By an agreement with the Maryland Department of Natural Resources, Indian Head is allocated an average daily limit of 1.4 million gallons, with a maximum daily limit of 2.3 million gallons per day. The term of the agreement is through July 10, 1991. Water consumption is currently over 95% of the allotment for the thirteen wells at Indian Head and Stump Neck. Consumption has been above 90% for the last five years (see Figure 7-12). Over the last ten years the water table has lowered by 30 feet. This drop, and the appearance of brackish water in some wells, make it unlikely that the allotment will be increased.

There are three distinct water systems at Indian Head: low silica (Figure 7-13), high silica (Figure 7-14), and river water (Figure 7-15). Low silica water is used primarily for the power house boilers and steam system and industrial process water. High silica water is used for domestic water. River water is used for fire protection and industrial cooling applications. Leaks are considered to be a problem in all three systems but the extent of water loss is unknown.
High silica water is pumped from seven wells on Indian Head. Water is chlorinated at each well house and stored in two 150,000-gallon elevated tanks, nos. 897 and 896 (tanks 1 and 3). Wells A, 2, 6, 7, 9, and 12 feed the distribution system. Well 3A is connected to a 200,000-gallon elevated tank, no. 1533 (tank 4) and is dedicated to the Steam 'B' Plant. Design is underway to eliminate well 3A because of its poor water quality, and to feed the steam B elevated storage tank with low silica water from well 15.

Low silica water is pumped from three wells located on Indian Head and is used primarily as boiler feedwater for the Goddard Steam Plant. The low silica water must be used at the Power Plant to prevent the formation of scale on the turbine generator. Current low silica capacity is 718,000 gallons per day. Water from wells 15, 17, and 18 is chlorinated at the well house and pumped to a 150,000-gallon elevated tank, no. 874 (tank 2). From this tank, water is sent to the distribution system or to a 300,000-gallon ground-level reservoir. This reservoir, no. 898, is dedicated storage for the Goddard Steam Plant. Well 16A was designed to be a low silica well but, when put into continuous service, its silica concentration was unacceptable for use at the Power Plant. The well has a 700,000 gallon per day capacity but is not curently in use except for emergencies. Plans are being developed to connect 16A to the high silica system. Well 15 has a hole and severe offset in its casing and is programmed for replacement in FY90.

River Water Supply

The river water system is supplied by two pump houses located on the Potomac River. Pump house A (Building 100) contains four electric pumps with a total capacity of 8,400 gallons per minute (gpm). Two are constant speed pumps with a capacity of 2,000 gpm each, and one a variable speed with a capacity of 2,000 gpm. The fourth is a constant speed diesel pump with a capacity of approximately 2,000 gpm. A back-up system in Building 254 uses two variable speed diesel-powered pumps rated at 1,000 gpm each. Pump house B (bldg. 739) uses two electric driven pumps, one constant speed and the other variable, each with a capacity of 2,000 gpm, and a constant speed diesel powered pump with a capacity of 1,800 gpm. The water is

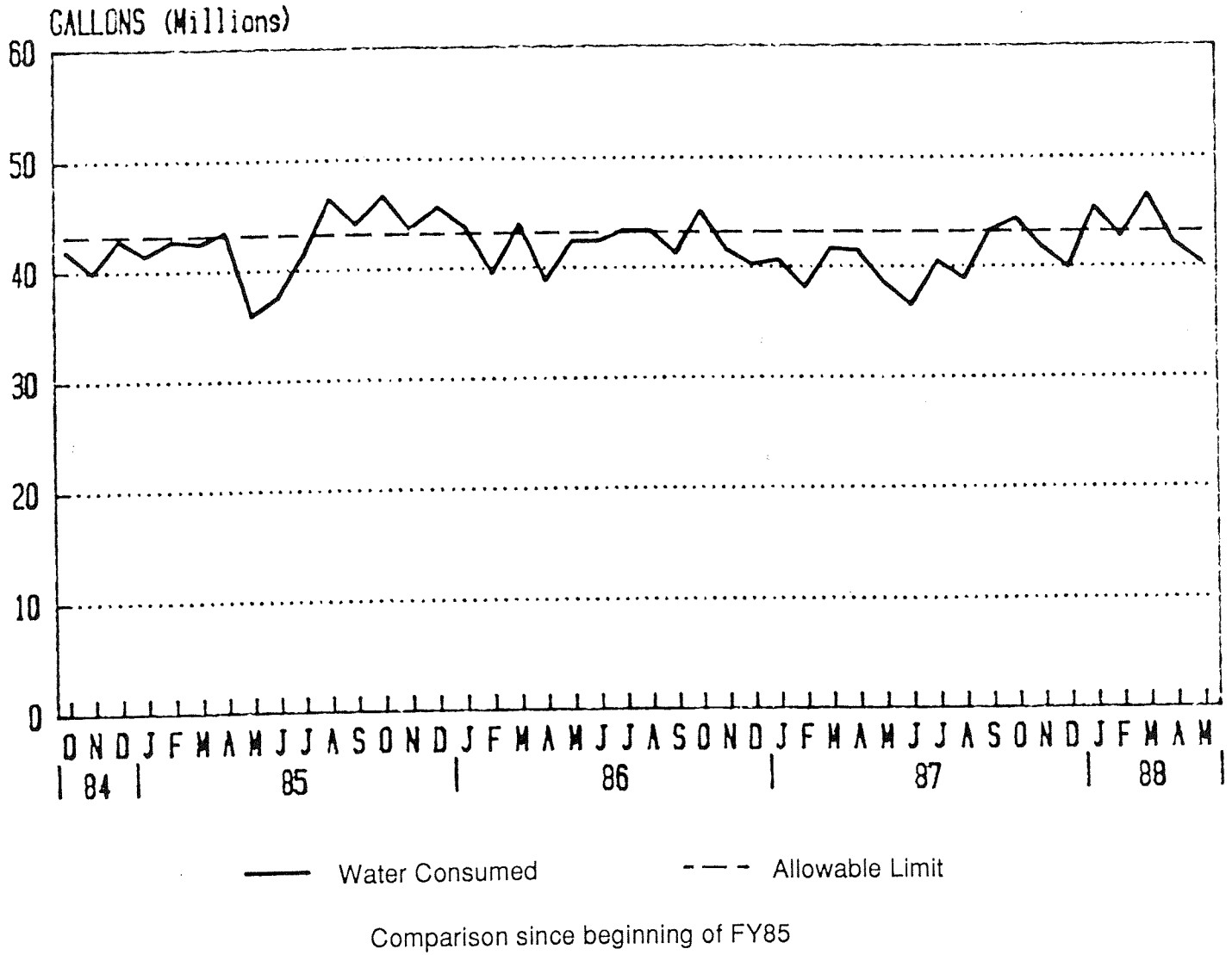
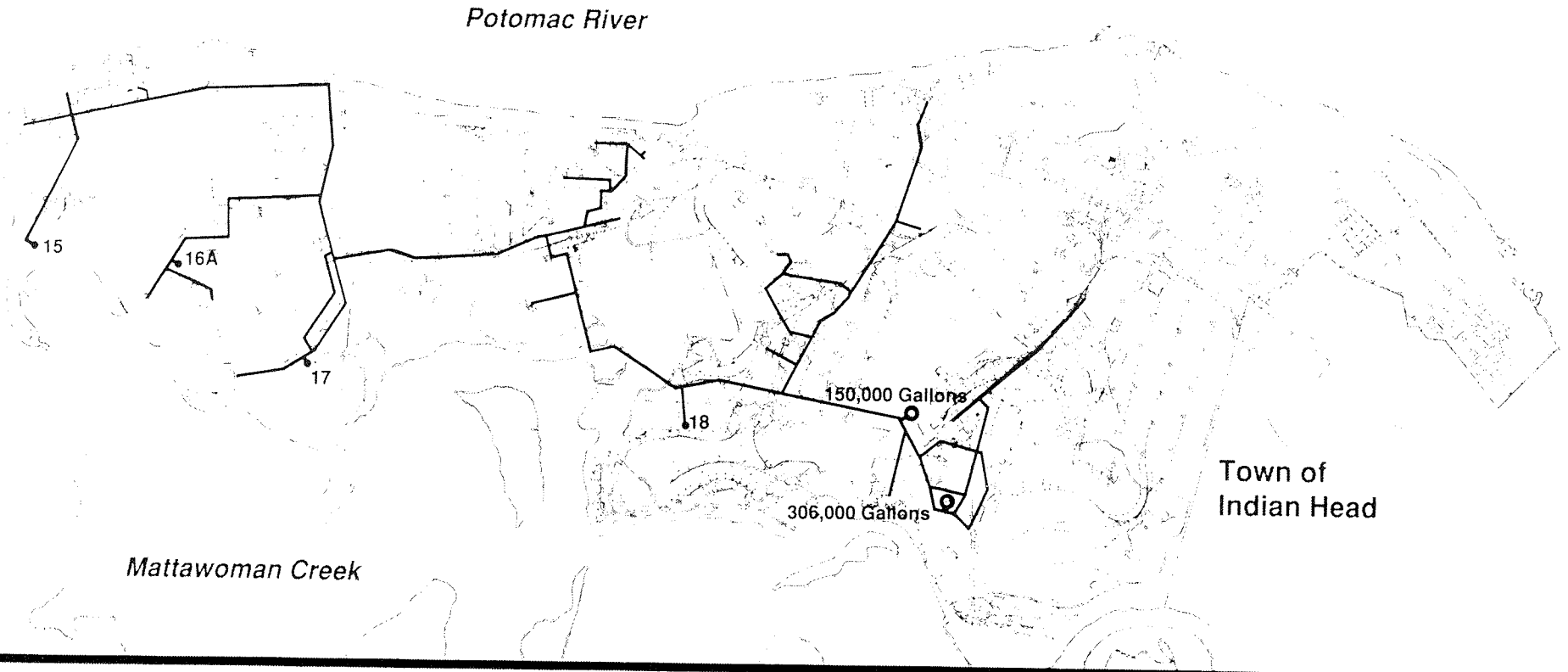


Figure 7-12

Water Consumption Vs. Allowable Limits - NOS, Indian Head



INDIAN HEAD
Low Silica Water System

Source: Master Plan Update (1982), Water and Wastewater Operations Branch (Dept. 09)

LEGEND

— Main Distribution Line

• Well

o Storage Tank

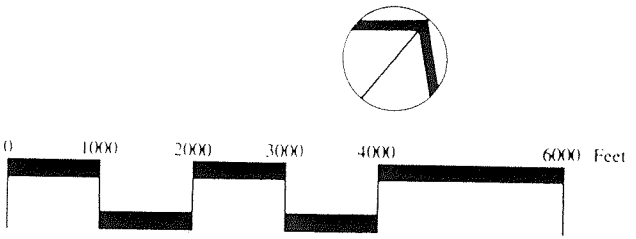
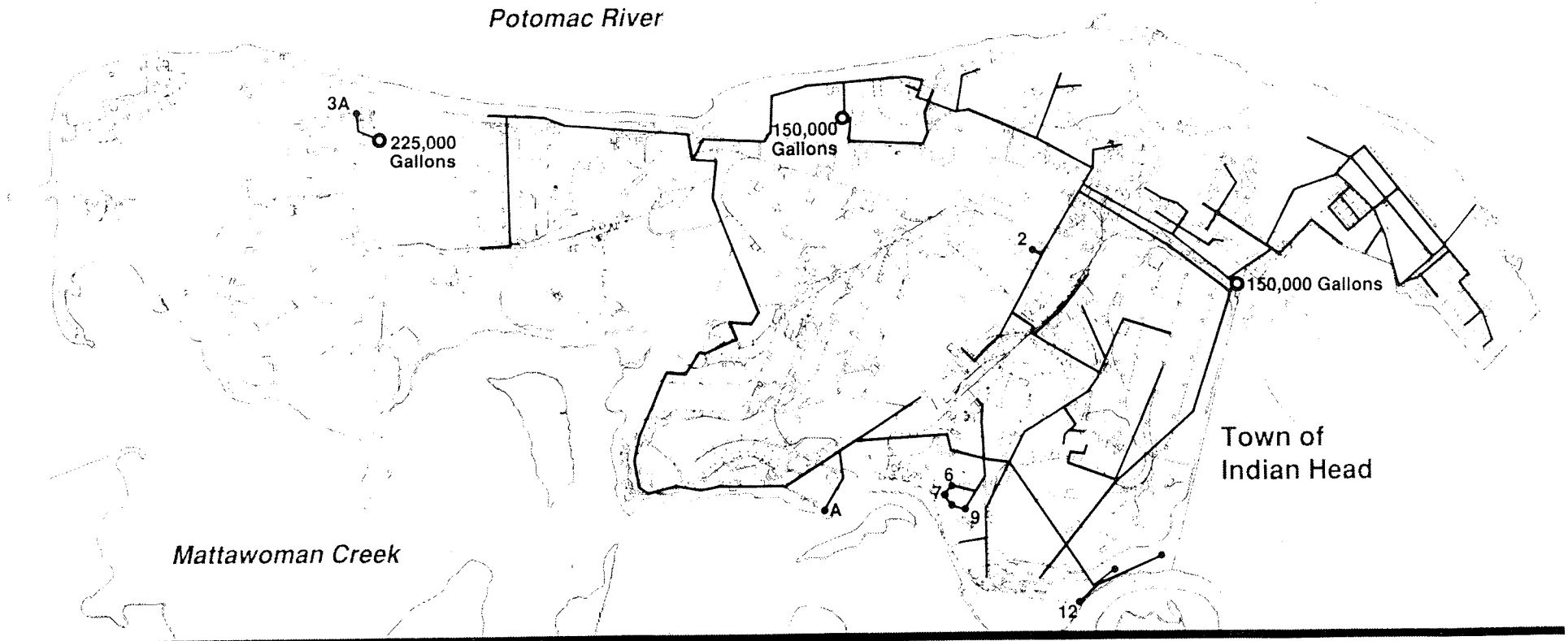


Figure 7-13

Naval Ordnance Station, Indian Head



INDIAN HEAD
High Silica Water System

Source: Master Plan Update (1982), Water and Wastewater Operations Branch (Dept. 09)

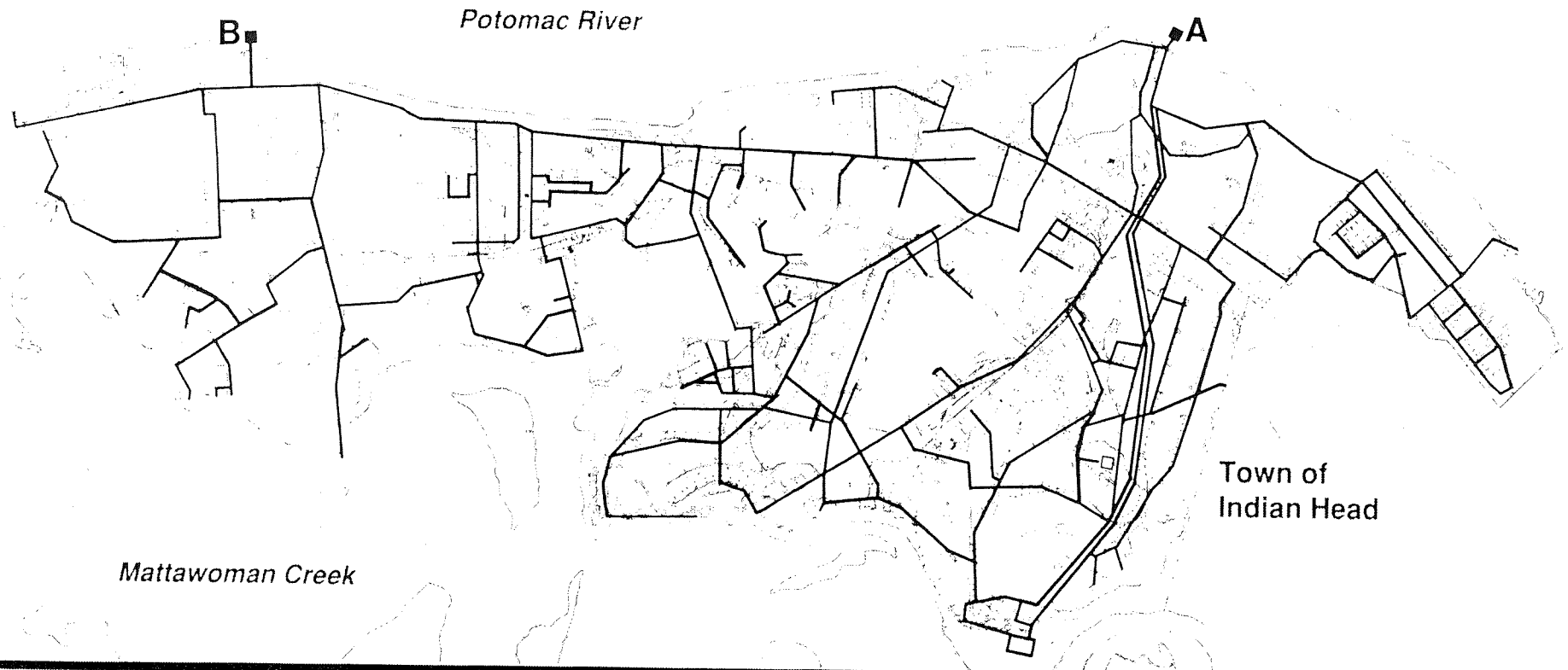
LEGEND

- Main Distribution Line
- Well
- Storage Tank

0 1000 2000 3000 4000 6000 Feet

Naval Ordnance Station, Indian Head

Figure 7-14



INDIAN HEAD
River Water System

Source: Master Plan Update (1982), Water and Wastewater Operations Branch (Dept. 09)

LEGEND

— Main Distribution Line

■ Pump House

□ Abandoned Treatment Plant

Figure 7-15

Naval Ordnance Station, Indian Head

chlorinated at each pump house before entering the distribution system. At one time, a portion of the river water was given further treatment in a plant (Buildings 483 and 484) consisting of clarifiers, chemical dosing chambers, and pressure filters. Treated water from the plant was stored in a ground level, concrete storage tank with a capacity of two million gallons. The treatment plant and storage tank are in poor condition and considered unusable. They are scheduled for demolition in FY90.

The poor quality of the water removed from the Potomac River has taken its toll on the river water distribution system. The system, built 20-30 years ago, is made of steel pipe. The highly turbid water has reacted with the pipe forming a coating which has reduced the pipe size by 20 to 35%. Regular maintenance keeps the lines operable, but the only solution to the problem is repair or replacement with cement lined piping or construction of a river water treatment facility (MILCON P-056, currently unprogrammed). A large portion of the river water mains were relined or replaced in FY87.

A river water system upgrade program was started in FY85. Phase I included piping in the housing area; Phase II, in FY86/87, upgraded piping in the Main Industrial area. Phase III, in FY90, will completely upgrade the two pump houses including replacement of several pumps. These efforts must continue to assure continued use at the river water system.

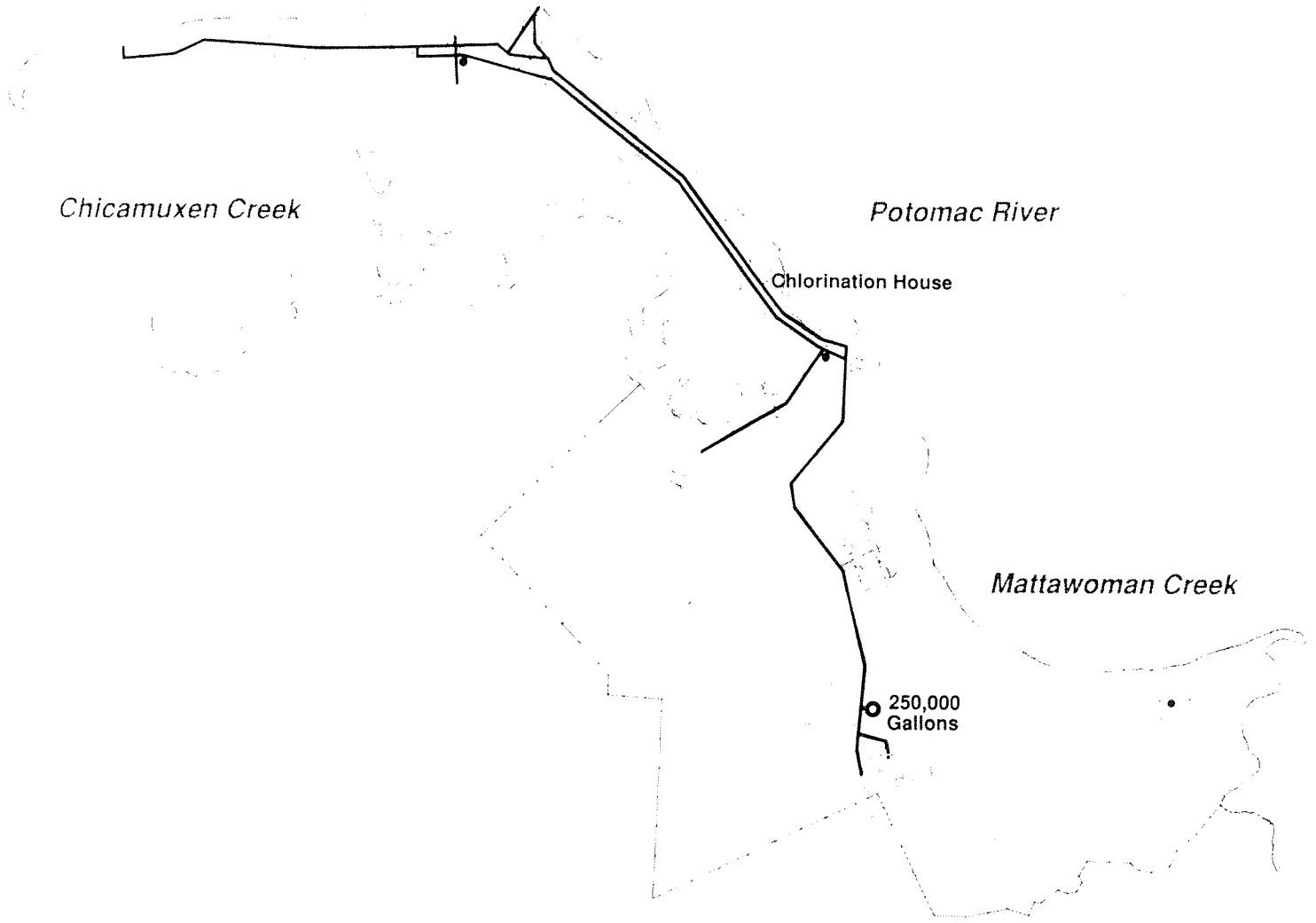
The Stump Neck area has its own wells and water distribution system (Figure 7-16). Two wells provide water for this area. Only one well is in service; it has a capacity of 300 gpm which is more than adequate. The backup pump has not been operated in several years and has an unknown capacity. Water is chlorinated at the pump house, and stored in a 250,000 gallon elevated tank. This water system provides water for domestic, industrial and fire protection use at Stump Neck. Water distribution does not extend into the Rum Point area. Buildings in this area are served by a separate deep well. Water supply in the Stump Neck area is sufficient to meet current needs, but it must be considered in the overall water usage at NOS.

A study of the water supply and usage at Indian Head was conducted in May 1982. The survey showed that the largest consumer of well water at NOS is the Goddard Power Plant. Sanitary use by Station residents and employees is the next largest demand. Several recommendations for reducing water use were made:

1. Elimination of the use of once through cooling water.
2. Installation of water-saving sanitary fixtures.
3. Increased awareness of water conservation methods by employees.
4. Include on-site waste water recycling systems in large scale projects.
5. Reduction of water pressure in housing areas.

Planning for future facilities at NOS Indian Head will be extremely difficult without current and accurate water use figures. The water appropriation and use permit with the State of Maryland will expire in July, 1991, and current conditions make it unlikely that the allotment will be increased. Thus, new facilities will have to be provided for by an overall reduction in water use. The conservation measures recommended in the 1982 study should be implemented. NOS should also conduct a leakage survey of the existing water system.

On July 14, 1988, a meeting was held to discuss the problem of brackish water in the Indian Head area as described in a 1984 study by the Maryland Water Resources Administration. The meeting was attended by representatives of NOS Command Staff, Public Works, and the Town of Indian Head. The 1984 study reported an increase in



STUMP NECK

Water System

Source: Master Plan Update (1982), Water and Wastewater Operations Branch (Dept. 09)

LEGEND

— Main Distribution Line

• Well

o Storage Tank

Figure 7-16

Naval Ordnance Station, Indian Head

chloride (CL) concentration and total dissolved solids (TDS) in two of four town wells and three of twelve NOS wells. The NOS wells cited were 3A, 3B, and 17. The highest levels were in well 3A, with CL at 146 mg/L and TDS at 430 mg/L, compared with 1971 levels of CL at 95 mg/L and TDS at 400 mg/L. These concentrations are very close to the EPA recommended limits for CL and TDS. While these levels do not cause any serious health problems, the town and NOS are concerned that they may continue to increase. If the problem is not dealt with soon, it may be necessary to provide costly water treatment, construct replacement wells,or find a new water source for the area. The Water Resources Administration suspects that the source of the CL and TDS is intrusion from the Potomac River. Brackish water may be seeping into the Patapsco aquifer as it passes beneath the river flowing southeast to the Indian Head area. Current hydrogeologic data on the area is not sufficient to determine the future impact of continued pumping from the aquifer.

The result of the meeting was a proposal for a preliminary study to determine the requirements of a detailed study of the brackish water problem in the Indian Head area. The following actions have been taken;

1. Historic data on pumpage, water-levels, and CL and TDS concentrations has been assembled.
2. The hydrogeologic make-up of the aquifers has been documented.
3. Wells are monitored for water levels and CL and TDS concentrations.

NOS is proceeding with the second phase of the Brackish Water Intrusion Study with the U.S. Geological Survey.

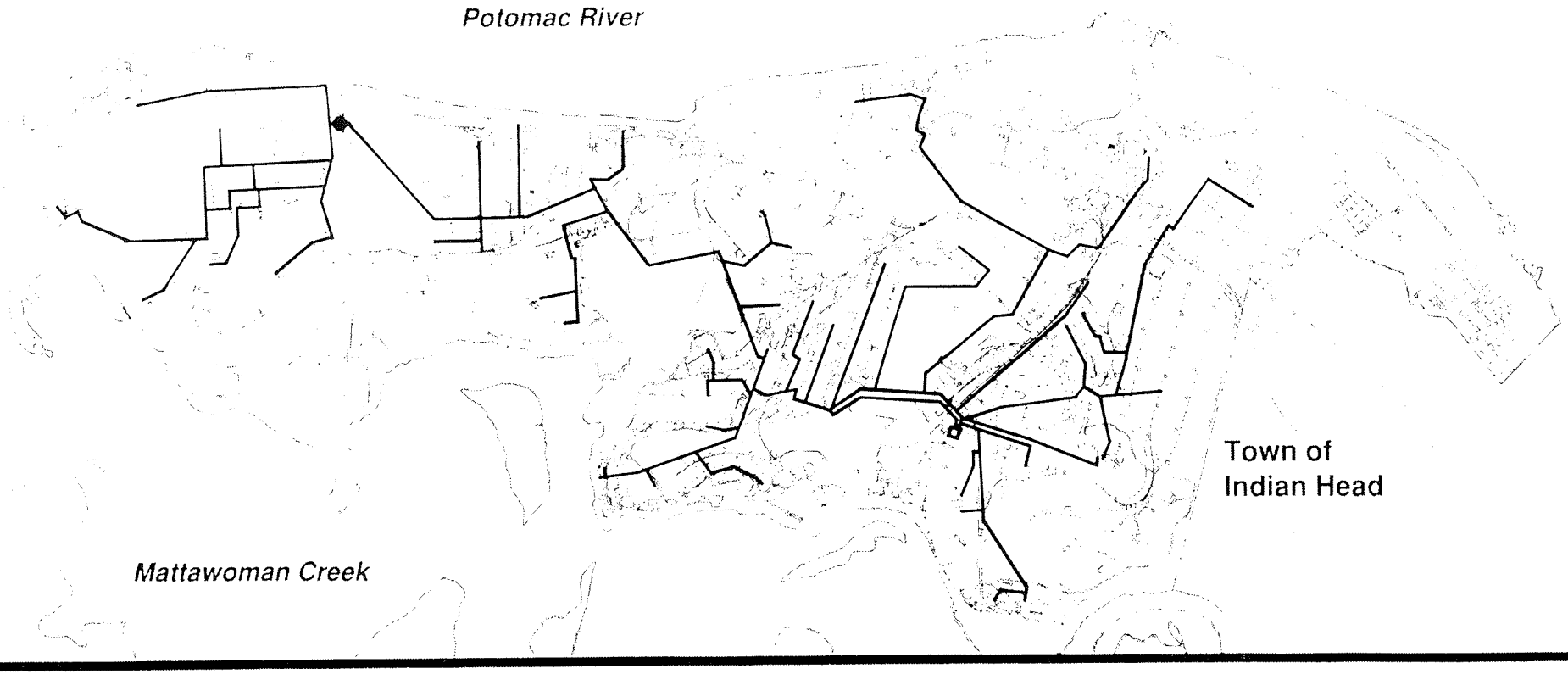
Steam System

Steam is produced at the Goddard Power Plant where it is used to drive turbine generators. It is then distributed throughout the Station for heating and production uses. The distribution system consists of 32 miles of piping ranging in size from 1" to 18" diameter (see Figure 7-17).

The Goddard Power Plant, building 873, has three boilers, installed in 1957. Each is capable of producing steam at the rate of 150,000 lbs/hr. During normal operation, one boiler will be on line, one on stand-by, and one down for maintenance. Use of the boilers is rotated to allow a continuing maintenance program. Each of the boilers has a dual fuel capability. Pulverized coal is the primary fuel with #6 oil as the secondary fuel. The boilers can switch fuel sources with no interruption in service.

During the winter months, supplemental steam is generated in the Steam B plant, building 712. A dual fuel boiler produces up to 30,000 lbs/hr, of steam to boost steam pressure during the winter heating season.

Steam is distributed radially from the Goddard plant by 32 miles of piping. Ninety percent of the system is above ground and in generally good condition. A problem area is external valves and reducing stations where insulation has deteriorated or been removed for service and not replaced. Approximately 30 smaller boilers of assorted sizes are located throughout NOS. These boilers serve housing, specific facilities, or processes with a combined capacity of 32,000 lbs/hr.



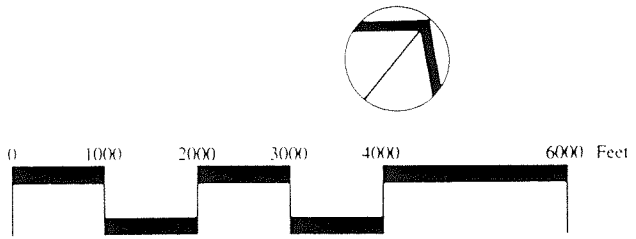
INDIAN HEAD

Steam System

Source: Facilities Planning Branch and Power Generation and Distribution Branch (Dept. 09), Master Plan Update (1982).

LEGEND

- Main Distribution Lines
- Goddard Power Plant
- Steam 'B' Plant



Naval Ordnance Station, Indian Head

Figure 7-17

Compressed Air System

Industrial facilities in the restricted area of Indian Head are served by a compressed air system (See Figure 7-18). The system is supplied, in part, by two compressors located in Building 111, near the Goddard Power Plant. One is a 700hp compressor with a 3,200 cfm capacity at 100 psi and is less than five years old. The other is a 500hp Chicago-Pneumatic compressor with a 2,200 cfm capacity at 100 psi installed in the early 50's. Distribution lines extend radially from the main compressors in Building 111 to the industrial and research areas. The lines generally follow the steam lines, extending to a length of 27 miles. Pipe sizes for the air system vary from 1" to 6" in diameter.

An additional 800hp compressor with a 3,130 cfm capacity at 100 psi in Building 1647, near the Steam B plant, helps to maintain pressure in the west end of the restricted area. The two facilities are connected by a 6" line. This interconnection provides a means to balance the system and to assure a reliable and consistent supply of compressed air throughout the Station.

The overall condition of the compressed air system is good. The system is well maintained, but is beginning to fall short of meeting the current demand. Users at the west end of the system have had a problem with an insufficient volume of air being available.

As compressed air requirements have grown, many new taps have been made into the system. Often these taps are made without being recorded or notification given to the physical plant. The total compressed air requirement at NOS is unknown. The plant has continued to keep up with the demand but no record of compressed air usage has ever been made.

Due to the size of the system, there is a problem with condensation in the lines. The effects of this problem are especially felt during the winter months when the water may freeze, blocking the line.

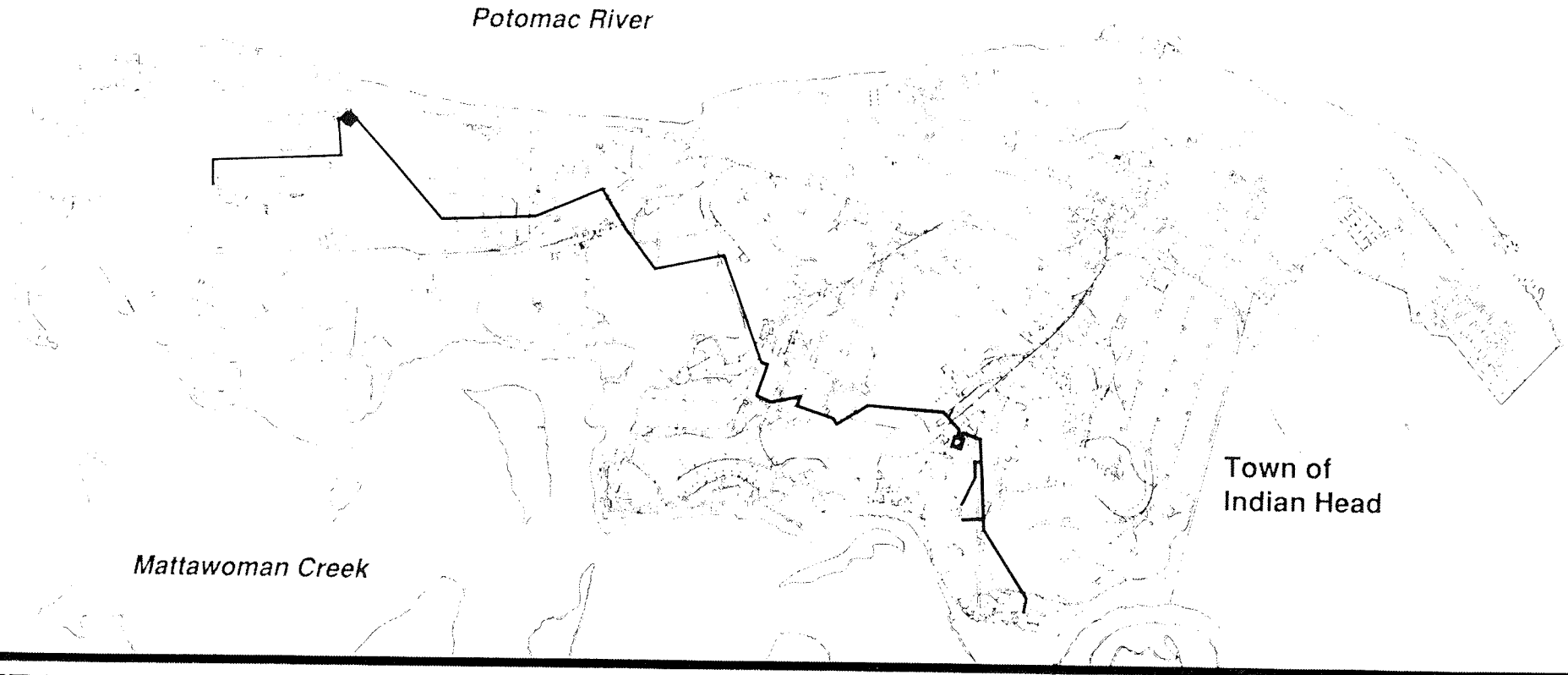
The compressed air system is being evaluated under Contract Number, N62477-88-C-3824 (ES). Work to be accomplished under this contract includes:

1. Mapping the system
2. Checking for leaks
3. Testing all valves
4. Finding low points
5. Determining capacity
6. Determining NOS compressed air requirements over the next five years

Sewer System

The FY83 completion of MILCON Project P-950 expanded the Station's largest treatment plant (Figure 7-19). Combined with the construction of new force mains, gravity mains, and pumping stations, the new plant meets all sanitary sewer requirements for the Indian Head area. All but one septic system at Indian Head have been disconnected and abandoned in place. The remaining active system services Building 313. The new treatment plant has a capacity of 500,000 gallons per day, and meets all State and Federal requirements. Discharge from the plant is to the Potomac River.

Groundwater infiltration and storm water inflow into the sanitary sewer system has been identified as a significant problem at NOS. A Sanitary Sewer Evaluation Survey (SSES), completed in July, 1988 studied in detail the Pump Station 11 Basin, (see Figure 7-19), and performed flow monitoring throughout Indian Head. During the two



INDIAN HEAD
Compressed Air System

Source: Master Plan Update (1982), Power Generation and Distribution Branch and Engineering Design Branch (Dept. 09)

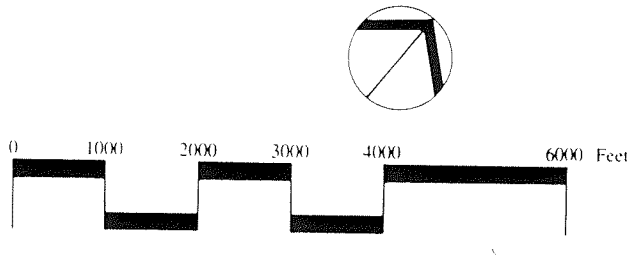
LEGEND

— Main Distribution Lines

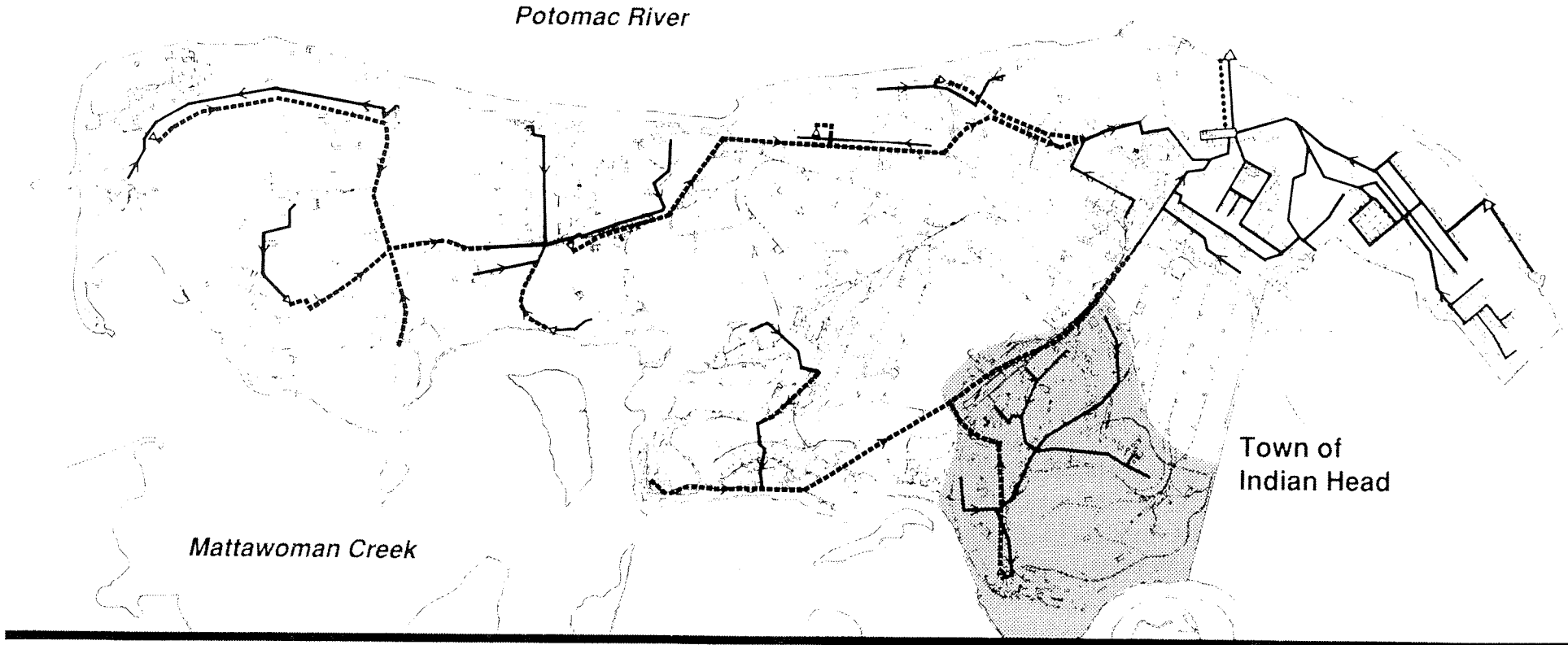
▫ Goddard Power Plant

● Steam 'B' Plant

Figure 7-18



Naval Ordnance Station, Indian Head



INDIAN HEAD

Sanitary Sewer System

Source: Water and Wastewater Operations Branch (Dept. 09), Sanitary Sewer Evaluation Survey, RJN Environmental Assoc. (1988), Master Plan Update (1982).

LEGEND

- Force Main
- Gravity Main
- Outfall
- Pump Station
- Sewage Treatment Plant
- PS 11 Basin

Naval Ordnance Station, Indian Head

Figure 7-19

month monitoring period, the average flow to the treatment facility was 0.46 million gallons per day (mgd), 92% of the facility's 0.50 mgd design capacity. The study showed that 66% of the average daily flow came from infiltration and inflow. The base, or actual sewage flow to the treatment plant is 0.156 mgd.

The report projects that during a one year storm, sewer flows could increase to an instantaneous peak of 2.7 mgd due to storm water inflow.

Continued rehabilitation of the sanitary sewer system at Indian Head can significantly reduce the rate of flow to the NOS treatment plant. Reducing flow in this manner will assure that the plant will continue to meet NOS sanitary sewer requirements well into the future.

Design for the rehabilitation of the Pump Station No. 11 subarea is underway and scheduled for construction FY90. Detailed evaluation of five other subareas will be completed in mid FY90. Design contracts for those projects will be awarded the same year for construction of the projects in FY91 and FY92. NOS has programmed $300,000 for repair of sanitary sewers over the next three years.

Production facilities at Indian Head release waste water that contains organics, nitrogen, or explosive nitrate esters. Current operations are subject to National Pollution Discharge Elimination System (NPDES) permit which requires these waste products to be treated with the "best available technology".

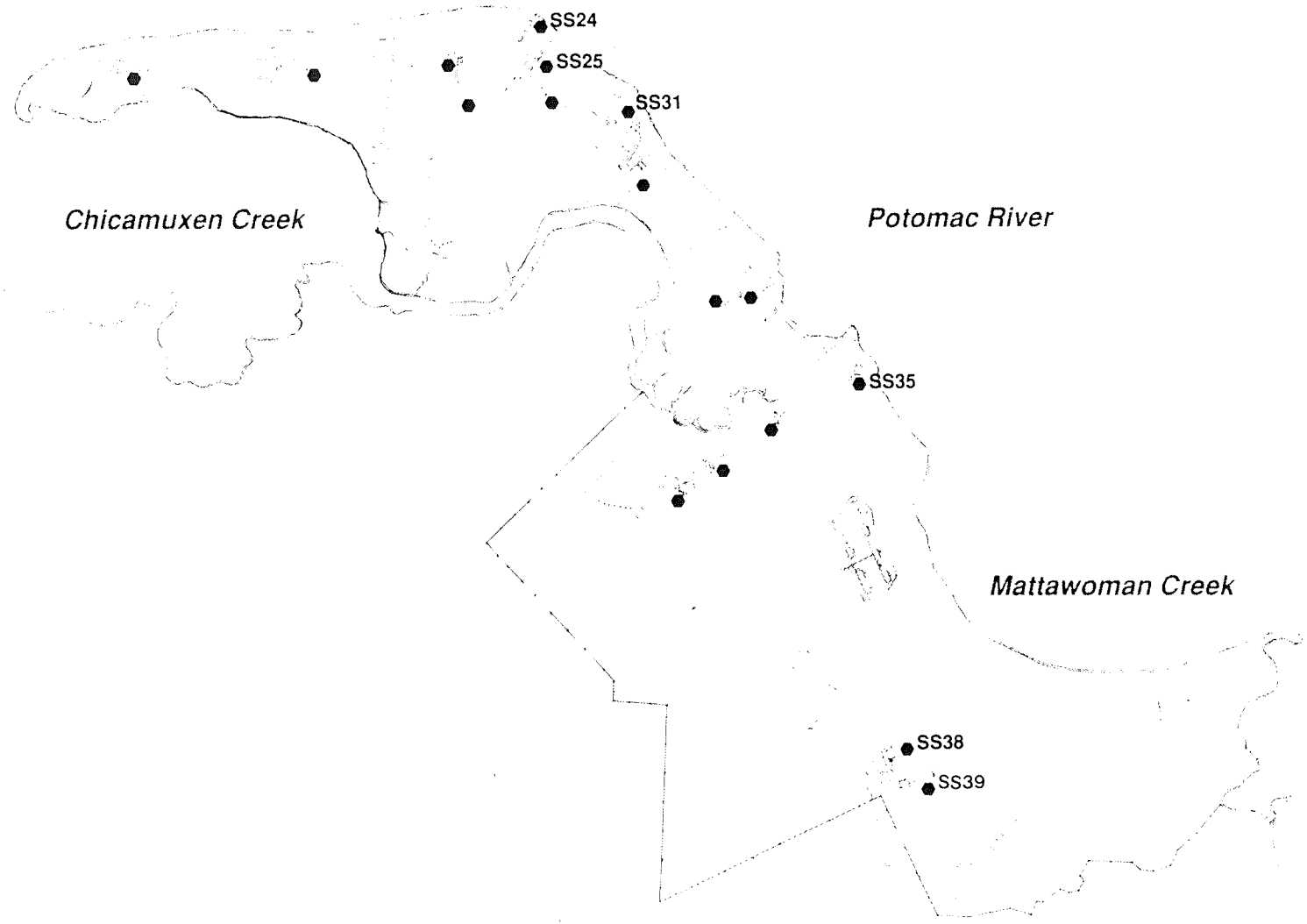
To meet this requirement, MILCON Project P-963, Industrial Waste Water Treatment Facility - Phase I, was proposed. When completed, this project will provide a collection system and treatment facility for industrial waste water generated by explosives and propellant operations at the Biazzi and Moser plants and extrusion plant buildings #215 and #874. The proposed facility consists of a carbon absorption process followed by evaporation. Condensate from the evaporation process will be reused by the plants or released to the storm sewer system. Also included are sanitary sewer connections for other industrial facilities.

Phase II of the Waste Water Treatment Facility, project no. P-106, has been proposed for FY92 funding. This project will provide additional connections of ordnance and inert operations to the existing sanitary sewer system. Wastewater from ordnance operations will flow into a holding tank where it will be tested. Results will determine if the waste water is transferred to the Industrial Treatment Facility or allowed to flow into the NOS sanitary sewer system. Inert operations will be tied directly to the sanitary sewer system.

The Stump Neck area does not have a central sanitary sewage system because the buildings are so widely dispersed. Sewage treatment is handled by 17 septic systems (Figure 7-20). Six of these systems, SS24, SS25, SS31, SS35, SS38, and SS39 are surface discharge systems operated under permits from the State of Maryland. Effluent is monitored on a regular basis to track compliance with the permit limits.

Replacement of the six surface drainage systems is underway with an estimated completion date of September, 1990. With the completion of this project only SS31 will discharge to the surface requiring an NPDES permit. The new system at SS31 will use an ultraviolet radiation disinfection process to eliminate the toxic effects of chlorination on aquatic life.

The remaining eleven septic systems are sub-surface discharge systems which do not require permits.



STUMP NECK
Sanitary Sewer

Source:

LEGEND

- Septic System

Figure 7-20

Naval Ordnance Station, Indian Head

Construction of any major new facility in the Stump Neck area requires a new septic system, although finding a location with soils suitable for septic systems is difficult. Building additions or small scale projects can sometimes be added to existing systems, but most of these systems are working near capacity.

The use of water conserving sanitary fixtures is essential for all new construction at Stump Neck. Measures such as this will minimize the size of new septic systems and preserve the remaining capacity in existing systems. The Charles County Health Department performs percolation tests prior to the design of any new subsurface septic system and must review and approve all designs for new systems.

Communications

Telecommunications service is provided to NOS, Indian Head through the Chesapeake and Potomac Telephone Company of Maryland (C&P). The main cable into the Station as well as all distribution cables are owned and operated by C&P. Switching equipment is leased from AT&T and installed in the Base Telephone Central Office (BTCO), Building 698. All communications at NOS are handled through two pieces of switching equipment, an AT&T 701-B and an AT&T Dimension 2000 with Feature Package 8.

The 701-B is an electromechanical device installed in 1967. It takes up about two-thirds of the space in Building 698. This older technology equipment is limited to accepting only rotary dial pulse dialing. It is wired for 1300 lines and is currently used at 88% of its capacity. Because this equipment is no longer manufactured, the system cannot be expanded.

Two Western Electric 608 cord board operator positions, located in the BTCO, are supported by the 701-B. Trunking from the 701-B includes:

- 34 Direct Inward Dial trunks
- 54 Direct Outward Dial trunks
- 21 Washington Foreign Exchange trunks
- 16 Two-way Dial AUTOVON trunks
- 13 Incoming only AUTOVON trunks

The 701-B requires daily maintenance to stay in operation. AT&T has a technician on site to keep the switch in operation.

The Dimension 2000 with Feature Package 8 is an electronic Private Branch Exchange (PBX), installed in 1984. Wired for 640 lines, the Dimension 2000 is at 98% of its capacity. The 12 remaining lines are reserved for emergency service requests and maintenance use. It can be expanded to 1064 lines under the AT&T lease by adding more cabinets and circuit cards. This system is also at capacity for trunking. The following trunks are served by the Dimension 2000:

- 18 Direct Inward Dial trunks
- 10 Direct Outward Dial trunks
- 15 Two-way Dialing trunks
- 25 Tie lines to the 701-B switch
- 4 Direct Inward Dial AUTOVON trunks

Neither of the switches meets current NOS requirements for voice/data transmission. Access to the Defense Data Network is not available through the 701-B. This link is currently made through SEAADSA in Building 1581. NOS has a broadband Local Area Network (LAN) known as NOSNET, which serves over 400 users. The network interfaces a number of smaller LANs and Digital

Terminal Equipment (DTE) devices throughout the Station. Current plans call for the NOSNET to be expanded to serve 87 buildings with the capacity to add the NAVSCOLEOD, Mix House, Cast Plant and CAD test facility.

There is no source of emergency power for the BTCO. Building 698 has no emergency generator or uninterrupted power source. The 701-B switch has an internal battery system which will provide power for up to eight hours. The Dimension 2000 system has 10 power failure trunk-to-station connections to provide emergency service.

Use of the Station telephone distribution lines, known as the outside plant (OSP), is saturated. The Station is working to provide additional pole space in the central administration area, but space is limited. Direct buried cable has been installed primarily in the storage areas paralleling the existing pole distribution system. Stump Neck is served by a 200-pair copper submarine cable which crosses the Mattawoman Creek. The cable is being used at its capacity. The NAVEODTECHCEN has an immediate need for 194 more lines which cannot be met by the existing cable.

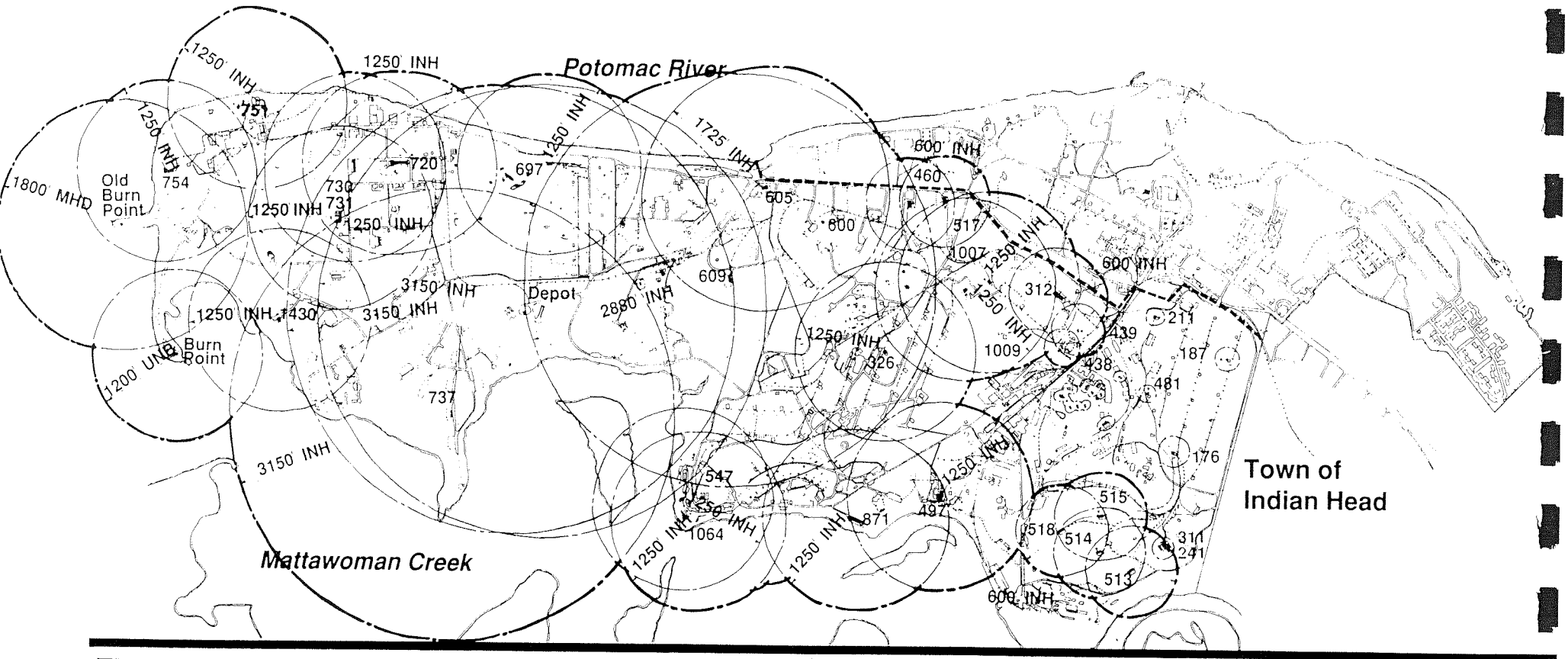
Long-term plans for the base communications system are to upgrade the system through two major projects. The first is to replace the existing 701-B and Dimension 2000 switches with a Digital Switching System (DSS). The DSS will increase the number of available lines to meet Station requirements and be capable of handling voice and data transmissions. The second project is to develop a new OSP. The new plant is to be based on a fiber optic system. Phase One will connect the BTCO with Building 22SN, allowing the connection of the Stump Neck and Indian Head LANs. Additional phases will allow the connection of voice, data, fire, security, and energy monitoring equipment.

ESQD

The primary mission of NOS Indian Head is the design, development, testing, evaluation, and manufacture of various ordnance components for the Department of Defense (DOD). Tenant activities include the EOD School and EOD Technology Center, which conduct training, research, and development in the operation and disposal of explosive materials and devices. To meet this mission, NOS requires many different munitions manufacturing, testing, and storage facilities. These range from storage magazines to explosives processing plants and test detonation ranges. Explosive Safety Quantity Distance (ESQD) arcs are established to provide for the safety of personnel and protection of facilities.

On the Indian Head site (Figure 7-21) all arcs are produced by production, testing, and storage facilities. These arcs are generated within the restricted area, but extend beyond the fence into the unrestricted area. Existing arcs range in distance from 50 feet to 3,150 feet. Two storage magazines, Buildings 494 and 523, are located outside the restricted area but are not currently used for explosives storage. Some of the arcs extend out over the Potomac River and the Mattawoman and Chicamuxen Creeks. The Station maintains a navigational danger zone in these areas, described more fully in the next section.

ESQD arcs at Stump Neck (Figure 7-22) are generated by storage magazines and two detonation ranges. The test ranges are used primarily by the NAVEODTECHCEN for research and by the EOD School for training. While the detonation of explosives is a small part of the activity, it plays an important role in the work accomplished here.



INDIAN HEAD
Inhabited Distance ESQD Arcs

Source: Explosives Quantity Distance Maps, 1987

LEGEND

INH Inhabited Distance

UNB Unbarricaded Distance

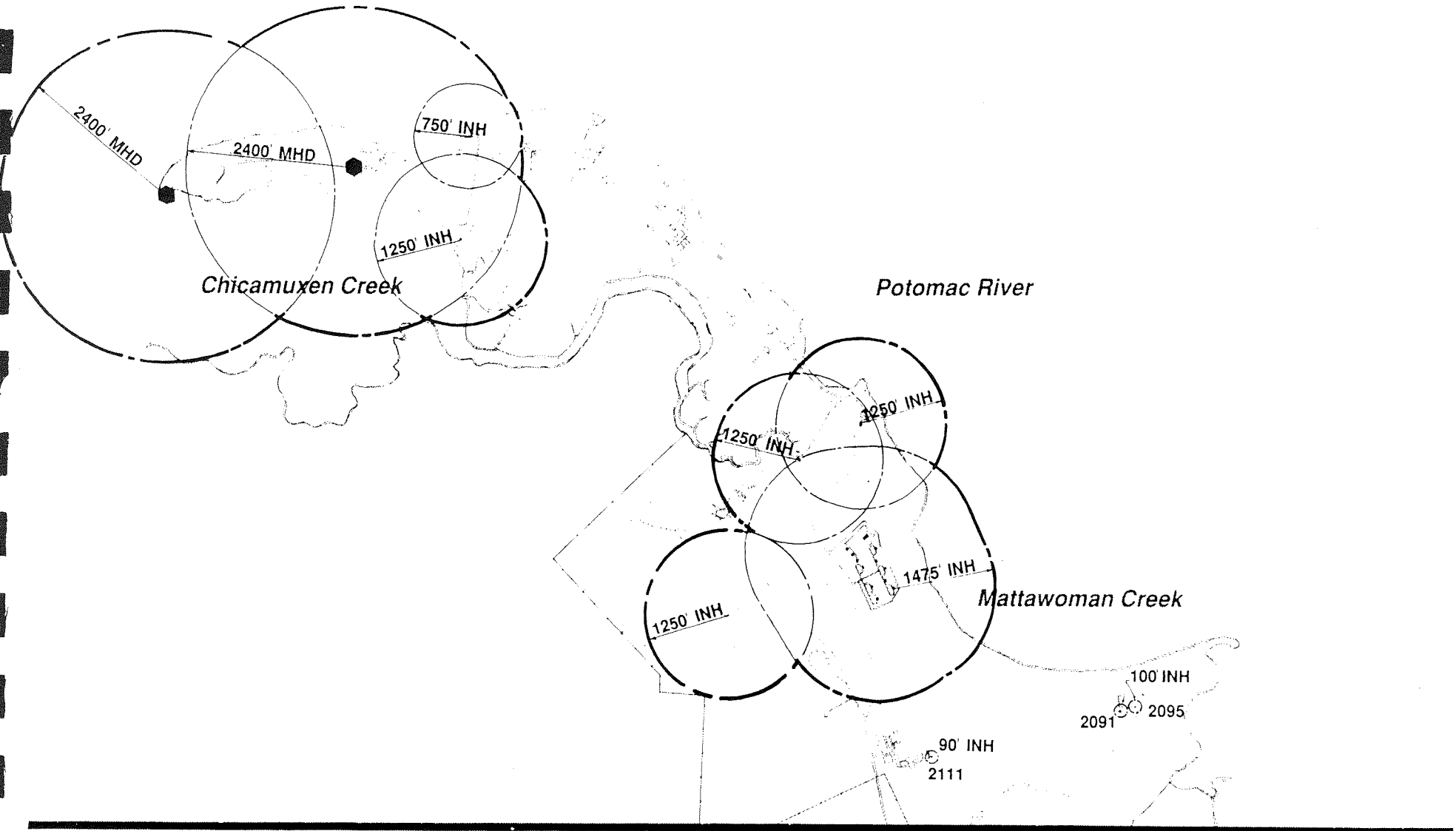
MHD Missile Hazard Distance

--- Existing Restricted Area Line

0 1000 2000 3000 4000 6000 Feet

Figure 7-21

Naval Ordnance Station, Indian Head



STUMP NECK
Inhabited Distance ESQD Arcs

Source: Explosives Quantity Distance Maps, 1987

LEGEND

INH Inhabited Distance

MHD Missile Hazard Distance

⬢ Field Area Where Explosives Are Used

0 1000 2000 3000 4000 6000 Feet

Figure 7-22

Naval Ordnance Station, Indian Head

The regulation governing the establishment of ESQD arcs and the overall storage and handling of explosive materials is NAVSEA OP5. Arcs are determined by calculations based on the amount and type of material, type of operation, and construction and use of adjacent facilities. Because of its unique mission, NOS, Indian Head must be concerned with explosive material in all stages of the manufacturing process. There are also explosive test ranges and disposal sites.

NAVSEA OP5 defines Quantity Distance as a relationship between the quantity of material stored and the distance required to provide a given level of protection. The relationships are based on acceptable levels of risk for different types of exposure. ESQD arcs do not determine absolute safe distances, but reduce the risk based on the type of exposure.

ESQD arcs limit the location and occupancy of structures, and play an important role in installation development. Approximately 66% of Indian Head and 41% of Stump Neck are located within the inhabited distance ESQD arcs. The inhabited distance arc is the most restrictive. It prohibits construction that is not related to ordnance-related facilities. An area of particular concern is where arcs extend outside the restricted area along Farnum Road.

All siting within ESQD arcs, and establishment of new or revision of existing arcs is reviewed on-station by the Safety Department (CODE 04). Final approval is from NAVFAC, with prior concurrence from the Department of Defense Explosive Safety Board or Chief of Naval Operations. The OP-5 rules are currently being interpreted and enforced more conservatively, resulting in the need for more barricading and greater distances. Waivers or exemptions may be issued for temporary conditions or mission essential requirements. NOS currently has 7 waivers and 11 exemptions in effect. Exemptions of particular interest include: use of the Burn Point at less than 1,800 feet from Station Buildings, and occupancy of Buildings 2019 and 22SN at less than the distance required between inhabited buildings and explosive storage sites.

Navigational Danger Zone

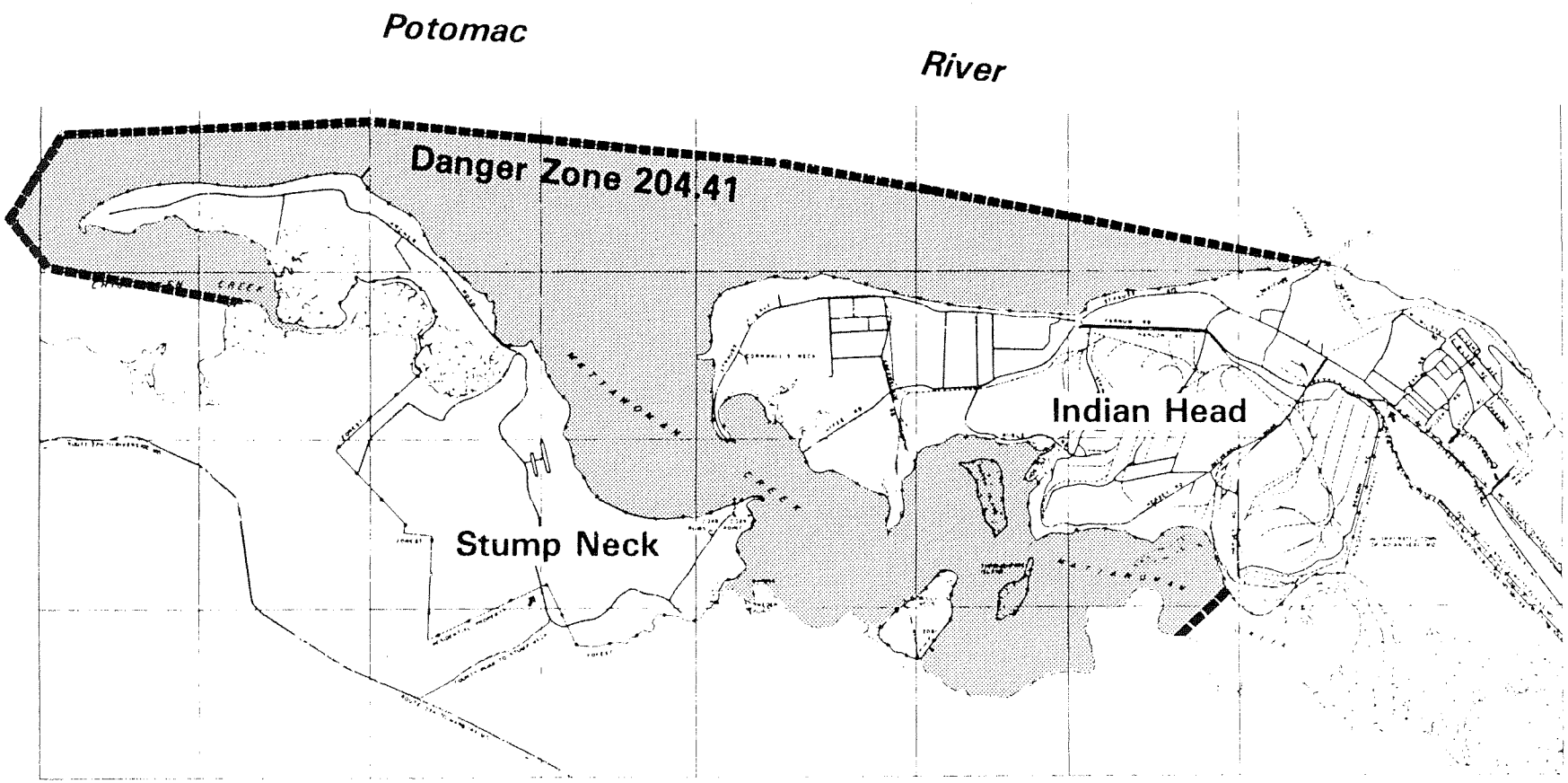
A navigational danger zone has been defined by the U.S. Coast Guard for portions of the Potomac River, Mattawoman Creek, and Chicamuxen Creek in the vicinity of Indian Head and Stump neck. The extent of the navigational danger zone is shown in Figure 7-23. This zone may be redefined once current plans to dredge an alternate boating channel outside of existing ESQD area have been implemented.

Regulations that apply within the navigational danger zone (33CFR334.240) are as follows:

(1) Firings consisting of controlled explosions within the danger zone, and controlled shore operations, or accidental explosions, hazardous to vessel traffic within the limits of the danger zone, may take place at any time of the day or night and on any day of the week.

(2) Flashing red lights, horns, and signs established at appropriate points will warn vessels of impending tests or operations considered to be hazardous to vessels within the danger zone.

(3) No vessel except vessels of the United States or vessels authorized by the enforcing agency shall enter or remain in the danger zone while lights are flashing, when warning horns are in operation, or when warned or directed by a patrol vessel.



NAVIGATIONAL DANGER ZONE

Danger Zone Area Limits

0 2000 4000 6000 8000 Feet

0 500 1000 2000 Meters

Source: 33 CFR 334.240

Figure 7-23

(4) Nothing in this section shall prohibit the use of Mattawoman Creek or Chicamuxen Creek as a harbor refuge because of stress of weather.

(5) Except as prescribed in paragraph (3) of this section, vessels may enter and proceed through the danger zone without restriction; however, accidental explosions may occur at any time and vessels entering the area do so at their own risk.

(6) Fishermen operating in the danger zone when warning signals are sounded shall evacuate the area immediately.

(7) The regulations in this section shall be enforced by the Commanding Officer, U.S. Naval Ordnance Station, Indian Head, Maryland.

intruders, would be useful to discourage casual or inadvertent trespassers. The primary problem with perimeter fencing is the erosion occurring along much of the shoreline of Indian Head, and along Stump Neck as well. If perimeter fencing is installed, it *must* be installed in conjunction with erosion control measures. In the absence of erosion control, the fencing is likely to exacerbate the problem, resulting in loss of both land and fencing.

Perimeter patrols are also needed. A new security docking facility, if relocated from the Potomac River shoreline, should be located on the Old Burn Point if available. This location will provide good access to all NOS shorelines, and will minimize the need for dredging, which may disturb accumulated sediments. A feasibility study is needed to determine an appropriate alignment of a perimeter path to minimize shoreline impacts. This study should also address perimeter fence location and shoreline protection plans.

Security for the existing Stump Neck facilities can be improved with minor modifications to the area surrounding the entrance to Stump Neck. Access to the small arms range and RDT&E facilities is currently unrestricted. Rum Point Road should be relocated to intersect with Archer Avenue inside the security gate. The new road, shown in Figure 8-6, combined with new perimeter fencing will significantly increase safety and security at Stump Neck.

A skeet and trap range will be relocated to Rum Point. The existing small arms range at Stump Neck should be expanded and upgraded to assure the safety of personnel and property both on and off-station. The existing small arms range location should be maintained; however, NOS should request that NAVFACENGCOM conduct a range evaluation report for both ranges. The evaluation will make recommendations to assure that the ranges meet the design criteria in Military Handbook 1027/3; Range Facilities and Miscellaneous Training facilities, Other than Buildings.

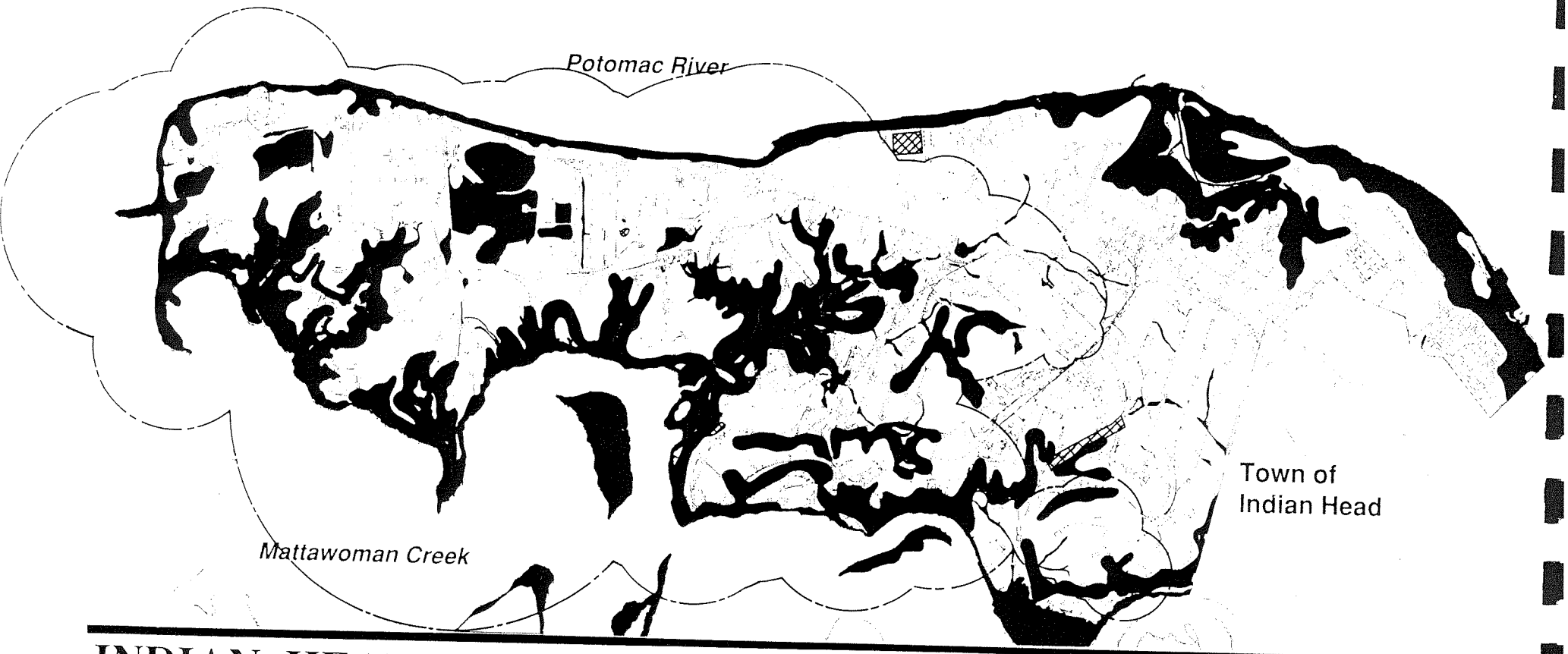
Conflicts with Off-Station Uses

The potential for off-station uses to inhibit NOS activities is a realistic concern. Given the current level of build-out at NOS, on-station land use options for limiting conflicts with off-site uses are limited. However, some basic principles should be applied when making land use decisions that may have an impact on off-site uses:

Explosive storage and industrial-type facilities should be located away from Station boundaries. Navy land adjacent to the boundary fence between the Station and off-site properties should be maintained in (or returned to) an undeveloped state to serve as a visual and acoustical buffer. These efforts will reduce the level of risk perceived by owners of property adjacent to NOS. While the actual risk to adjacent property is limited by ESQD arcs and compliance with state permitting requirements, reducing the perceived or psychological risk will further enhance NOS' image as a "good neighbor."

When possible, ESQD arcs over Mattawoman Creek should be reduced. Although the creek is a declared Navigational Danger Zone, public disregard of the potential hazard areas may have adverse impacts on operations. Land use decisions should reflect a realization that public use of this waterway is increasing.

Beyond these simple measures, there is little that can be done with on-station development to protect against conflicts with off-site parties. NOS should undertake efforts recommended in the Land Use



INDIAN HEAD

Development Constraints

Source: Master Plan Update Maps: Topography, Hydrology, ESQD Arcs, Former Waste Disposal Sites

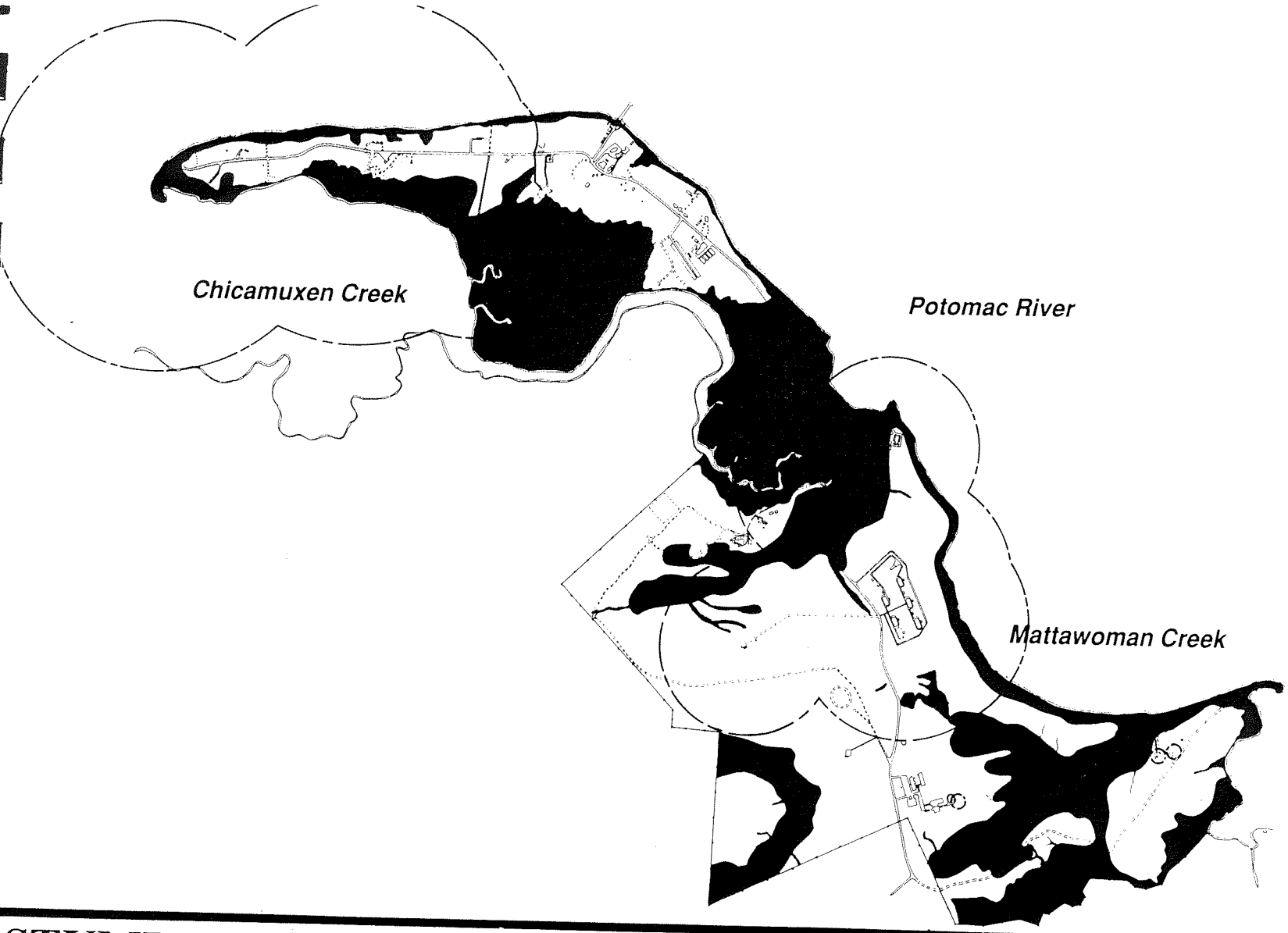
LEGEND

- Legal Constraints (floodplains, wetlands)
- Engineering Constraints (steep slopes)
- Safety Constraints (former waste sites, ESQD arcs)

0 1000 2000 3000 4000 6000 Feet

Figure 8-8

Naval Ordnance Station, Indian Head



STUMP NECK

Development Constraints

Source: Master Plan Update Maps: Topography, Hydrology, ESQD Arcs, Former Waste Disposal Sites

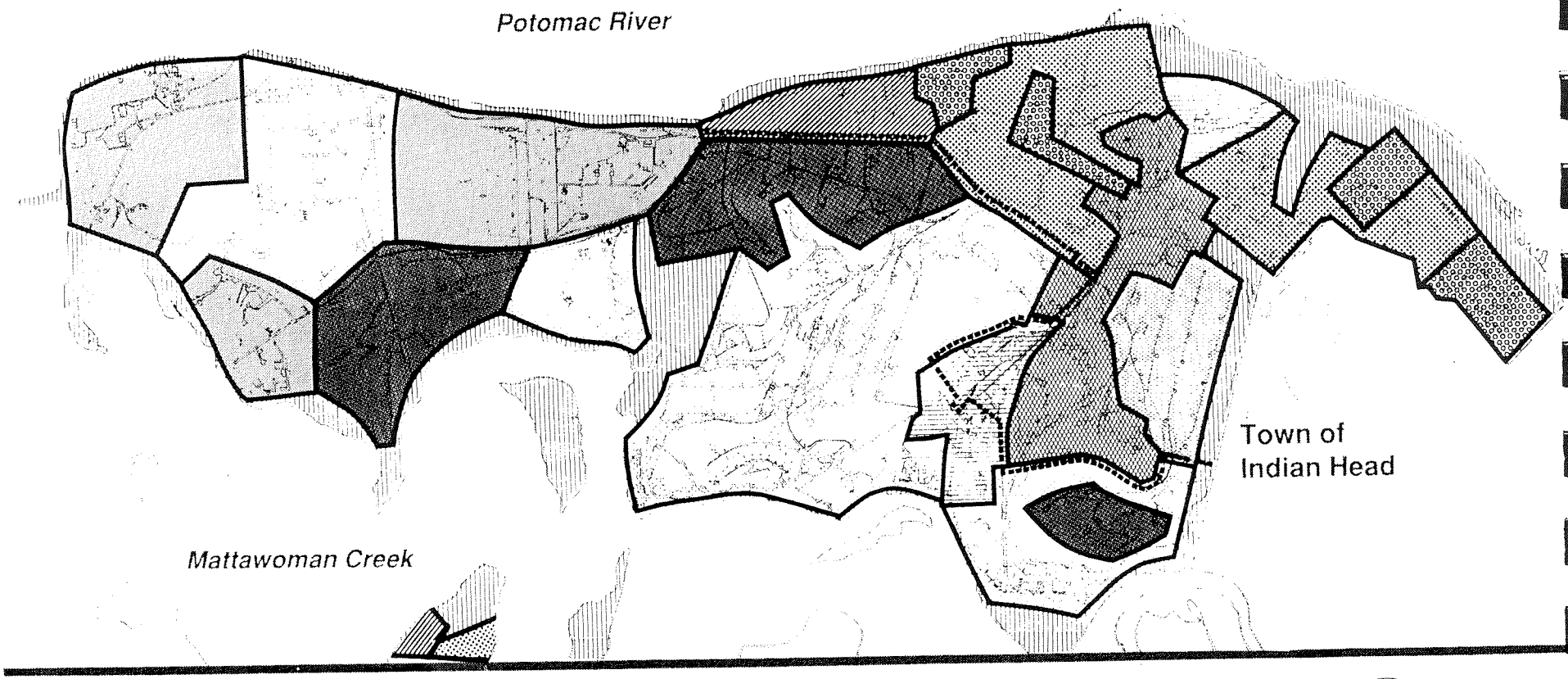
LEGEND

- Legal Constraints (floodplains, wetlands)
- Engineering Constraints (steep slopes)
- Safety Constraints (former waste sites, ESQD arcs)

0 1000 2000 3000 4000 6000 Feet

Figure 8-9

Naval Ordnance Station, Indian Head



INDIAN HEAD

Proposed Land Use

Source: 1989 Master Plan Update

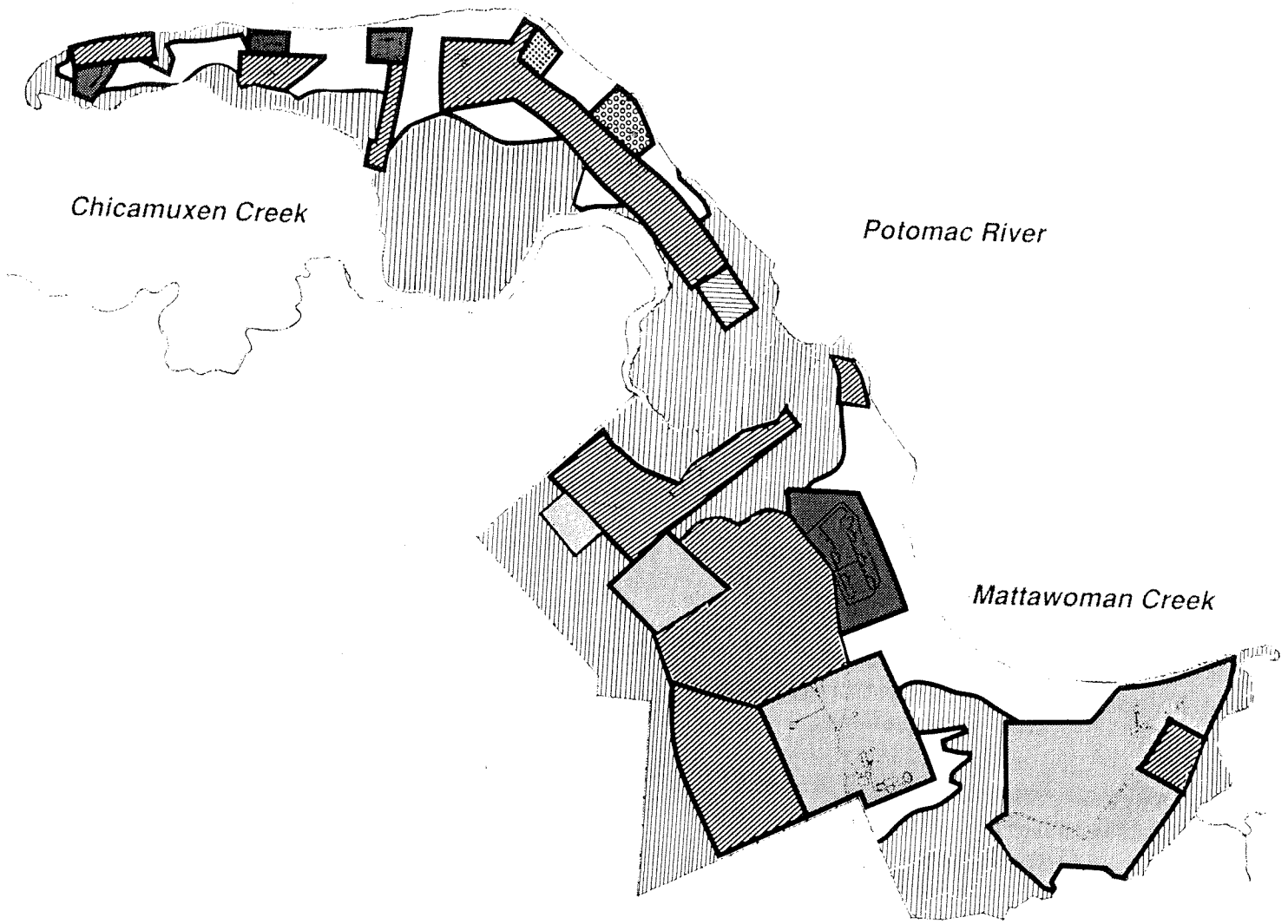
LEGEND

- Operations / Training
- Production
- Maintenance / Utilities
- RDT & E
- Explosives Storage
- Supply / Non-Explosive Storage
- Administration
- Community Facilities and Services
- Housing
- Limited Development
- ..... Proposed Restricted Area Boundary

0 1000 2000 3000 4000 6000 Fe

Naval Ordnance Station, Indian Head

Figure 9-1



STUMP NECK

Proposed Land Use

Source: 1989 Master Plan Update

LEGEND

- Operations / Training
- RDT & E
- Explosives Storage
- Community Facilities and Services
- Housing
- Maintenance / Utilities
- Limited Development
- Open Space

0 1000 2000 3000 4000 6000 Feet

Figure 9-2

Naval Ordnance Station, Indian Head

PRELIMINARY ENVIRONMENTAL ASSESSMENT (PEA)

Prepared by: The Chesapeake Division, Naval Facilities Engineering Command for the Naval Ordnance Station, Indian Head, Maryland, in accordance with OPNAVINST 6240.3E in compliance with the National Environmental Policy Act of 1969. The Chesapeake Division may be contacted at the following address:

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Naval Facilities Engineering Command, Code 20
Building 212, Washington Navy Yard
Washington, DC 20374

Summary

The purpose of any PEA is to alert the activity and the Navy to potential environmental impacts and additional investigations that may be required in order to implement the Master Plan. The highlights of this PEA are listed below:

Eight MILCONs are programmed through FY92. Of these, four are programmed for construction at Stump Neck and Rum Point, and four are programmed for construction at Indian Head.

The primary issue at Stump Neck/Rum Point is the current reliance on septic systems for wastewater disposal. The availability of soils capable of renovating water quality is limited at Stump Neck especially, and care should be taken to ensure that septic systems are not sited on constrained soils. Consideration should be given to construction of a centralized, or several localized wastewater treatment plants. If this approach is taken, adequate operator training will be an important environmental consideration.

Air emission restrictions, while not currently onerous, may become so as the regulatory framework for air quality evolves. Regulatory developments should be closely monitored, and planned projects reevaluated in light of proposed and actual restrictions.

A summary of environmental concerns that should be considered for all projects is provided in Table 10-1. Environmental concerns that will need to be addressed for specific MILCONs are summarized in Table 10-2. More detailed information is provided under Project Descriptions and Potential Environmental Consequences.

Table 10-1. Environmental Concerns for all Projects

Compliance with NEPA process
Coastal Zone Consistency review
Wetland and floodplain avoidance
Threatened and endangered species protection
Cultural resource protection
Sediment and erosion control

Table 10-2. Potential Environmental Concerns for Specific Projects

FY	MILCON NO.	Air Emissions	Wastewater Treatment	Water Use	Hazardous Waste	Spill Controll	Shoreline Erosion
89	P-064	-	X	X	-	-	-
	P-088	X	X	X	X	-	-
90	P-034	X	X	X	X	-	-
	P-059	X	X	-	X	-	-
91	P-963	X	X	-	X	-	-
92	P-106	X	X	-	X	-	-
	P-109	X	X	-	X	-	-
	P-759	-	X	-	-	-	-

Introduction

The major objectives of the Master Plan for the Naval Ordnance Station, Indian Head, Maryland, are listed below:

- To provide a comprehensive Master Plan designed to support current and projected mission requirements.
- To provide recommendations useful in assisting in the improvement of the Station's operational capabilities, management of its natural resources, protection of the natural environment, conservation of energy, aesthetic enhancement of the Station's buildings, streets and landscape, and the maintenance of a safe working environment.
- To demonstrate the Navy's commitment to the implementation of the Department of Defense, Federal, and State policies.
- To document the planning process which is the result of planning efforts that have taken into consideration the regional, local and site-specific manmade and natural land use constraints, and that alternative locations, configurations, and uses for plan recommendations have been pursued.
- To develop a Capital Improvements Plan (CIP).

Existing Environment

Topography

Indian Head and Stump Neck are two separate peninsulas of land emerging from the eastern shoreline of the Potomac River. The Indian Head site consists of 1,974 acres and Stump Neck 1,171 acres. Both Indian Head and Stump Neck have relatively low topographic profiles. From its northeastern highpoint of over 100', the Indian Head terrain slopes to the Mattawoman Creek shoreline. The Potomac shoreline, however, is characterized by severely eroded bluffs up to 90' high. The highest elevations at Stump Neck, over 110', are located in its northeastern corner. The terrain then slopes gradually to the Mattawoman and Chicamuxen Creek shorelines.

Soils

The soils at NOS are derived from the unconsolidated sediments of the coastal plain geologic province. Soils vary from sandy to clayey in texture and from excessively drained to poorly drained. Hard pans,

high water tables, and severe erosion are common problems. Crystalline rock occurs 600' beneath the Station. Many soils at Stump Neck are constrained for septic systems.

Vegetation

Five major categories of vegetation have been identified at NOS. Sixty-one percent is made up of pine, hardwood, and pine/hardwood forest. Remaining vegetated areas are tidal wetlands and landscaped areas. Non-vegetated land area is considered "developed" with man-made structures including roads, railroads, buildings, and parking lots.

Wildlife

The wildlife at NOS may be described as abundant and typical of the open field and shrub, forest, and marsh eco-systems that make up the Station. White-tailed deer are over-abundant, and may have exceeded the habitat carrying capacity at the station. There are three known Federally listed endangered species resident to the Station, all at Stump Neck. There is one species of special concern (listed by the State of Maryland), also at Stump Neck.

Hydrology

The hydrology of NOS is dominated by the Potomac River, Mattawoman Creek, and Chicamuxen Creek. These brackish water systems are subject to tidal action and the area is characterized by swamps, wetlands, floodplains, and numerous tributary streams. Areas within the 100-year floodplain, and areas classified as wetlands at NOS have been identified in the Master Plan as being inappropriate for development.

Cultural Resources

There are four sites at NOS considered to be eligible for nomination to the National Register of Historic Places. An additional eight sites might be eligible but need further investigation. The entire region of Bullets Neck is considered eligible for registration as a prehistoric site district which should be preserved as a unit.

Project Descriptions and Potential Environmental Concerns

This section of the PEA will review the potential environmental impacts to be expected from the programmed MILCONs at NOS. Each project is evaluated in accordance with environmental criteria outlined in NAVFACINST 11010.63B. Projects included in this PEA are programmed through FY 92. These are projects that are approved, or for which approval is anticipated. Specific environmental documentation will be accomplished as the design of each project advances. At this time only general information can be provided, as projects are in the concept stage.

MILCON projects for FY93-95 are currently unprogrammed, although priorities have been assigned, as demonstrated by their inclusion in the Capital Improvements Plan. These projects have been included in the Master Plan and Capital Improvements Plan to establish future planning goals for NOS. MILCON projects for FY93 and later have not been included in the PEA.

All projects described below, unless otherwise specified, must be reviewed for Coastal Zone Consistency, due to location in Charles County, Maryland; must provide for sediment and erosion control both

Main Gate Development - Phase II **Project No.: FFF**

The second phase of the Main Gate Development will provide a personnel office and contractors bid room, and will include development of a truck inspection area and parking.

Renovate Soda Sheds - Phase I **Project No.: GGG**

The proposed Land Use Plan calls for two of the sheds to be part of the Administrative functional area and the other two in the Community Support functional area. These four unique structures are a landmark at NOS and provide an opportunity for redevelopment. A growing need for secure office space can be met by adaptive reuse of these buildings. The concrete base of the soda sheds provides a wall enclosure meeting security requirements. Addition of a concrete floor slab completes the enclosure. The second floor may be used for non-secure office space.

Child Development Center **Project No.: JJJ**

Consolidate three existing separate child care facilities into one meeting current criteria.

Bicycle Path/Fitness Trail **Project No.: KKK**

Small Arms Range Improvements **Project No.: LLL**

Continue Marina Development **Project No.: MMM**

Credit Union **Project No.: NNN**

Third party construction of a new credit union in the community service area.

Stump Neck Gate **Project No.: OOO**

Increase security at the entrance to Stump Neck. Re-route Rum Point Road so traffic to Rum Point must pass through security gate. Includes a new gate house and a pass office.

Navy Exchange **Project No.: PPP**

Construct a new Navy Exchange retail store in the community service area. The existing facility is old, cramped (about half the size required for the military population served) and contains entirely inadequate storage space. The new facility should include approximately 15,800 SF in retail store area, with a contiguous warehouse area of about 5,000 SF. An exchange gasoline service/repair station of about 2,500 SF, with 3 fuel pumps (one each for regular unleaded, super unleaded and diesel fuel) and at least one repair bay, should also be included near the exchange store. NOS currently has no Exchange Service Station.

Carpool Shelter **Project No.: QQQ**

Construct a carpool shelter of about 500 SF in the carpool staging area to provide shelter in inclement weather to NOS employees while waiting for carpools; this will facilitate the station goal of encouraging ridesharing and thus reducing on-station traffice and parking problems.

Skeet Range **Project No.: RRR**

Construct a Skeet Range for recreational use by military personnel stationed at NOS with a skeet range building of about 3,900 SF to include office, storage, sales area, gun maintenance shop and a lounge and toilet facilities. The land area required for the range itself is about 1100 x 2400 feet.

Chesapeake Bay Coastal Ecosystems Program

Laurie Hewitt

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The Chesapeake Bay Coastal Ecosystem Program, located at the Chesapeake Bay Field Office in Annapolis, Maryland, was established in 1984 to protect and restore the living resources so vital to the ecological and economical health of the Chesapeake Bay watershed. It was first of 11 coastal ecosystem programs established by the U.S. Fish and Wildlife Service. The Chesapeake Bay Coastal Ecosystem Program: identifies important fish and wildlife populations; seeks solutions to threats facing these resources; protects, restores, and enhances wildlife habitat; and promotes stewardship of fish and wildlife resources through public outreach.

More than 15 million people reside or work in the watershed. Over the past 300 years, human activities have led to a decline in water quality, mainly due to an increase in nutrients from agricultural, urban and suburban runoff. Land development has caused a loss of wetland, forest and shallow water habitats critical to Chesapeake Bay fish and wildlife. Damming of rivers and other blockages prevents anadromous fish from reaching traditional spawning grounds. Industrial development has resulted in highly contaminated areas in the Bay. The following are some of the projects undertaken by the Program to address these problems.

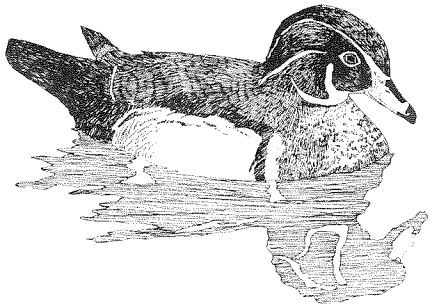
Working With EPA's Chesapeake Bay Program: In 1985, the U.S. Fish and Wildlife Service became a major partner in the multi-agency Chesapeake Bay Program. As the lead wildlife agency, the Service ensures that the CBP's primary focus is to restore living resources, specifically submerged aquatic vegetation, wetlands, waterfowl and anadromous fish. The Program facilitated a multi-agency effort to identify the habitat requirement parameters necessary to maintain or restore 31 Chesapeake Bay species of submerged aquatic vegetation, shellfish, finfish, waterfowl, colonial wading birds and raptors. This information is used by federal, state and local governments to ensure habitat restoration projects address the needs of these wildlife species.

Watershed Assessments: Using a Geographic Information System (GIS), the Program is able to target habitat protection and restoration and water quality improvements. In Virginia's Chickahominy River watershed, the Program is looking at the effects of natural and human-induced changes on wetlands, currently focusing on forest breeding birds and fisheries. Local governments are using this information to ecologically target habitat restoration. A study of Maryland's Chester and Choptank River watersheds identified areas of high nutrient levels. Planning agencies are using this information to coordinate habitat restoration and conservation activities needed to reduce nutrient inputs.

Partnerships For Habitat Restoration: Throughout the watershed, the Program provides technical and financial assistance to partners in order to restore fish and wildlife habitat. In partnership with federal, state and local agencies, private landowners and non-governmental groups, the Program has restored more than 180 acres of wetlands, 60 acres of riparian forest, 40 acres of uplands, and 8 miles of streams. Stream restoration workshops in Maryland, Virginia and Pennsylvania trained more than 500 federal, state and local government officials and non-governmental representatives, resulting in the restoration of more than 250 miles of stream and riparian habitat. To date, more than 170 miles of fish spawning habitat have been reopened and more than 30,000 acres of submerged aquatic vegetation restored.

BayScapes and Schoolyard Habitats: Traditional landscaping degrades the Chesapeake Bay and the wildlife it supports. Through BayScapes, the Program encourages the use of landscape practices that reduce pollution and provide habitat for wildlife. Bayscapes demonstration sites have been completed at Eastern Neck National Wildlife Refuge and Anacostia Naval Facility. An information packet and accompanying video provides suggested activities to help homeowners turn traditional yards into BayScapes. Newspaper articles about BayScapes have reached more than 250,000 readers.Through the Schoolyard Habitat Project, the

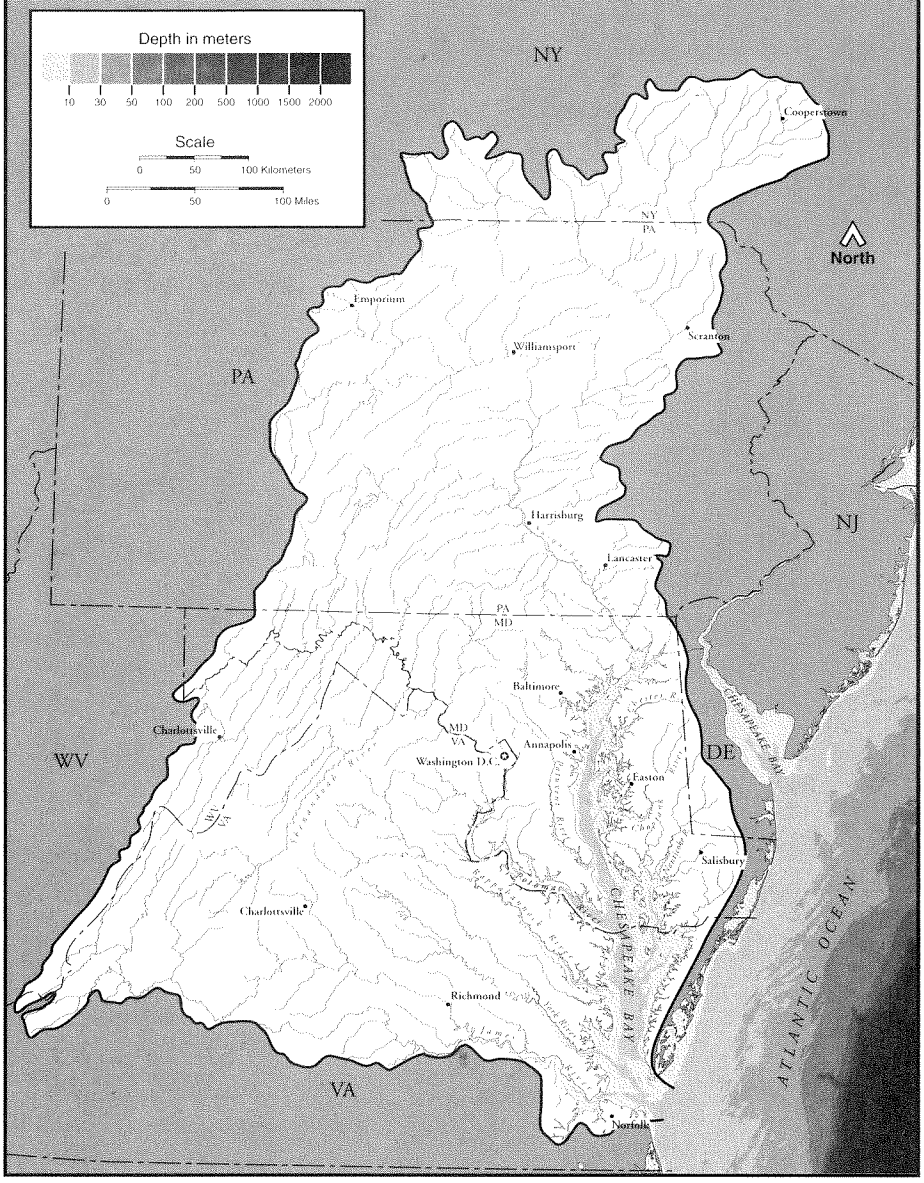
Program provides training and technical assistance to teachers and students for creation or restoration of woodlands, wetlands and meadows on school grounds. To date, habitats have been restored at more than 20 schools in Maryland. Several thousand students have been involved with planning and implementing habitat projects.



The Chesapeake Bay Coastal Ecosystem Program area spans a drainage basin of 64,000 square miles, encompassing parts of the states of Delaware, Maryland, New York, Pennsylvania, Virginia and West Virginia and the entire District of Columbia. Waters from this expansive landscape flow into the Chesapeake Bay, the nation's largest estuary. The watershed contains an array of habitats, including mixed hardwood forests; grasslands and fields; lakes, rivers and streams; wetlands and shallow water habitats; open water; and the cities and suburbs in between.

The Chesapeake Bay and its tributaries support more than 2,700 plants and animal species, including threatened and endangered species, waterfowl, raptors, anadromous fish, and commercially important fish and shellfish. Forested uplands are nesting and resting habitat for migratory songbirds. Coastal wetlands provide valuable wintering grounds for swans, geese, sea ducks and bay ducks. The tributaries within the watershed are spawning grounds for anadromous fish species like striped bass, blueback herring, alewife, American shad, hickory shad, shortnose sturgeon and Atlantic sturgeon. Shallow water areas support submerged aquatic vegetation, underwater plants that provide food and cover for waterfowl, blue crabs and juvenile fish. The open water of the Chesapeake Bay supports striped bass, bluefish, weakfish, shad, herring, anchovy and menhaden. Commercially valuable shellfish, like oysters and clams, live on the bottom of Chesapeake Bay.

Chesapeake Bay Watershed



U.S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service provides the federal leadership to conserve, protect and enhance fish and wildlife resources and their habitat for the continuing benefit of people.

The Service manages more than 500 national wildlife refuges, representing the most comprehensive wildlife habitat management effort in the world. The Service also manages national fish hatcheries, enforces federal wildlife laws and international treaty obligations, and provides leadership in habitat protection.

National resources entrusted to the Service for conservation and protection are: refuges, migratory birds, fishery resources, threatened and endangered species, wetland resources, and certain marine mammals.

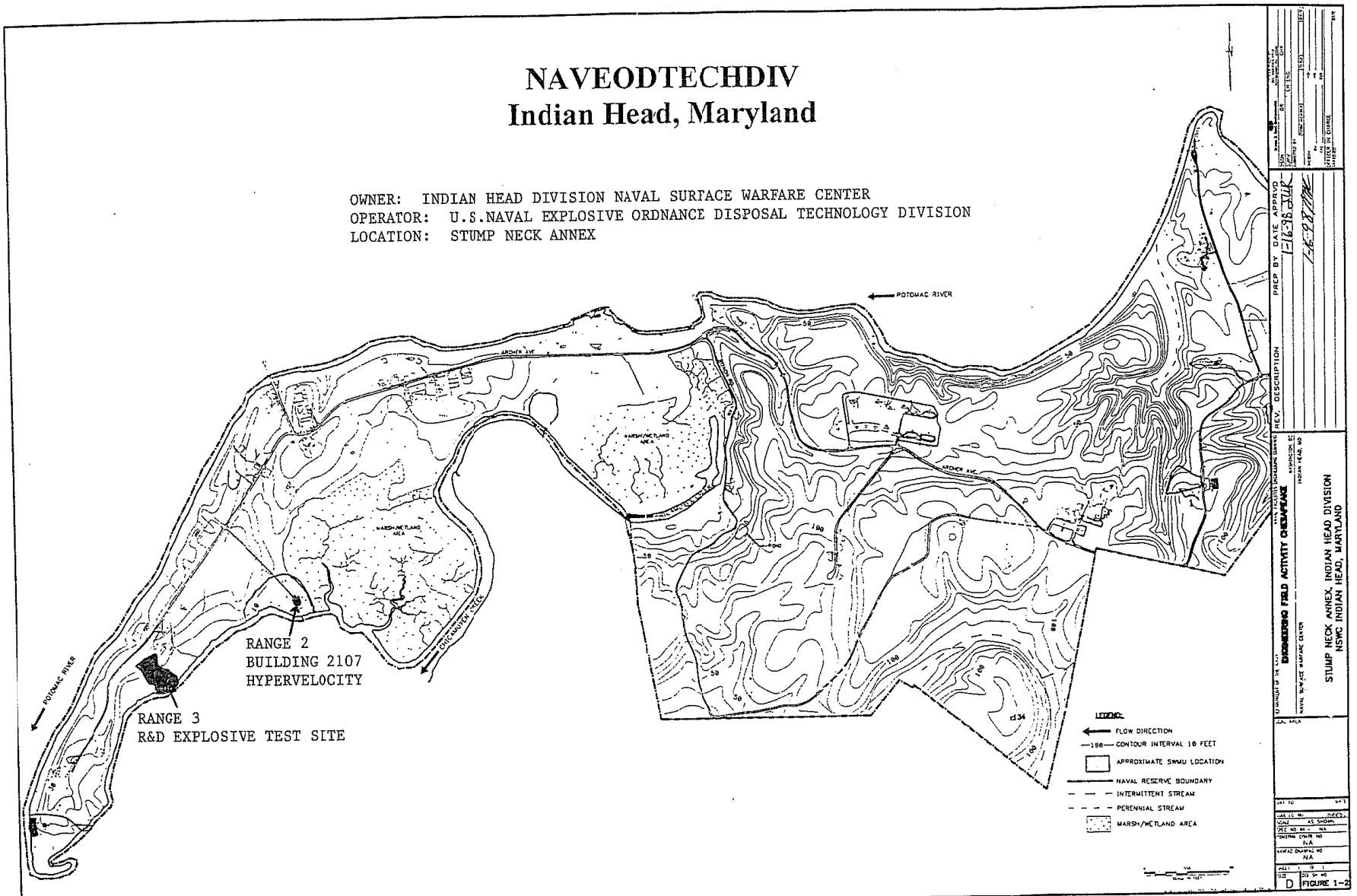
The Service's Northeast Region encompasses 13 states from Maine to Virginia with more than 100 field offices. Headquarters for the region are located in Hadley, Massachusetts.

♻ Printed on recycled paper August 1996

PART THREE
Attachments for
Range 2
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER

NAVEODTECHDIV
Indian Head, Maryland

OWNER: INDIAN HEAD DIVISION NAVAL SURFACE WARFARE CENTER
OPERATOR: U.S.NAVAL EXPLOSIVE ORDNANCE DISPOSAL TECHNOLOGY DIVISION
LOCATION: STUMP NECK ANNEX



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FOR REFERENCE USE ONLY

NAVAL EXPLOSIVE ORDNANCE DISPOSAL TECHNOLOGY DIVISION

STANDARD OPERATING PROCEDURE
for
EXPLOSIVE OPERATIONS
at
HYPER VELOCITY TEST FACILITY (SITE TWO)
6012-01-01.0-0003

Prepared By: AOC(EOD) Marc K. Bond

DEPT.	APPROVAL SIGNATURE	DATE
6012	Lawrence A. Ryan OSCS	10/14/97
601	Danny D. Wood	10/16/97
60A	Danny D Wood	10/16/97
AC-3	BMCS	23 Oct 97
AC-4	Hope Dustin	23 Oct 97
MED-73	Jeff Stalnaker	23 Oct 97
AC-5	BMCS	23 Oct 97
B		23 Oct 97

T. K. McCauley — COMMAND APPROVAL (Signature)

24 Oct 97 — DATE

(AFTER COMMAND APPROVAL, ROUTE TO AC-5 FOR RETENTION)

Two copies to Bond 10/27/97

DISTRIBUTION PAGE

SOP# 6012-01-01.0-0003

COPY	DATE	LOCATION	NAME AND CODE
ORIGINAL	1/15/99	ESO	L. A. Kijek, OSS / AC-3/5
COPY 1	1/15/99	Range 3	M. Bond, AOC / ~~AC-3/5~~ 6012
COPY 2	1/15/99	Hypervelocity	M. Bond, AOC / 6012
COPY 3			

Notes:

(1) Copies of Explosive SOP's will only be made by AC-3/5.
(2) All supervisors must sign the process supervisor's statement in the original SOP.
(3) A Level III supervisor must sign the Annual Certification of Review in the original SOP.
* These dates and signatures must also be annotated in the copies.

RECORD OF CHANGES

Make approved pen and ink or page change(s) as directed and insert change approval page following this record of changes. Record each change entered in the table below.

CHANGE NO.	DATE	BRIEF DESCRIPTION	ENTERED BY
1	29 Mar 99	change pg 3-3, 6. to read "2 operators"	AOC M. BOND

TABLE OF CONTENTS

SECTION 1 ADMINISTRATION

101. References
102. Enclosures
103. Certification of Annual Review
104. Change Procedures

SECTION 2 SECURITY

201. General

SECTION 3 HAZARD CONTROL

301. Hazard Control Briefings
302. General Safety Precautions
303. Specific Safety Precautions
304. Hazards
305. Hazard Analysis
306. Explosive Components and Net Explosive Weights
307. Hazardous Waste Control
308. Material Safety Data Sheets (MSDS)
309. Emergency Response and Contingency Plans
310. Site Diagram

SECTION 4 EQUIPMENT LISTS

401. Safety Equipment
402. Processing Equipment, Tools and Consumables

SECTION 5 STEP-BY-STEP PROCEDURES

501. Pre-Explosive Operations
502. Explosive Work-up Trailer
503. Explosive Operations
504. Post Explosive Operations
505. Misfire Procedures

SECTION 6 SUPERVISOR'S AND WORKER'S STATEMENTS

601. Supervisor's Statement
602. Workers Statement

SECTION 1

ADMINISTRATION

101. REFERENCES.

(a) NAVSEAINST 8023.11 Standard Operating Procedures for the Processing of Expendable Ordnance
(b) NAVEODTECHDIVINST 8023.11C Standard Operating Procedures for the Processing of Expendable Ordnance
(c) NAVEODTECHDIVINST 5510.16 NAVEODTECHDIV Information and Personnel Security Program
(d) NAVEODTECHDIVINST 5530.1B Procedures Concerning the Security of Arms Ammunition and Explosives (AA&E)
(e) NAVEODTECHDIVINST 3571.2K Qualification and Certification of Personnel Performing or Supervising Conventional Ammunition / Explosive Operations
(f) NAVEODTECHDIVINST 5090.1B Hazardous Waste Management Plan (HWMP)
(g) OPNAVINST 5102.1C Mishap Investigation and Reporting
(h) NAVSEA SWO60-AA-MMA-010 Demolition Materials
(i) NAVSEA OP 5, VOL. 1 Sixth Revision, Ammunition and Explosives Ashore
(j) Standard Operating Procedures for Explosive Test Site Range Three 2011-01-01.0-0001

102. ENCLOSURES.

1 Fire Bill for 2107

103. CERTIFICATION OF ANNUAL REVIEW.

1. In accordance with reference (a) and (b) an annual review is required of all sops dealing with the processing of expendable ordnance. If no major changes are required, the review is sufficient at the immediate supervisor level. If a major change is required, the SOP must be submitted to all elements involved in the development of the SOP.

Annual Review:	Marc K Bo	Branch Hd	30 Oct 98
	Signature	Title	Date
Annual Review:	Marc KB	Brand Hd	14 Oct 99
	Signature	Title	Date
Annual Review:	_____	_____	_____
	Signature	Title	Date

2. SOP Record of Approval expires 4 years from the date of approval and requires review by all elements involved in the development of the SOP.

104. CHANGE PROCEDURES.

1. **CRITICAL CHANGE.** Any changes to the step-by-step procedures of this SOP which may present additional hazards to the worker or involves the hands on manipulation of ordnance is considered a critical change. Critical changes will be reviewed by the same officials that granted approval.

2. **NON-CRITICAL CHANGE.** Any changes to the step-by-step procedures of this SOP that will not increase hazards to the worker or create an unsafe condition (e.g. tool type or size) or changes such as phone numbers , correction of typographical errors, or re-wording of paragraphs (to clarify meaning or intent) that do not affect the safety of the procedures delineated in this SOP do not require recertification and are considered non-critical changes. Non-critical changes will be approved by a qualified/certified Skill Level III RSS directly involved with this process and may be hand written into this SOP.

SECTION 2

SECURITY

201. GENERAL.

1. The security of the United States in general, and of Naval operations in particular, depends in part upon the success attained in safeguarding classified information and protecting Arms, Ammunition and Explosives (AA&E).

2. References (c) and (d) establish security procedures which serve to implement the Security Program within the Explosive Operations Branch. Inquiries for guidance and interpretation of references are encouraged and should be addressed to the security department via the Chain of Command.

3. All personnel are responsible for providing protection and accountability for all classified information under their custody and for locking classified information in approved security containers whenever it is not in use or under direct supervision of authorized personnel.

4. Ensure all buildings containing AA&E are locked when not in use or under direct supervision of authorized personnel and that security alarms are set at the end of each work day.

SECTION 3

HAZARD CONTROL

301. HAZARD CONTROL BRIEFINGS.

1. All personnel involved in the range evolution will receive a hazard control brief prior to conducting operations under this SOP. The Range Safety Supervisor (RSS)/Demolition Burn Operation Supervisor (DBOS) is ultimately responsible for ensuring that each individual who will be involved in the operation has received a hazard control briefing.

2. Document each hazard control brief conducted and include who presented the brief as well as who was in attendance.

HAZARD CONTROL BRIEFING

ALL PERSONNEL WILL BE BRIEFED ON THE HAZARD/ HAZARD CONTROL SECTION OF THIS SOP EVERY 30 DAYS. PERSONNEL WILL SIGN THIS SHEET TO SIGNIFY THEY HAVE RECEIVED THE BRIEFING.

Brief conducted by:_____ **Date:**_____

Project:_____

NAME (PRINTED)	SIGNATURE	BLOOD TYPE	NAME (PRINTED)	SIGNATURE	BLOOD TYPE

302. GENERAL SAFETY PRECAUTIONS.

1. **Personnel Requirement.** A minimum of 2 EOD Technicians are required to conduct explosive operations. One technician must be qualified/certified to Level III (Team Leader and designated as a Range Safety Supervisor (RSS) or Demolition Burn Operations Supervisor (DBOS) per reference (e). Note: Test Plans will only be supervised by a qualified RSS.

2. **Responsibilities.** The RSS/DBOS will be responsible for the following:

a. Review all developmental project SOP's for maximum personnel safety and accuracy of sequence of events (RSS).

b. Conduct an Explosive Safety Brief prior to all explosive operations.

c. Ensure all safety precautions are followed during explosive operations.

d. Take prompt action to preclude or control any hazardous situation.

3. **Range limits.** HYPER VELOCITY Test Facility (Site Two) has a 5 lb C/D 1.1 Net Explosive Weight (N.E.W.) limit.

4. **Lightning detection.** The Electrical Storm Indicating Device is located at Bldg's 2185 and 2008 and is equipped to monitor electrical storms within a 30 mile radius. Electrical storms within a 15 mile radius will be closely monitored by quarterdeck personnel for direction and hazards to Range Two. In addition, the RSS/DBOS will wear the NSWC weather beeper. Explosive operations will be secured when an electrical storm is within 5 miles.

5. **Adjacent Areas.** Range Two is restricted from use when Range Three is processing fragment producing materials. There are no restrictions for using Range Two when non-fragmenting materials are processed at Range Three.

303. SPECIFIC SAFETY PRECAUTIONS.

WARNINGS

USE TWO PEOPLE: ONE AS A BACK UP AT A SAFE DISTANCE WHEN APPROACHING A MISFIRE

DO NOT DISTURB A MISFIRED BLASTING CAP.

WARNINGS

ELECTRIC DETONATORS SHALL BE SUFFICIENTLY BARRICADED TO PREVENT PERSONNEL INJURY FROM A PREMATURE FIRING WHILE CONDUCTING CONTINUITY CHECKS AND CONNECTING LEG WIRES TO FIRING LINE

ANY ENTRY INTO THE FIRING AREA AFTER THE MISFIRE MUST BE REGARDED AS EXTREMELY HAZARDOUS, EXTREME CAUTION MUST BE TAKEN

1. No eating, drinking or smoking permitted in any explosive operating or storage area.

2. No lighters, matches or spark producing devices are permitted in any explosive operating or storage areas.

3. Safety glasses will be worn whenever handling or checking continuity of detonators and also when checking misfires.

4. Ensure detonators, or any other initiating devices are sufficiently barricaded during continuity checks and hook up.

5. The assigned RSS/DBOS has complete control during explosive operations.

6. Personnel limits for the outdoor testing facility at bldg 2107 will be ~~8 personnel, 4 transients and 4 operators~~ 2 operators.

7. Explosives will only be transported in vehicles authorized for this purpose. Initiating explosives will not be transported in the same compartment as the main charge or bulk explosives. Detonators will be carried in a MK 663 container.

8. The RSS/DBOS will ensure only qualified/certified personnel handle explosives or explosive items.

9. The RSS/DBOS will maintain control of the jumper cables and control box keys while explosives or explosive actuated tools are being set up.

10. Do not divide responsibility for preparation, placement and detonation of charges. One person shall oversee the entire project with alternates appointed to take his place if needed.

11. Do not leave explosives or detonators exposed to direct sunlight or any other heat source.

12. Do not use electrically initiated detonators in the vicinity of static electricity, transmitters of radio frequency energy, or high voltage transmission lines.

13. Electric detonators are sensitive to initiation by static discharge. Emphasis the importance of grounding procedures when the relative humidity is less than 60%.

14. All explosive operations will be secured when electrical storms are detected within 5 miles.

15. Non-essential personnel will return to the control room, bldg 2107 prior to initiator work-up and before priming in.

16. Personnel will remain in the control room until area is cleared by the RSS/DBOS.

17. Ensure all personnel know the location of first aid kits and burn blankets which are located in the control room.

18. Ensure all personnel know the location of the phone located on the wall inside of bldg 2107.

19. Demolition material will never be left unattended at the test site. If there is a break in operations, demolition material will be returned to the Range Three magazines and secured.

20. Silk, wool, rayon, nylon or other synthetic-fibre outer or undergarment shall not be worn during any explosive operation if the generation of static electricity would create a hazard.

304. HAZARDS.

1. Each ordnance item presents unique explosive and mechanical hazards. If it is unclear what hazards are presented by a particular ordnance item, available publications and manufacturer's documentation shall be used to identify the hazards. The following is a general list of some of the hazards associated with typical ordnance items and is not meant to be all encompassing.

a. High Explosive. High explosives can be detonated by improper handling. Although some are relatively insensitive to shock, friction, and flame, this does not preclude the possibility of accidental detonation when subjected to improper treatment.

b. Detonators, Leads and initiators. Detonators, leads, and initiators may detonate or present a fire/fragmentation hazard if subjected to heat, shock, or friction. Electrically fired devices may be susceptible to initiation as a result of static discharge

305. HAZARD ANALYSIS.

1. High Explosive

a. All personnel conducting explosive operations will be certified at a minimum Explosive Handler/Under Instruction as per reference (e).

b. When possible, operations involving explosive components will be accomplished either remotely or behind explosive safety equipment to prevent or minimize injuries to workers during range operations.

2. Detonators, Leads and initiators

a. Personnel will properly ground themselves prior to handling detonators, leads, and initiators

b . Detonators will be transported in MK 663's.

c. Safety glasses will be worn whenever handling detonators.

306. EXPLOSIVE COMPONENTS AND NET EXPLOSIVE WEIGHTS. Explosive components and N.E.W.'s shall be determined for each piece of ordnance being tested, but as these vary among the many different ordnance types, it is not possible under the scope of this SOP for them all to be listed.

307. HAZARDOUS WASTE CONTROL. Explosive Hazardous Waste (EHW), may include explosive solids , residues, or explosively contaminated items. EHW generated during the procedures contained within this SOP will be managed per reference (f). Non-explosive hazardous waste, such as lead seals will be managed per reference (f). Additionally, a record of all explosive operations for EHW control, and methods of treatment for disposal will be maintained in the Range Operations Log. This will include; EPA waste number and/or source codes, quantity of explosive by type, method of treatment, to include disposal by Open Burn (OB) and total N.E.W. The amount of EHW treated by OB will be forwarded to Code AC-4 at the end of the calendar year, who will incorporate the EHW totals in the annual reports.

308. MATERIAL SAFETY DATA SHEET (MSDS). All MSDS's for HYPER VELOCITY Test Facility will be located in building 2107 for review upon request.

309. EMERGENCY RESPONSE AND CONTINGENCY PLANS.

NOTE

EMERGENCY NOTIFICATIONS ARE POSTED ON CONTROL ROOM WALL NEXT TO THE PHONE

1. The site diagram/fire bill is posted in bldg 2107 and 2108. Fire bill is Enclosure (1).

2. If an emergency situation such as fire or unplanned/unscheduled explosion occurs during a period that explosive operations are being conducted, the RSS/DBOS shall be responsible for evacuating all personnel from the test site and mustering them in bldg 2108 (Range Three Control bldg). In addition, they must make notifications listed below.

(a) **FIRE DEPT/PRIMARY EMERGENCY MEDICAL SUPPORT: X4333/6900**
(b) **CORPSMAN: X6986**
(c) **COMMANDING OFFICER: X6803/6804**
(d) **DIVISION HEAD: X6893**
(e) **COMMAND EXPLOSIVE SAFETY OFFICER: X6871/6872**

3. Should an Explosive accident or injury to personnel occur, the RSS/DBOS or senior range personnel shall:

(a) Render immediate first aid to injured personnel and assign extra personnel to fight and contain fire(s) as required in order to move/protect injured personnel.

NOTE

WHEN MOVEMENT OF THE INJURED PERSONNEL MAY NOT BE FEASIBLE DUE TO THE NATURE OF THE INJURIES. MOVEMENT MAY BE NECESSARY DUE TO THE POTENTIAL OF FURTHER INJURIES BECAUSE OF FIRE(S) INVOLVING EXPLOSIVE MATERIALS. MOVEMENT OF INJURED PERSONNEL AND/OR FIGHTING FIRES SHALL OCCUR ONLY N ALL OTHER MEANS OF PROTECTION HAVE BEEN EXHAUSTED

(b) Remain with injured personnel and assess the degree and extent of injury(s).

(c)Attempt to stabilize the injured personnel (First Aid ABC's, treat for shock, prevent further contamination of injuries, etc) until EMT/Fire Department arrives.

(d) Assign one person to initiate the Emergency Response phone calls **(EMT/Fire Dept. X4333)** to request an ambulance. Inform the dispatcher as to the type and extent of injuries, vital signs, and number of casualties.

NOTE

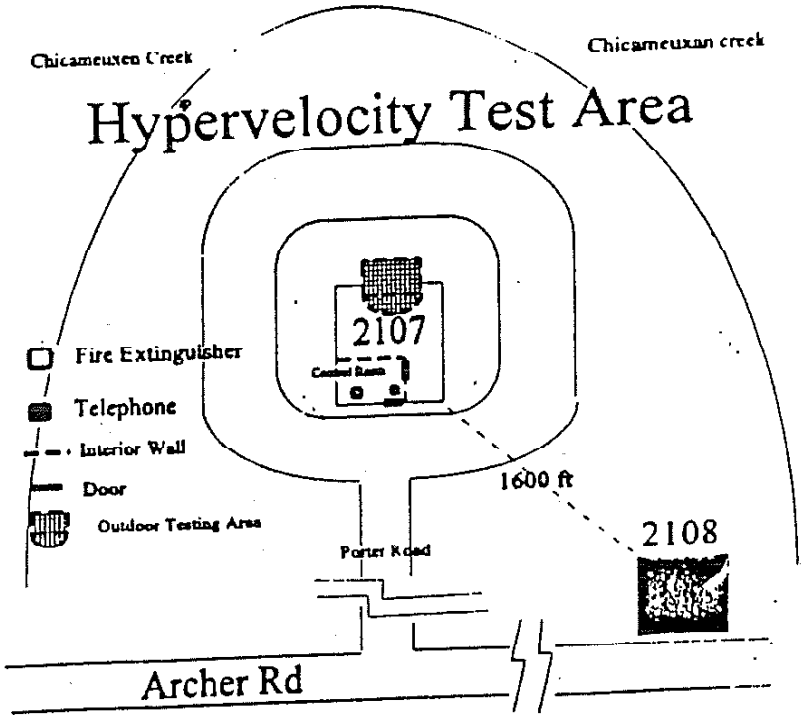
THE INFORMATION PASSED TO THE DISPATCHER IS CRITICAL SEVERITY OF INJURY DETAILS WILL ALLOW THE DISPATCHER TO ACTIVATE THE HELICOPTER REQUEST TO THE COUNTY COMMUNICATION CENTER IF REQUIRED WHILE ASSIGNING THE AMBULANCE FROM IHDIVNSWC TO RESPOND. UPON ARRIVAL AND AFTER ACCIDENT SCENE ASSESSMENT, THE NAVEODTECHDIV EMT/RESCUE UNIT WILL MAKE THE FINAL DETERMINATION AS TO THE FINAL TRANSPORT NEEDS (AMBULANCE VS. HELICOPTER) REQUIRED AND WILL INITIATE THE APPROPRIATE ACTIONS. HELICOPTER LANDING COORDINATES ARE AS FOLLOWS:

Longitude: 77 degrees 13 minutes, 20 seconds West
Latitude: 38 degrees 33 minutes, 16 seconds North.

4. Personnel injury. Minor injuries should be attended using supplies contained in the first aid kit located in the safety bunker. Further medical treatment should be attended by either the Corpsman (X6986) or the EMT/Fire Department (X6900).

5. A mishap investigation shall be conducted per reference (g) following any unplanned or unexpected event causing personnel injury, occupational illness, death, material loss or damage.

310. SITE DIAGRAM. The site diagram of HYPER VELOCITY Test Facility is shown as figure 3-1 and posted inside building 2107 and 2108 (Range Three Control Office).



SECTION 4

EQUIPMENT LISTS

401. SAFETY EQUIPMENT.

ITEM	DESCRIPTION	SPECIFICATIONS	QTY
01	Safety glasses w/ side shields	ANSI Z-87	As reqd
02	First Aid Kit	Sealed	2
03	Burn Blankets	N/A	2
04	Explosive Vehicle	Per OP 2239	As reqd

402. PROCESSING EQUIPMENT, TOOLS, AND CONSUMABLES.

ITEM	DESCRIPTION	SPECIFICATIONS	QTY
01	General Hand Tools	Misc.	As reqd
02	Rags	N/A	As reqd
03	Sand Bags	N/A	As reqd
04	Firing System	Per test plan	As reqd
05	Electric Firing Wire	N/A	As reqd
06	Firing Cable	N/A	As reqd

SECTION 5

STEP-BY-STEP PROCEDURES

501. PRE-EXPLOSIVE OPERATIONS.

1. Short notice projects/high priority projects as determined by the project officer will be addressed initially by the assigned project officer and range personnel. Rescheduling of projects will only be done by range personnel.

2. The RSS/DBOS and assigned range personnel will review all approved SOP's/Test Plans for compliance with applicable safety precautions and regulations. All range personnel will have a thorough understanding of the SOP/Test Plan objectives, project munitions or disposal procedures.

3. All ordnance and explosives will be requisitioned by the project officer using NAVEODTECHDIVINST 8000.1M and delivered to Range Three by magazine personnel prior to the scheduled operation. The RSS/DBOS is responsible for the custody and accountability of all explosive material delivered to Range Three supporting the operation under their supervision.

4. Demolition material will be visually inspected to verify the quantity and nomenclature match supporting documentation upon receipt. The RSS/DBOS will immediately be notified that the material has been received and a copy of the munitions transfer document will be maintained by Range Three.

5. Demolition material will be stored in Range Three's magazines until required for use. When required for demolition operations, material will be transported to the test site.

6. The RSS/DBOS will ensure all required tools and equipment are available, clean and in good working order prior to the scheduled test date.

7. Atmospheric conditions will be monitored and recorded in the HYPER VELOCITY Range Log.

8. Prior to explosive break out, the amber light will be turned on and the bravo flags will be hoisted at building 2107, and at entrance gate to magazine area.

9. The red light and siren will be tested prior to placing explosives at the test site.

10. The road barricade will be manually lowered prior to explosive work-up to prevent unauthorized entry and departure.

11. The road barricade will be manually lowered prior to explosive work-up to prevent unauthorized entry and departure.

12. The following notifications will be made prior to conducting and upon completion of any explosive operations.

a. Fire Dept (primary EMT)---------- 4333, 6900
b. Quarterdeck/CO/XO---------- 6800, 6801
c. Division Head ----------6893/4
d. Explosive Safety Officer ---------- 6871

13. Ensure a designated safety vehicle is located at each site where explosive operations are being conducted prior to the placement of explosives.

14. All personnel who will be involved in explosive operations at Site Two will sign the Range Worker's Statement directly after the range safety brief.

15. Ensure all personnel know the location of the phone (inside of 2107).

16. Ensure all personnel know the location of first aid kits and burn blankets in range truck and in bldg 2107.

502. EXPLOSIVE WORK-UP TRAILER. (Located on Range Three)

1. This section pertains to the packing and preparation of special charges and EOD specific explosive charges involving, but not limited to Deta Sheet, C-4, and other authorized explosives under the cognizance of the Range Two Hypervelocity Test Site.

2. Safety.

a. Personnel involved in explosive work-up operations, while in the work-up trailer at Range Three, will be kept to the minimum required to safely complete the job. A minimum of 2 personnel are required and a maximum of 6 are allowed in the work-up trailer.

b. Initiating devices will **NOT** be allowed in the work-up trailer unless prior approval of the Division Head and Explosive Safety Officer has been obtained.

c. Flame/spark producing devices will not be permitted inside or within 50 feet of work-up trailer.

d. The explosives within the confines of the trailer during work-up will be kept to a minimum, not to exceed 100 lbs. Upon completion of work-up operations, all explosives will be returned to Range Three's magazines or temp storage bunkers located on the Range prior to explosive operations.

e. Prior to commencing range operations, the assigned RSS/DBOS will ensure the trailer is clear of personnel, explosives, secured and appropriate explosive placards are displayed.

f. The RSS will ensure that proper protection equipment, as identified in the project SOP, is utilized.

503. EXPLOSIVE OPERATIONS.

1. Safety.

a. Handle all misfires in accordance with reference (h). Refer to section 505 for misfire procedures.

b. The RSS/DBOS shall ensure the area is clear of watercraft prior to initiator workup or hero unsafe ordnance handling, to maintain safe EMR radio transmitter distances.

c. Before firing any demolition charges the RSS shall ensure that:

- Explosives not utilized are returned to the magazine or designated temporary storage area at Range Three.
- All personnel are accounted for and safely sheltered.
- The road barricade is down and the siren is sounding.
- The bravo flag is raised above 2107 and Porter road is clear of approaching vehicles.
- The waterway is clear of boats (within 2500 feet).
- All equipment is at a safe distance from hazard area.

2. Equipment.

a. Inspect all required equipment. This may include but is not limited to:

- Firing System
- Electric Firing wire (Outside)
- Firing Cable (Inside)

3. Down Range Procedures.

WARNING

ELECTRIC DETONATORS SHALL BE SUFFICIENTLY BARRICADED TO PREVENT PERSONNEL INJURY FROM A PREMATURE FIRING WHILE CONDUCTING CONTINUITY CHECKS AND CONNECTING LEG WIRES TO FIRING LINE.

a. All explosive build up will be conducted in the explosive work up trailer (C-22) located at Range Three.

b. All explosives will be kept in Range Three magazines or temporary storage bunkers at Range Three until ready for use.

c. RSS/DBOS will check the continuity of the firing wire prior to bringing explosives to the firing area.

d. RSS/DBOS will ensure he has positive control of the initiating device.

e. The project officer will set up the mirrors and firing stands per individual project test plan.

f. The RSS will turn on the red light and ensure the barricade is lowered prior to bringing explosives to the test facility.

g. The RSS will place explosives or explosive test object.

h. Complete all camera setup/testing, including film loading.

I. All personnel not essential to the firing phase return to the control room in bldg 2107.

j. The RSS will check continuity of the detonator in the same manner as checking a electric blasting cap. Refer to reference (j).

k. The RSS will connect the detonators to the firing line/wire.

l. Remaining personnel retreat to control room, bldg 2107.

m. The RSS will visually check the area for cars, boats, and ensure all non-essential personnel are in the control room.

n. RSS/DBOS will check for continuity of firing line.

o. The RSS/DBOS will install the detonator into the explosive/explosive project.

p. Prior to firing, the RSS will activate the siren and a "FIRE IN THE HOLE" will be announced over the external loud speaker. Then the firing system may be initiated.

q. The project officer will fire the shot per individual test plan.

r. A 5 minute wait time shall be observed after each shot.

s. Handle all misfires in accordance with reference (h). Refer to section 505 for misfire procedures.

t. The RSS (with monitoring by a designated safety observer at a safe distance) will inspect the site for hazardous materials.

u. If the ordnance is in an unsafe condition, do not allow unauthorized personnel in the firing area until it has been deemed safe by the RSS.

v. Any undetonated or partially detonated explosives will be disposed of per section 505 of this SOP.

504. POST EXPLOSIVE OPERATIONS

1. At the end of each day's operations, the RSS shall ensure that all unused explosives are returned to Range Three's magazines. Explosives/munitions that have been subjected to excessive heat, friction and/or shock will be disposed of per section 505 of this SOP.

2. After all explosive materials have been removed from the range and secured, the bravo flags and red light will be secured.

3. Ensure all notifications securing explosive operations are made IAW Para. 501.11.

4. All tools and equipment will be cleaned and/or repaired and restowed in their proper location. If damaged beyond repair, replacements will be ordered in a timely manner and a Financial Liability Investigation of Property Loss (DD Form 200) will be submitted.

5. All debris will be removed from the range after each operation, more frequently if deemed necessary by the RSS, and placed in the appropriate receptacle.

a. Scrap metal bin - located on Range Three.

b. Combustible/explosive contaminated material bin - located on Range Three.

c. The RSS/DBOS will ensure that all empty explosive containers from the day's operations are accounted for. They will be visually inspected to verify they contain no explosive material. The letters MT will be spray painted on the container to signify they have been inspected and staged for pickup by magazine personnel.

d. The range log will be completed and the magazine keys locked in the safe at the end of each operation or work day. Expenditures will be reported in the Hyper Velocity Range Log will be signed by the RSS/DBOS.

505. MISFIRE PROCEDURES

1. PRIMARY for EBW's

WARNINGS

ANY ENTRY INTO THE FIRING AREA AFTER THE MISFIRE MUST BE REGARDED AS EXTREMELY HAZARDOUS, EXTREME CAUTION MUST BE TAKEN

USE TWO PEOPLE: ONE AS A BACK UP AT A SAFE DISTANCE WHEN APPROACHING A MISFIRE.

NOTE

IF THE RSS DEEMS THAT THE MISFIRE POSES AN UNSAFE SITUATION, THE RSS MAY PLACE A COUNTER CHARGE TO REMOVE THE UNSAFE CONDITION.

a. In the event of a misfire, the RSS will shut off the power switch on the control panel.

b. Check the continuity of the detonator. If an obvious fault can be identified, such as a grounded firing lead, and the fault may be corrected. Then another attempt at firing the shot can be made.

c. If no fault can be detected, the RSS will secure the firing system and turn off all power supplies leading to the firing system. The RSS will maintain control of the initiating device.

d. A minimum of thirty (30) minutes must elapse before entering the firing area.

e. The outside leads of the firing wire will be in the shorted, grounded position.

f. Remove the EBW leads from the firing leads and shunt the leads.

g. The RSS will remove the EBW from the explosive assembly.

h. Place the EBW in a closed metal container.

i. Retrieve a new EBW, test and insert it into the assembly following the exact same procedures required for attaching the original detonator.

j. RSS will return to the control room.

k. Fire the shot per individual test plan.

2. **ALTERNATE PLAN for EBW's (When utilizing detonating cord to initiate main charge).**

a. If detonating cord is used to initiate main charge, complete steps 505.1a. through d.

b Disconnect the EBW firing leads from the firing wire and shunt the ends.

c. Retrieve a new EBW, test it for continuity and attach it to the firing wire.

d. All personnel retreat to the control room.

e. Test the circuit for continuity.

f. The RSS will attach the EBW to the detonating cord using the exact same procedures as before.

g. Fire the shot per individual test plan.

3. **MISFIRE PROCEDURES for Blasting Caps.**

a. If a misfire occurs, attempt to identify the fault, such as a grounded firing lead. If identified , the fault can be corrected, and another attempt at firing can be made.

WARNINGS

DO NOT DISTURB A MISFIRED BLASTING CAP.

USE TWO PEOPLE: ONE AS A BACK UP AT A SAFE DISTANCE WHEN APPROACHING A MISFIRE.

b. If no fault can be detected, the RSS will secure the firing system and turn off all power supplies leading to the firing system. The RSS will maintain control of the initiating device.

c. A minimum of thirty (30) minutes must elapse before entering the firing area.

d. Disconnect misfired cap lead wires from the firing wire and shunt.

e. Retrieve a new cap, test for continuity and connect to firing wire.

f. All personnel will retreat to control room and the RSS will check for continuity.

g. Reprime the charge only if it can be done without disturbing the old cap. Otherwise, prime and place a second charge to ensure initiation of both.

h. Return to control room and fire the shot per test plan.

SECTION 6

SUPERVISOR'S AND WORKER'S STATEMENTS

601. SUPERVISOR'S STATEMENT.

THIS STATEMENT SHALL BE SIGNED BY THE IMMEDIATE SUPERVISOR(S) OF THE PROCESS AFTER COMMAND APPROVAL SIGNATURE HAS BEEN OBTAINED, DURING ANNUAL REVIEW, AND WHEN AN APPROVED CHANGE IS MADE TO THE SOP.

I have read this Standard Operating Procedure (*SOP 6012-01-01.0-0003*) and understand it. To the best of my knowledge the processing described within this SOP can be done in a safe, healthful and environmentally sound manner. I have made sure all persons assigned to this process are qualified and have signed the worker's statement for the process. I will conduct an annual review of this SOP during recurring processing. If deviations from this SOP are necessary, I will ensure that this processing is stopped until the SOP is revised and approved. I will make sure this processing is stopped until the hazards have been eliminated.

Supervisor/Team Leader	Signature	Date
Marc K. Bond		15 JAN 99
John M. Crabtree		1/15/99

602. WORKERS STATEMENT

THIS STATEMENT SHALL BE SIGNED BY ALL WORKERS INVOLVED IN THE PROCESS AFTER COMMAND APPROVAL SIGNATURE HAS BEEN OBTAINED, WHEN AN APPROVED CHANGE IS MADE TO THE SOP.

I have read this Standard Operating Procedure (*SOP 6012-01-01.0-0003*) and have reviewed the hazard control briefing. I understand it. I will follow this SOP unless I identify a hazard not addressed in it or encounter an operation I do not understand. If that occurs, I will stop this procedure and notify my immediate supervisor of the problem.

Worker's Name	Signature	Date	Supervisor's Signature	Date

BLDG 2107 FIRE BILL

In the event that a fire exist in bldg 2107 involving explosives, the following steps will be taken:

1. KEEP CALM AND THINK SAFETY!

2. Notify all personnel in the vicinity of the emergency and make certain that all personnel retire to the designated safe area (bldg 2108, Range Control).

3. Immediately report the fire to the Stump neck Fire Department at extension 4333 and give the following information:

- Your name
- Building name and number
- Nature of the fire
- Type of material involved or likely to be involved
- Number of casualties (if any)

4. Call the quarterdeck at Stumpneck by phone at extension 6800/6801 and give the following information:

- Your Name
- Building Name and Number
- Number and names of all casualties (if any)

5. Proceed at least 650 ft from the affected area in the direction in which the fire department is responding, and await the arrival of fire fighting forces. It shall be the responsibility of the person meeting the fire fighting forces to acquaint these personnel with the exact location and the extent of the fire.

6. If possible, fight the fire and remove any hazardous material from the path of the fire.

7. If possible, move injured personnel to a safe location and administer first aid until proper medical help arrives.

8. Point of contact is AOC(EOD) Marc Bond at extension 6868 or after hours, 301 934-6369.

Enclosure (1)

I. Primary Points of Contact:

	Range POC	Environmental POC
Name	AOC Marc K. Bond	Jack Meyers
Title/Code	Range Safety Supervisor	Environmental Manager
Address	NAVEODTECHDIV	NAVEODTECHDIV
	2008 Stump Neck Road	2008 Stump Neck Road
	Indian Head, MD 20640-5070	Indian Head, MD 20640-5070
PhoneNumber	(301) 744-6867/6868	(301) 744-6871/6872
Email Address	Bond@eodmgate.navsea.navy.mil	Meyers@eodmgate.navsea.navy.mil

II. Range Characteristics:

A. Range Name: **Range 3**

B. Range Status:

☑ Active ☐ Inactive

C. Range Classification (check each that applies):

☐ Small Arms Range (.50 cal. & under)
☐ Firing Range (projectile, torpedoes, etc.)
☑ Testing
☑ Training
☑ Open Burning/Open Detonation
☐ Other (Please Describe):

D. Range Type (check each that applies):

☐ Air to Air ☐ Land to Air ☐ Water to Air
☐ Air to Land ☐ Land to Land ☐ Water to Land
☐ Air to Water ☐ Land to Water ☐ Water to Water
☑ OB/OD (RCRA permitted or interim status unit)
☑ OB/OD (Training and/or emergency ops)
☑ Other (Please Explain): R & D testing to develop explosive ordnance disposal render safe procedures for joint service EOD

E. Where is/was the range located? (Include installation, town/city, county, state)

Installation: IHDIVNAVSURFWARCEN, STUMP NECK ANNEX

City or Town: Indian Head County: Charles State: MD

Longitude: 77 14 48W Latitude: 38 32 51N

F. What is the area of the range (in acres for land, square nautical miles for water)?

a. Impact area: Land portion 0 Water portion 0

b. Entire range (includes impact area): Land portion 3 Water portion 0

G. If wetlands are present at the range, what is the area of wetlands in each of the following (in acres)?

Impact area: 0 acres

Entire range (includes impact area 0.5 acres

H. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.)

☐ Less than 3 ☐ Between 3 and 12 ☐ Between 12 and 200 ☐ Over 200

I. If the range or portion of the range is within 3 miles of the shore, do any ordnance items enter the water in that portion of the range?

☐ Yes ☑ No ☐ Unknown ☐ Not Applicable

J. The enclosed geographical map shows the following:

☑ Range location ☑ Range bounderies ☐ Target locations

☐ Range areal extent including:

☐ Counties ☐ Tribal reservations ☐ Independent cities/towns/states

III. Range Ownership:

A. Who is the current owner of the land/range? (Select one. Be as specific as possible.)

☑ Navy ☐ Other Federal Agency ☐ Other

Identify: IHDIVNAVSURFWARCEN

B. If the land is not owned by the Navy, when does the lease or agreement to use the land expire?

C. Is the range or a portion of the range scheduled to be closed in accordance with the Base Realignment and Closure Act (BRAC)?

☐ Yes ☑ No

D. Who is the cognizant authority/range manager?

Name	AOC Marc K. Bond
Command	NAVEODTECHDIV
Title/Position	Range Safety Supervisor
Address	2008 Stump Neck Road
	Indian Head, MD 20640-5070
Phone #	(301) 744-6867/6868
Email	Bond@eodmgate.navsea.navy.mil

E. Who are the primary users of the range? List training groups, squadrons, other services, foreign countries, etc.

No.	User Name
1	NAVEODTECHDIV
2	NAVSCOLEOD

IV. Range Access:

A. How is access currently controlled? (Select all that apply.)

☐ No controls
☑ Signs
☐ Log-in book
☐ Office check in
☐ Guard at gate
☐ Fences
☐ Access key maintained by security/range officer
☑ Barricaded during operations
☑ Siren/notification during operations
☑ Patrolled by security officer or other official
☐ Patrolled by vessel
☐ Patrolled by aircraft
☐ Other

B. Have there been any documented instances of unauthorized access to the range by the public?

☑ None ☐ 1-2 instances per year ☐ Unknown
☐ 3-5 instances per year ☐ More than 5 instances

Please provide specific information for ranges with more than 3 instances per year.

V. Range Use:

A. When was the range last used? Mar 2000

B. When was the range established? Jun 1956

C. Is the range scheduled for closure ☐ Yes ☑ No

If Yes, what is the scheduled closure date?

D. Does a range manual/instruction (or operating guide) exist? ☑ Yes ☐ No

If Yes, please list title/date and provide documen Range 3 SOP; Oct 1996

E. How often is the range used? (Select one)

☑ Daily ☐ Weekly ☐ Monthly ☐ Unknown

☐ Other

F. Do records exist that can be considered accurate and complete?

☑ Yes ☐ No ☐ Unknown

If Yes, please describe the records including the years for which they exist.

Range 3 keeps a log of every detonation and OB/OD event to include type of ordnance, amount of high explosive and time.

G. If records of the range's use are kept, who maintains them?

Name	AOC Marc K. Bond
Command	NAVEODTECHDIV
Title/Position	Branch Head/Range Safety Supervisor
Address	2008 Stump Neck Road
	Indian Head, MD 20640-5070
Phone #	(301) 744-6867/6868
Email	Bond@eodmgate.navsea.navy.mil

H. What type of range records are maintained? (Check all that apply)

☑ Munitions expenditures including:

☑ Types ☑ Quantities ☐ Locations ☐ Estimated dud rates

☐ Munitions mishaps attributed to UXO that occurred either on or off-range

☐ UXO clearance operations conducted on range

☐ All areas containing known or suspected UXO on range maps or installation master planning map

☐ Information on any rounds landing off-range that were unrecoverable or not loc

☑ List of personnel, squadrons, other services, foreign countries, etc. that use/used the range

☑ Other (please explain) Date and time of detonation or OB/OD event.

I. What type of ordnance is/was used at the range? (Select all that apply)

☑ Small Arms Ammunition (.50 cal or under
☑ Hand Grenades
☑ Rifle Grenades
☑ Projected Grenades
☑ Mortars
☑ Bombs
☑ Rockets
☐ Large rocket motors (> 1,000 lbs)
☑ Warheads
☑ Projectiles
☐ Guided Missiles
☐ Ballistic Missiles
☑ Submunitions
☐ Torpedoes
☑ Mines
☐ Depth Charges
☐ Riot control agents
☑ Bulk propellant, propellant charges
☑ Bulk high explosives, demolition charges
☑ Pyrotechnics (flares, signals, simulators)
☑ Primers, detonators, fuzes, squibs
☐ CADs/PADs
☐ Other

J. If possible, please provide the NSNs, DODICs (i.e. NALCs), and standard nomenclature of these items as well as the number used at the range per year:

No.	Dodic/NALC	NSN	Nomenclature	Number Used CY97	CY98	CY99
1	M130	1375002839442	Blasting Cap - Electric	792	773	678
2	M131	1375002839440	Blasting Cap - Non-Electric	85	23	18
3	M023	1375007247040	C-4	407	225	331
4	M041	1375000385328	TNT, Block	101	37	17
5	M670	1375002621674	Time Fuze (Quantity in feet)	580	370	100
6	M456	1375003102677	Detonating Cord (Quantity in feet)	1960	755	2350

K. On average, how much ordnance was used at the range annually? Please provide this information in total

Total Weight (lbs): 6018 NEW

L. What types of targets were/are used at the range? ☐ Stationary ☐ Mobile ☑ None ☐ Unknown

If targets are/were used, please provide details including types and locations:

M. What range use reports are/were forwarded to a higher command?

If yes, please provide details including requirement referenc

Annual - Navy - P2ADS - OPNAVINST 5090.1B; Biennial - EPA-40 CFR; Biennial - MDE (Maryland Department of Environment) - COMAR Title 26.

VI. Range Clearance:

A. Does the range have an established maintenance schedule?

☑ Yes ☐ No ☐ Unknown

If Yes, please provide details:

On a as needed basis: debris and scrap metal pickup and removal; backfilling of holes; perimeter vegetation removal; and dragging the dirt surface.

B. Does/did the range have an established UXO, range debris, or target clearance schedule?

☐ Yes ☑ No ☐ Unknown

If Yes, please provide details (including technologies used for detection, retrieval and destruction):

C. Are/were range debris moved from the range?

☑ Yes ☐ No ☐ Unknown

D. If yes, how is/was the range debris decontaminated?

☑ 100% visual inspectio ☐ Thermally processed - enclosed unit

☐ Thermally processed - pan ☐ Thermally processed - no containment

☐ Thermally processed - hot gas ☐ Washout ☐ Other

Please provide details:

Range debris is visually inspected and certified by the Range 3 EOD technicians. Prior to tranporting the debris to IHDIVNAVSURFWARCEN Property Disposal Office for disposition, the Explosive Safety Officer either green tags or red tags the debris. If a red tag is issued the debris is flashed by IHDIVNAVSURFWARCEN.

E. Where does decontamination take place?

☐ On the range ☑ Off the range ☐ Both ☐ Unknown ☐ Not Applicable

F. In the past three years, has the activity recycled metal range debris through a local DRMO?

☑ Yes ☐ No ☐ Unknown ☐ Not Applicable

If Yes, please provide specific details (including the DRMO used and volume per year):

All range debris is delivered to IHDINAVSURFWARCEN Property Disposal Office (PDO), which is not a DRMO. IHDIVNAVSURWARCEN in turn uses the services of Fort Meade, MD., which is a DRMO. Volume - approximately 240 cu ft.

G. In the past three years, has the activity recycled metal range debris through a QRP?

☐ Yes ☑ No ☐ Unknown ☐ Not Applicable

If Yes, please provide specific details (including the types of items recycled, any processing of these items, and volume per year):

H. In the past three years, has the activity recycled metal range debris through direct sales?

☐ Yes ☑ No ☐ Unknown ☐ Not Applicable

If Yes, please provide specific details (including the types of items recycled, any processing of these items, and volume per year):

I. What is the position/title of the certifying individual? Branch Head/Range Safety Supervisor

VII. Environmental Investigations/Cleanups/Responses:

A. Is the range, including the impact area, undergoing or has already undergone any type of investigation, cleanup, or response action of unexploded ordnance (UXO) or other contamination?

☑ Yes ☐ No

Yes (Please elaborate):

Based on a 1990 EPA RFA, RCRA Corrective Action Permit (CAP) MD 4170090001 was issued by Region III EPA Jan 1991. Range 3 was designated Solid Waste Management Unit (SWMU) 2. Dump Site A located under Range 3 was designated SWMU 3.

If yes, please attach information including reason for the cleanup, regulatory authority (e.g. CERCLA, RCLA) the cleanup is/was conducted under, and anticipated/actual completion date. Include a copy of the work plan or reports if available.

B. If a response action is being taken or was taken, was it conducted under CERCLA or RCRA authorities?

☒ CERCLA ☒ RCRA ☒ Both ☒ Unknown

Please elaborate:

C. Has any investigation, sampling, or analysis of the range been conducted (i.e. soil, groundwater and surface water monitoring, air emissions assessment, impacts to endangered species and sensitive ecosystems,etc.)?

☑ Yes ☐ No

If Yes, please explain. Include media evaluated, tests conducted, results and subsequent actions taken.

Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Number N62472-90-D-1298, Contract Task Order 0287. Multi-media sampling and number of samples consisted of: Surface Soil 14; Subsurface Soil 22; Groundwater 4; Surface Water 2; Sediment 4. The majority of SWMU 2 and 3 is sparsely vegetated and currently provides limited terrestrial habitat. Results, conclusions and recommendations attached. Explosive detonation sound survey conducted at Range 3 by NNMC, Bethsda Industrial Hygentist, Sept 96, for effects on nesting eagles. NEPA exclusion issued for Range 2.

D. Is the range currently being monitored or sampled on a periodic basis for environmental reasons?

☐ Yes ☑ No

If Yes, please provide specific details.

E. Are any investigations, samplings, or analyses planned for the range in the future?

☑ Yes ☐ No

If Yes, please explain. Include estimated time frame, media to be evaluated, tests to be conducted, and potential actions to be taken.

EPA Region III recommended further studies. As yet, what direction those additional studies will take has not been determined.

VIII. Costs:

A. How much does it cost to maintain the range on an annual basis? (Please include the source of this funding): Total $ 133468

Security	$	12200	Maintenance	$	39141
Safety	$	15600	Permit conditions	$	0
Labor	$	66527	Other	$	0

Comments: Source of funds: Overhead and G & A.

B. If the range, including the impact area, is undergoing or has already undergone any type of investigation, cleanup, or response action for unexploded ordnance (UXO) or other contamination, please provide the following cost data as of the end of FY99.

☑ Investigation

			Type of Funds			
☑ Complete	Cost $	132000	☑ ERN	☐ BRAC	☐ O&MN	☐ Other
☐ On-going	Cost $		☐ ERN	☐ BRAC	☐ O&MN	☐ Other
☐ Planned	Cost $		☐ ERN	☐ BRAC	☐ O&MN	☐ Other

Comments:

CLEAN Contract Number N62472-90-D-1298

☐ Response Action Type:

☐ Complete	Cost $	☐ ERN	☐ BRAC	☐ O&MN	☐ Other
☐ On-going	Cost $	☐ ERN	☐ BRAC	☐ O&MN	☐ Other
☐ Planned	Cost $	☐ ERN	☐ BRAC	☐ O&MN	☐ Other

Comments:

C. If any environmental investigations, samplings, or analyses of the range have been conducted or are planned, please provide the following cost data as of the end of FY99.

☑ Environmental investigations, samplings, or analyse

☐ Complete	Cost $		☐ ERN	☐ BRAC	☐ O&MN	☐ Other
☐ On-going	Cost $		☐ ERN	☐ BRAC	☐ O&MN	☐ Other
☑ Planned	Cost $	395390	☑ ERN	☐ BRAC	☐ O&MN	☐ Other

Comments:

D. Please provide any other cost data that may be considered appropriate.

IX. Environmental Considerations:

A. Has the activity received any verbal and/or written notices from regulators regarding surface or ground water contamination associated with range use?

☑ None ☐ 1 ☐ 2-3 ☐ More than 3 ☐ Unknown

Please provide specific information for ranges with any notices.

B. Has the activity received any verbal and/or written notices from the public regarding surface or ground water contamination associated with range use?

☑ None ☐ 1 ☐ 2-3 ☐ More than 3 ☐ Unknown

Please provide specific information for ranges with any notices.

C. Do the activity's natural resource plans include resources located on the range?

☐ Yes ☑ No ☐ Unknown

D. Is there any information indicating the presence of any potential or known threatened/endangered species - flora and fauna - on the range?

☑ Yes ☐ No ☐ Unknown

If Yes, identify species: BALD EAGLES; RED-BERRIED GREEN BRIAR, LISTED BY THE STATE OF MARYLAND

E. Has the activity received any verbal and/or written notices from regulators regarding the adverse impacts on sensitive ecosystems or natural resources associated with range use?

☑ None ☐ 1 ☐ 2-3 ☐ More than 3 ☐ Unknown

Please provide specific information for ranges with any notices.

F. Has the activity received any verbal and/or written notices from the public regarding the adverse impacts

☑ None ☐ 1 ☐ 2-3 ☐ More than 3 ☐ Unknown

Please provide specific information for ranges with any notices.

G. Has the activity received any verbal and/or written notices from regulators regarding the permitting of range operations under any environmental media?

☑ None ☐ 1 ☐ 2-3 ☐ More than 3 ☐ Unknown

Please provide specific information regarding any such notice and the media in questio

H. Have any NEPA documents that address range operations been prepared?

☐ Yes ☑ No ☐ Unknown

If Yes, please list the titles of these documents.

X. Outside Interest:

A. Describe the degree of public interest in this range:

☐ None ☑ Slightly interested ☐ Very interested ☐ Extremely interested

This interest is generally: ☐ Favorable ☐ Neutral ☑ Negative

Comments

The Command has received several noise complaints as a result of explosive detonation noise. Range 3 initiated a Best Management Practice Plan for noise and incorporated the Sound Intensity Prediction System (SIPS) from NSWC Dahlgren Division.

B. Describe the degree of interest of any Federal land managers in the range:

☑ None ☐ Slightly interested ☐ Very interested ☐ Extremely interested

This interest is generally: ☐ Favorable ☐ Neutral ☐ Negative

Comments

C. Describe the degree of interest of any Federal and State regulators, including Indian tribes with regulatory authorities, in the range:

☒ None ☐ Slightly interested ☐ Very interested ☐ Extremely interested

This interest is generally: ☐ Favorable ☐ Neutral ☐ Negative

Comments

D. Are there any environmental justice issues associated with the range?

☐ Yes ☑ No

If Yes, please provide details:

GEOLOGIC FRAMEWORK, HYDROGEOLOGY, AND GROUND-WATER QUALITY OF THE POTOMAC GROUP AQUIFER SYSTEM, NORTHWESTERN CHARLES COUNTY, MARYLAND

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 91-4059

Prepared in cooperation with the

TOWN OF INDIAN HEAD, MARYLAND and the
UNITED STATES NAVY, NAVAL ORDNANCE STATION

CONTENTS

Abstract 1

Introduction 2
- Purpose and scope. 3
- Previous investigations. 3
- Data-collection network. 6
- Well-identification system. 7
- Acknowledgments. 7

Geologic framework 7
- Stratigraphy 7
  - Pre-Cretaceous basement complex 9
  - Cretaceous Potomac Group Deposits 11
    - Patuxent and Arundel Formations 12
    - Patapsco Formation 14
  - Tertiary and Quaternary deposits 15
- Erosional history of Potomac Group Deposits 16

Hydrogeology 21
- Aquifers 21
- Effects of pumping 22
  - History of pumping 22
  - Ground-water levels and flow 23

Ground-water quality 31
- Prepumping water quality 31
- Changes in water quality since development 32
- Effects of erosion of confining units 43

Summary and conclusions 47

References cited 49

Data tables, compiled by Daniel D. Edwards 53

PLATES (in pocket)

1. Map showing locations of selected wells in the:
   Indian Head quadrangle, Maryland
   Port Tobacco quadrangle, Maryland
   Mount Vernon quadrangle, Maryland

2. Map showing locations of hydrogeologic sections, wells, and auger holes used for geologic control

3-4. Hydrogeologic sections:
   3. C-C'
   4. D-D'

FIGURES

1-4. Map showing:
1. Location of the study area. 4
2. Location of 5-minute county quadrangles. 5
3. Location of water-quality-sampling and water-level-measurement sites 6
4. Potomac Group outcrop belt and physiographic provinces in the Middle Atlantic States. 8

5. Diagram showing generalized stratigraphic and hydrogeologic framework in the Indian Head area. 9
6. Map showing the approximate altitude and configuration of the top of the pre-Cretaceous basement complex. 11
7. Map showing surficial geology in the Indian Head area. 13
8. Map showing top of the Arundel-Patuxent Formations (undivided). 14
9. Graph showing borehole-geophysical logs of well CH Bb 22. 16
10. Map showing the approximate altitude and configuration of the top of the Patapsco Formation in the study area. 17
11. Generalized geologic map and section of Hybla Valley, Va. 19

12-13. Maps showing:
12. Approximate margins of Potomac River paleochannel deposits in the Indian Head area. 20
13. Location of production wells in the Indian Head area and average daily pumpage during 1988. 24

14-15. Graphs showing:
14. Ground-water pumpage from the Potomac Group aquifer system at Naval Ordnance Station, 1900-88, and pumpage in the Indian Head area, 1980-88. 25
15. Ground-water use in Charles County, Md., and percentage of each type of use, 1950, 1960, 1970, and 1980. 25

16. Map showing regional pumping centers and ground-water withdrawals in Charles County, Md., 1950, 1960, 1970, and 1980. 26

17-18. Hydrographs showing water-level altitudes in observation wells in the Indian Head area:
17. Measured periodically, 1952-89. 27
18. Continuously recorded, 1988-89. 28

19-20. Maps showing the altitude of the potentiometric surface of the Potomac Group aquifer system in the Indian Head area:
19. 1961-62. 29
20. 1989 30

21. Graph showing daily mean streamflow of the Potomac River at Washington D.C., and daily mean specific conductance of the Potomac River at Indian Head, Md., 1978-81. 34

FIGURES--Continued

22-23. Maps showing:
22. Maximum concentrations of dissolved chloride in water from wells sampled during 1970-75. 35
23. Mean concentrations of dissolved chloride in water from wells sampled during 1988. 36

24-25. Graphs showing:
24. Statistical distributions of concentrations of selected chemical constituents and physical properties of water from 26 wells in the Indian Head area, 1988. 38
25. Chloride concentrations in water from selected wells in the Indian Head area, 1938-88. 40

26. Map showing mean concentration of total dissolved solids in water from wells sampled during 1988. 42
27. Graph showing statistical distribution of concentrations of total organic carbon in water from wells in the Indian Head area during 1988 and in water from the Potomac River at Indian Head during 1975-88. 43
28. Map showing mean concentration of total organic carbon in water from wells sampled during 1988. 44
29. Graph showing tritium concentration in water from the Potomac River at Point of Rocks, Md., 1961-84. 45

TABLES

1. Stratigraphic relations and hydrologic character of geologic deposits in the Indian Head area of Charles County, Maryland 10
2. Typical concentration range of selected chemical constituents in the ground-water system and the Potomac River. 33
3. Summary of information for selected wells in the Indian Head area, of northwestern Charles County, Maryland 54
4. Summary of information for selected wells and auger holes in Prince William and Fairfax Counties, Virginia 86
5. Lithologic description of continuous core from well CH Bb 22. 88
6. Periodic water-level measurements at observation wells in the Indian Head area, 1981-89. 89
7. Summary of daily mean water-level depths at observation wells equipped with digital recorders. 91
8. Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87. 94
9. Summary of selected chemical-quality analyses of water samples collected from the Potomac River near Indian Head area, northwestern Charles County, Maryland, 1988 103
10. Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1988 104

CONVERSION FACTORS, ABBREVIATIONS, AND VERTICAL DATUM

Multiply	By	To obtain
inch (in.)	25.4	milliimeter
inch per year (in/yr)	25.4	millimeter per year
foot (ft)	0.3048	meter (m)
foot per second (ft/s)	0.3048	meter per second
foot per mile (ft/mi)	0.1894	meter per kilometer
mile (mi)	1.609	kilometer
gallon per minute (gal/min)	0.06308	liter per second
gallon per minute per foot [(gal/min)/ft])	0.2070	liter per second per minute
gallon per day per foot [(gal/d)/ft]	12.42	liter per day per meter
million gallons per day (Mgal/d)	0.04381	cubic meters per second
million gallons per year (Mgal/yr)	0.00379	cubic hectometer per year

Some data on sediment cores in meters (m) can be converted to feet by multiplying by 3.281.

Water temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) by using the following equation:

$$°F = 1.8\ (°C) + 32$$

Sea level: In this report, "*sea level*" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated water-quality units used in report: Chemical concentration and specific conductance are given in metric units. Chemical concentration is expressed in milligrams per liter (mg/L), or micrograms per liter (µg/L). Specific conductance is expressed in microsiemens per centimeter at 25 degrees Celsius (µS/cm).

GEOLOGIC FRAMEWORK, HYDROGEOLOGY, AND GROUND-WATER QUALITY OF THE POTOMAC GROUP AQUIFER SYSTEM, NORTHWESTERN CHARLES COUNTY, MARYLAND

By Steven N. Hiortdahl

ABSTRACT

This report presents the results of a study conducted from 1988 to 1990 by the U.S. Geological Survey, in cooperation with the Town of Indian Head and the U.S. Navy, Naval Ordnance Station (NOS), to assess the hydrologic and hydrochemical conditions in the Potomac Group aquifer system in northwestern Charles County, Maryland.

Large-scale ground-water withdrawals began in the Indian Head area around 1900. Withdrawals are from multiscreen production wells tapping unconsolidated, fluvial, sand deposits of the Patapsco and Patuxent Formations, which collectively comprise the Lower Cretaceous Potomac Group aquifer system. Continual pumping during this century in the Indian Head area, combined with recent pumping in the area to the northeast, has resulted in a regional decline in the potentiometric surface of the confined Potomac Group aquifer system. In the vicinity of Indian Head, the pumping has changed the hydraulic gradient and reversed the direction of ground-water flow in the subcrop area of the confined aquifers under the adjacent Potomac River.

Total pumpage in the Indian Head area during the 1980's ranged from about 1.5 to 2.0 million gallons per day. During 1988-90, static water-level altitudes in observation wells ranged from about 55 to 100 feet below sea level. The prepumping heads in wells screened in the confined aquifers at Indian Head were above sea level; thus, it is likely that ground water in the aquifer subcrop area previously discharged to the Potomac River. River water in this area can range from fresh to brackish. Dissolved-solids concentration varies considerably in response to substantial changes in upstream flow conditions. In 1980, the average chloride concentration in interstitial water from twelve 1-meter-long cores of river-bottom sediment collected near Indian Head was about 500 milligrams per liter.

A downward head gradient has probably existed since about the 1920's and has resulted in river-water intrusion, or recharge to the subcrop area of the confined aquifers. The magnitude and extent of river-water intrusion into the aquifer system is controlled, in part, by the hydraulic gradient, the depth and location of the present day Potomac River channel, and relative differences in the permeability of river-bottom sediments. Significant changes in the permeability of the river bottom could result from scour associated with floods or from the

dredging of shipping channels in shoal areas. The hydraulic connection between the modern Potomac River and Potomac River paleochannel deposits, which are relatively permeable sediments deposited in valleys formed during periods of lowered sea level, tends locally to intensify river-water recharge. The magnitude and extent of river-water intrusion in the Indian Head area is greatest where the paleochannel deposits intersect the Potomac River shoreline.

Because of pumping-induced water-level declines and the proximity of the area to the tidal Potomac River, previous investigators acknowledged that intrusion of brackish river water could impair the chemical quality of the adjacent ground water. Comparison of historical ground-water-quality data with data collected in 1988 indicates that the chemical character of ground water in a zone adjacent to the Potomac River shoreline has gradually changed from a native sodium bicarbonate type with dissolved-solids concentration less than 250 milligrams per liter to a sodium chloride type with dissolved-solids concentrations greater than 500 milligrams per liter. In the zone of the aquifer most affected by river-water intrusion, concentrations of river-water indicator constituents such as chloride, dissolved solids, sodium, and total organic carbon are elevated above background concentrations. The maximum chloride concentration observed in ground water in 1988 was 210 milligrams per liter. Chloride and dissolved-solids concentrations have increased gradually in a zone of the aquifer adjacent to the river, and it has taken about 40-50 years for the comparatively higher chloride river water to reach its present extent and spatial distribution.

INTRODUCTION

Because of pumping-induced water-level declines, and proximity to the tidal Potomac River, river-water intrusion into confined-aquifer sediments hydraulically connected to the Potomac River has long been recognized as a possible threat to the ground-water quality of the Indian Head area, northwestern Charles County, Md. (Fiedler and Jacob, 1939; and Slaughter and Otton, 1968, p. 20). Fluvial sand deposits of the Lower Cretaceous Patuxent and Patapsco Formations (Potomac Group) have been tapped by all production wells in the Indian Head area.

In the early 1980's, increasing dissolved-solids and chloride concentrations were noted in water from several of the production wells in the Indian Head area (Maryland Water Resources Administration, 1984). In 1987, the U.S. Geological Survey (USGS), in cooperation with the Town of Indian Head and the U.S. Navy, Naval Ordnance Station (NOS), began an investigation to define the hydrogeology and assess changes in the chemical quality of ground water in the Potomac Group aquifer system in northwestern Charles County.

The study area covers about 165 mi^2 in Southern Maryland and Northern Virginia and is approximately centered on the Indian Head peninsula, which is about 20 mi south of Washington, D.C. (fig. 1) and is bounded by the eastern shore of the Potomac River and the western shore of Mattawoman Creek (fig. 2). Both the town of Indian Head and NOS are on the peninsula (fig. 2). The community of Potomac Heights is about 2.0 mi east of NOS. The NOS was originally known as the Naval Powder Factory, was later known as the Naval Propellant Plant, and is presently (1990) referred to as "NOS." Southern Maryland is in the Atlantic Coastal Plain Physiographic Province. The climate is humid, and temperate and mean annual precipitation at the La Plata climatological station (fig. 1) for 1951-80 was 42.6 in/yr (National Oceanic and Atmospheric Administration, 1988).

The Indian Head area has been the location of large ground-water withdrawals from the confined aquifers of the Potomac Group since about 1900

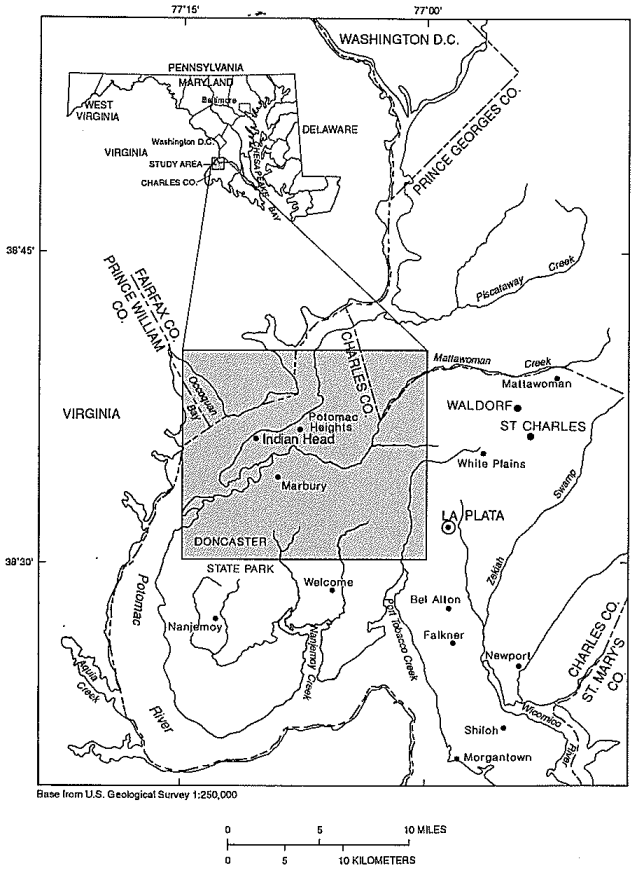


Figure 1. Location of the study area.

(Fiedler and Jacob, 1939, p. 12). Ground-water pumpage at NOS generally ranged from about 0.5 to 1.0 Mgal/d in the decades prior to World War II (1920-40). Although the magnitude of pumpage by NOS during World War II is uncertain, it could have ranged from 2.0 to as much as 3.0 Mgal/d. Pumpage at NOS averaged about 2.0 Mgal/d during the Vietnam War (1965-75).

During the 1980's, pumpage in the Indian Head area (NOS and neighboring towns) ranged from about 1.5 to 1.9 Mgal/d. Pumpage during the 1980's along the Route 210 corridor, immediately northeast of the Indian Head area (fig. 2), probably ranged from about 0.3 to 0.5 Mgal/d (Wheeler and Wilde, 1989, p. 59). The continual large scale withdrawals in the Indian Head area, combined with smaller withdrawals since about 1960, along the Route 210 corridor, has substantially reduced the head in the confined aquifers. In 1933, the static water level in observation wells at NOS ranged from 35 to about 100 ft below sea level (Fiedler and others, 1937). In 1988-90, static water levels in observation wells in the same area ranged from 55 to about 100 ft below sea level.

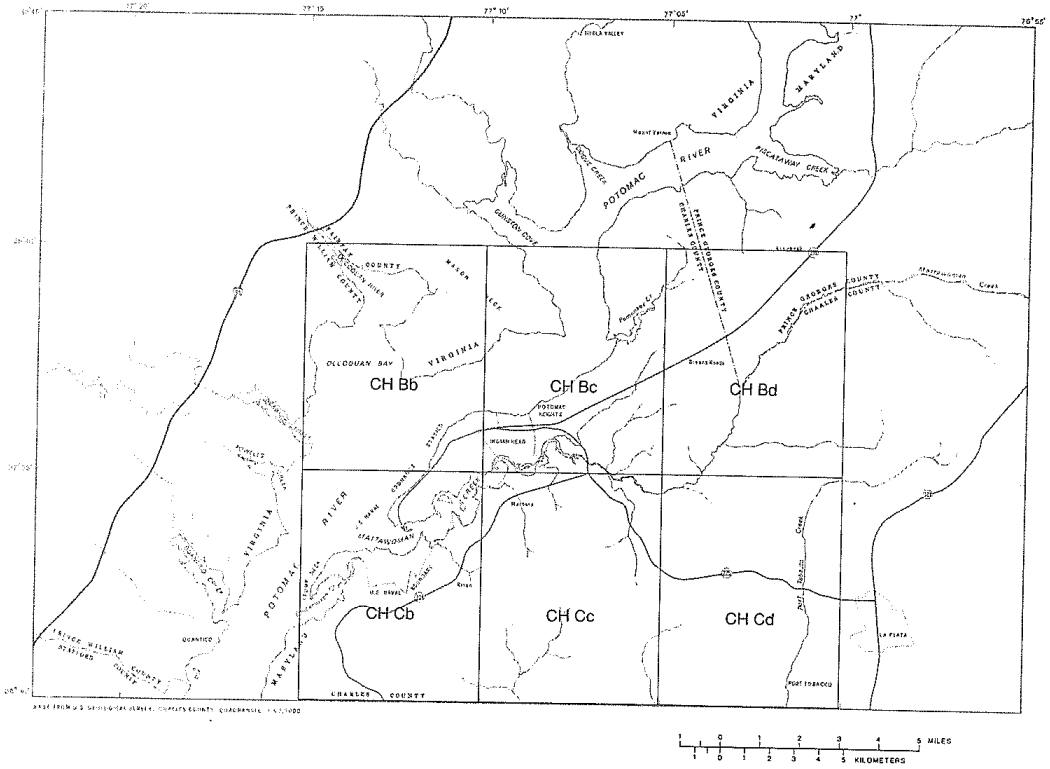


Figure 2. Location of 5-minute county quadrangles.

Purpose and Scope

This report describes the geologic framework, hydrogeology, and ground-water quality of the Potomac Group aquifer system in the Indian Head area of northwestern Charles County, Md. In addition, this report presents historical and recent hydrogeologic data, and describes changes in the water quality of the Potomac Group aquifer system at Indian Head. For the purposes of this report, the Potomac Group aquifer system in the Indian Head area is defined as a multiaquifer unit, which consists of separate confined aquifers in the Lower Cretaceous Patapsco and Patuxent Formations.

Water levels were measured in 13 observation wells during 1988-90 to assess changes in the potentiometric surface in the area. One hundred and three water samples were collected from 26 production and observation wells in the Indian Head area and analyzed to characterize inorganic ground-water quality during 1988-89. A reconnaissance marine-seismic-reflection survey was conducted in 1988 on the Potomac River and Mattawoman Creek to help evaluate the geometry

of the deposits beneath these estuaries. Preliminary data from a 700-ft-long continuous core that was drilled at NOS in 1989-90 are presented.

Information on regional geology and stratigraphy, well depths and locations, and ground-water pumpage, levels, and quality was gathered from a variety of published and unpublished sources. Sources of unpublished data included well-drillers' logs and records, and files of the USGS, Maryland Geological Survey, Maryland Water Resources Administration, NOS, and the Town of Indian Head. These data were compiled and evaluated to construct regional hydrogeologic sections, potentiometric-surface maps, preliminary structure-contour maps of the Potomac Group deposits, water-level hydrographs, and plots of ground-water pumpage and water quality in the Potomac Group aquifer system.

Previous Investigations

One of the first descriptions of the ground-water resources of the unconsolidated sediments in the Maryland part of the Atlantic Coastal Plain was by Darton (1896), who used the previously proposed term "Potomac Formation" to refer to the nonmarine, basal Cretaceous deposits cropping out near the inner edge of the Atlantic Coastal Plain sequence. Clark and Bibbins (1897) renamed these deposits the Potomac Group in Maryland, which they subdivided into the Patuxent, Arundel, Patapsco, and Raritan Formations. On the basis of an analysis of pollen assemblages, the Raritan Formation was determined to be Upper Cretaceous and is no longer considered to be part of the Lower Cretaceous Potomac Group in Maryland (Brenner, 1963, p. 3).

The USGS conducted a series of hydrogeologic investigations in the Indian Head area during the 1930's. The data and interpretations were published in two USGS Open-File Reports: Fiedler, Cady, and Meinzer (1937) and Fiedler and Jacob (1939). These investigations included inventories of wells and pumpage during the early 1900's, and measurements of water-level fluctuations and well interference, water quality, and aquifer characteristics based on tests from wells at NOS.

Slaughter and Laughlin (1966) published records of wells and springs, chemical analyses, and selected well logs in Charles County. Slaughter and Otton (1968) documented ground-water conditions in Charles County and described the hydrogeology of the Indian Head area in detail. Hansen (1968) used borehole-geophysical and lithologic data to construct a series of geologic sections that provide regional correlation of the Cretaceous and Tertiary Coastal Plain deposits in southern Maryland. Glaser (1969) provided a detailed description of the sedimentary history and lithology of the Cretaceous deposits of the Maryland Coastal Plain.

Contractors for the U.S. Navy conducted two hydrologic investigations at NOS. These include a test-drilling program conducted during 1970-71 (data on file at NOS) and an inventory of potable-water supplies in the early 1980's (Shoemake and others, 1982).

From 1977 to 1981, the USGS conducted an interdisciplinary investigation of the Potomac River estuary (Callender and others, 1984), which involved studies of the processes and dynamics controlling water quality and flow in the river. Samples of the water column, river-bed sediment, flora, and fauna were collected to characterize the water quality, flow, and aquatic biology. Shallow cores and marine-surface-geophysical data also were collected for palynological and chronostratigraphic studies to interpret the hydrogeologic framework and sedimentation patterns of the Potomac River estuary. A flow through water-quality monitor was operated on the Potomac River, at the NOS, by the USGS from October 1977 to September 1981. Data collection at this site included hourly measurements of pH, water temperature, dissolved-oxygen concentration, and specific conductance. A tide gage was maintained by the USGS at this site from 1977 to 1990.

A report by the Maryland Water Resources Administration (1984) presents a comprehensive water-resources development and management plan for Charles County. This report includes a chapter titled "Saline Water Intrusion at the Town of Indian Head." The report describes the available

data and implications of brackish-water intrusion from the tidal Potomac River into the aquifers of the Potomac Group. Water-level, water-quality, and ground-water-pumpage data were analyzed. The water-quality data showed a trend toward increased concentrations of total dissolved solids and chloride in the water from several supply wells in the area.

A 4-year study of the ground-water resources in the Waldorf area of north-central Charles County was completed in 1989 (Fleck and Wilson, 1990). Water-level, lithostratigraphic, and aquifer-hydraulic data were used to establish the hydrogeologic framework and to construct and calibrate a ground-water-flow model. This model was used to simulate the changes in water levels resulting from potential changes in pumpage in the Waldorf area (fig. 1).

Data-Collection Network

Field data collected during 1988-90 for this project included continuous (hourly) and periodic water-level measurements in the wells shown in figure 3. Four or five water-quality samples were collected from each of the production wells. These ground-water samples were analyzed to determine concentrations of major inorganic constituents, selected inorganic trace elements, total organic carbon, and tritium. Two water samples also were

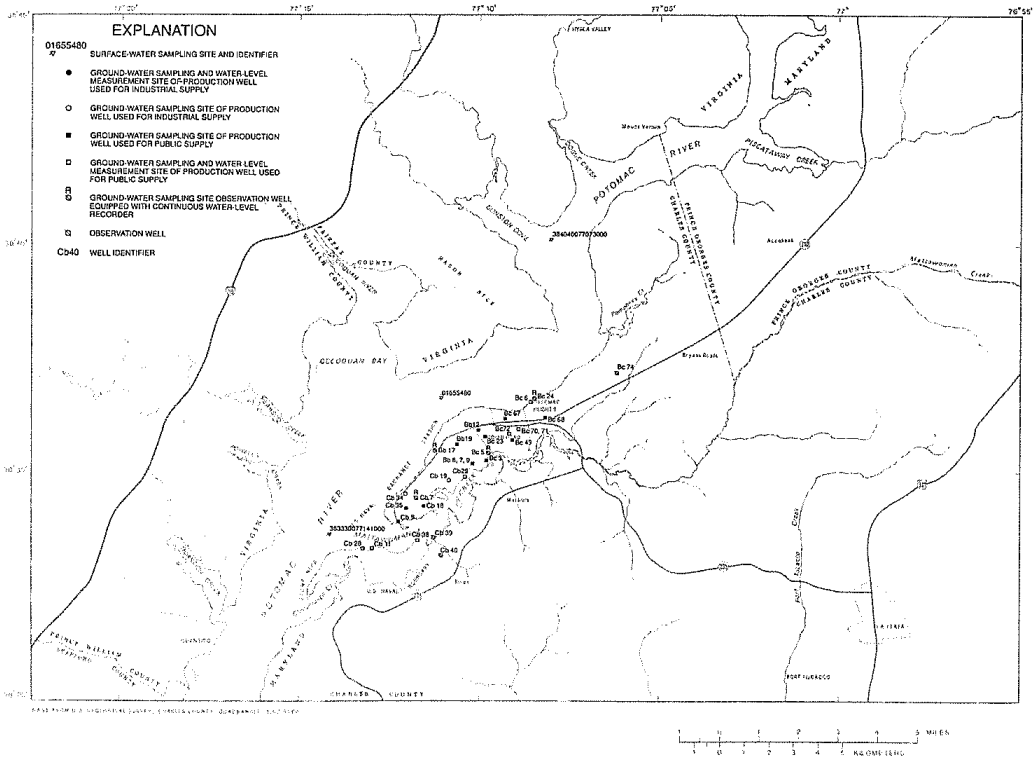


Figure 3. Location of water-quality-sampling and water-level-measurement sites.

collected at each of three locations in the Potomac River estuary (fig. 3) to characterize the quality of the river water adjacent to Indian Head.

Well-Identification System

Since about 1950, water wells in Maryland have been assigned a State permit number when a drilling permit is issued. In this report, wells and borings in Maryland are identified and located using an identification system adopted from the Maryland Geological Survey. The locations of wells in Maryland that were inventoried for this study are shown on plate 1. All wells in a quadrangle have not been inventoried and new wells are not included in the identification system until they are inventoried. In this report, the wells and test borings in Virginia have been assigned arbitrary identifiers on maps and tables.

This system used in Maryland consists of two pairs of letters followed by a number (for example, CH Bc 72). The first pair of letters is the county prefix (CH for Charles County), which, for expediency, is omitted in most tables in this report. The second two letters designate one of the 5-minute quadrangles of latitude and longitude into which the county has been subdivided (fig. 2). Each quadrangle within a county is designated from north to south by the first letter and from west to east by the second letter. The wells that have been inventoried in each quadrangle are sequentially numbered as they are inventoried; thus, CH Bc 72 is the 72d well inventoried in the Bc 5-minute quadrangle in Charles County.

Acknowledgments

The author wishes to thank the Public Works and Utilities Division personnel of the Town of Indian Head and the Naval Ordnance Station for providing access to the historical information in their files and for assisting in the collection of water-quality samples from their production wells. Gratitude is also expressed to the many well drillers who provided well-construction and borehole-geophysical data from their files. The author thanks John M. Wilson of the Maryland Geological Survey, for contributing suggestions in a review of an earlier draft of this manuscript.

GEOLOGIC FRAMEWORK

The Indian Head peninsula lies about 8 to 10 mi downdip of the Fall Line (fig. 4), which approximately marks the western extent of the Atlantic Coastal Plain deposits. West of the Fall Line, the crystalline rocks of the Piedmont are exposed. The Atlantic Coastal Plain deposits form a wedge of continental and marine sediments that thickens from a few feet at the Fall Line to more than 7,000 ft at the Maryland coastline of the Atlantic Ocean (Hansen and Edwards, 1986, p. 11).

Stratigraphy

The generalized stratigraphic and hydrogeologic framework of the Indian Head area is shown in figure 5. The total thickness of the Coastal Plain deposits at Indian Head ranges from about 650 to 750 ft. These deposits rest unconformably on an eroded, subsiding crystalline basement-rock surface (Obermeier, 1984). Table 1 shows the stratigraphic relations and generalized hydrologic character of the geologic deposits in the Indian Head area. Most of the Coastal Plain deposits in this area consist primarily of interbedded layers of unconsolidated clastic sediments (Potomac Group), which were deposited during the Early Cretaceous Epoch. The depositional environment in the Maryland Coastal Plain during Early Cretaceous time was primarily fluvial, in riverine or deltaic settings (Glaser, 1969, p. 71). In the Indian Head area, the Potomac Group consists of alternating and interbedded layers of clay, silt, sand, and gravel, which thicken and dip gently to the southeast.

The Tertiary deposits in the Indian Head area consist of unconsolidated marine sediments that rest unconformably on the eroded surface of the Potomac Group deposits (Hansen, 1978, p. 17). The Tertiary deposits are relatively thin (20-40 ft) and pinch out or are absent on the Indian Head peninsula. Tertiary deposits are absent in the lowlands at Indian Head, where the Potomac Group deposits also were deeply eroded, and the Potomac Group is unconformably overlain by a complex of late Miocene to Pleistocene fluvial and estuarine sediments (paleochannel deposits) that subsequently filled the eroded channels and valleys (fig. 5).

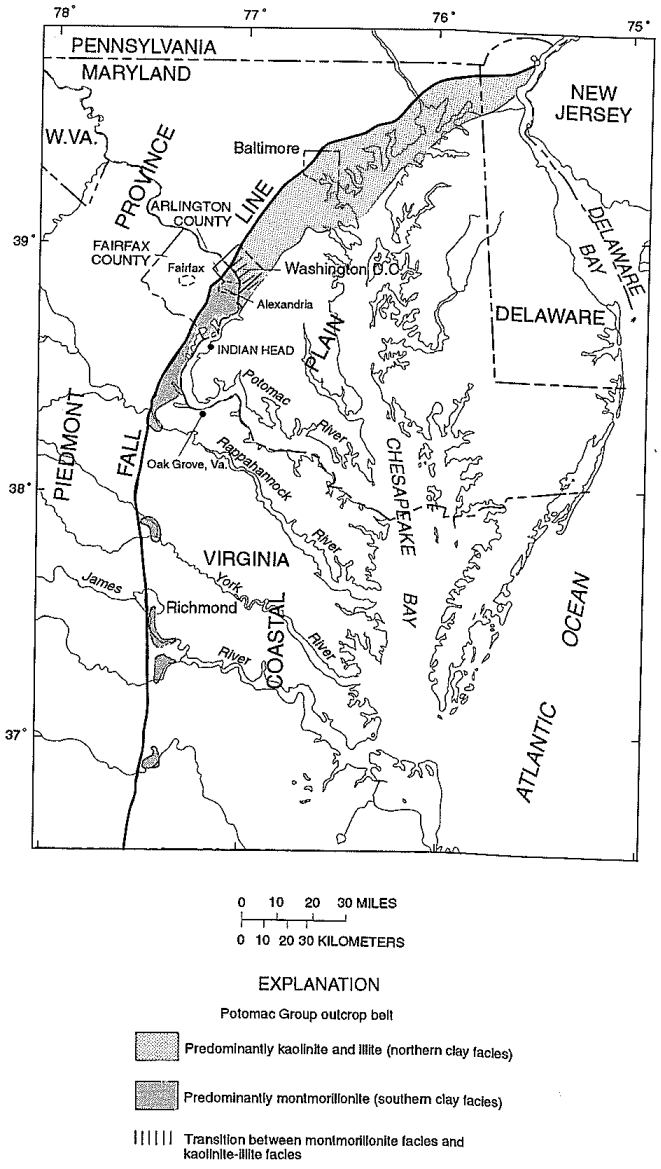


Figure 4. Potomac Group outcrop belt and physiographic provinces in the Middle Atlantic States (From Force and Moncure, 1978).

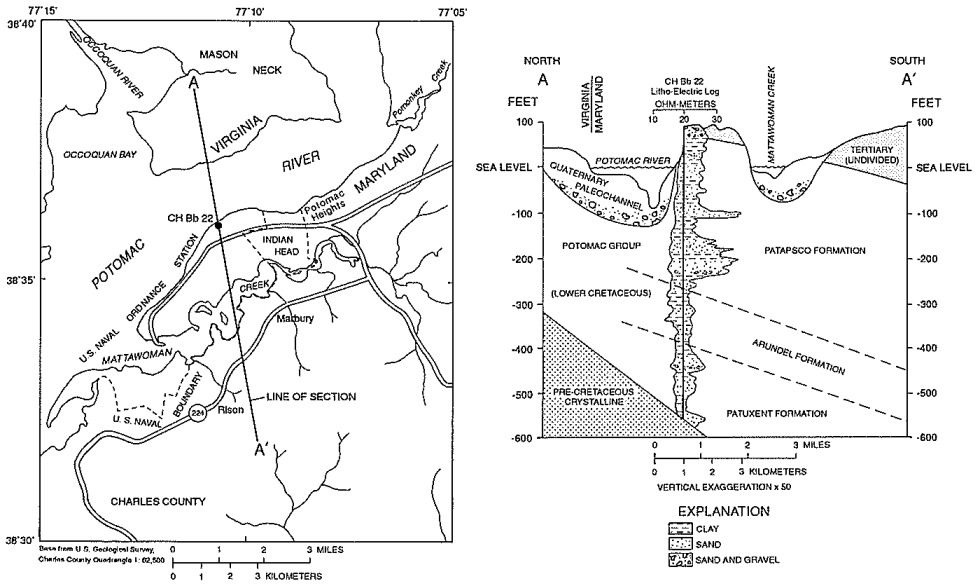


Figure 5. Generalized stratigraphic and hydrogeologic framework in the Indian Head area.

The location of the hydrogeologic sections and the identifiers and locations of wells and auger holes used for geologic control are shown on plate 2. Table 3 (at end of report) lists additional information on wells in Charles County that were used to construct the sections, and table 4 (at end of report) lists additional information on wells and auger holes in Virginia that were used for control.

The hydrogeologic sections (pls. 3 and 4) show the general configuration and stratigraphic relations of the geologic deposits in the vicinity of the Potomac River and Indian Head. The wedge of Coastal Plain sediments thickens southeastward from the outcrop at the Fall Line (fig. 4). The individual Potomac Group formations increase in thickness to the southeast; however, much of the increase is from clay units, which thicken downdip.

Pre-Cretaceous Basement Complex

The Potomac Group deposits in the Indian Head area lie unconformably over pre-Cretaceous gneiss, schist, and gabbroic rocks, which in this report are collectively referred to as the "basement complex." To the west, in the Piedmont of Virginia, this rock complex crops out at the land surface. To the east, in Charles and St. Marys Counties, Md., several test holes have been drilled into Triassic (?) or Jurassic (?) rocks beneath the Potomac Group deposits. Presence of these rocks indicates that in some areas, buried Mesozoic rift basins underlie the Cretaceous deposits of the Maryland Coastal Plain (Hansen and Edwards, 1986, p. 12).

The approximate altitude and configuration of the top of the pre-Cretaceous basement complex in the Indian Head area is shown in figure 6. On a regional scale, the basement-rock surface dips to the east-southeast at about 80 to 100 ft/mi. The contours were developed using a compilation of data and interpretations on basement depth and structure in the Virginia Coastal Plain, as adapted from Seiders and Mixon (1981) and Mixon and others (1972). Lithologic data from deep holes in northwestern Charles County, Md., were adapted

Table 1. - Stratigraphic relations and hydrologic character of geologic deposits in the Indian Head area of Charles County, Maryland.

System	Series	Group	Formation	Range of Thickness (feet)	Hydrologic Character	Map Symbol on fig. 7
Quaternary and Tertiary	Holocene to Miocene		Alluvium and terrace deposits	30-100	Water table to semi-confined aquifer	Q
			Unconformity			
Tertiary	Paleocene	Pamunkey	Aquia	20-40	Confining Unit	Ta
			Unconformity			
Cretaceous	Lower Cretaceous	Potomac	Patapsco — Upper	250-300	Confining unit Aquifer	Kp
			Patapsco — Middle		Confining unit Aquifer	
			Patapsco — Lower part		Confining unit Aquifer	
			Unconformity			
			Arundel	50-75	Confining unit	
			Patuxent	250-300	Aquifer Confining unit Aquifer	
			Unconformity			
Pre-Cretaceous Rock			Basement complex	Unknown	Confining unit	

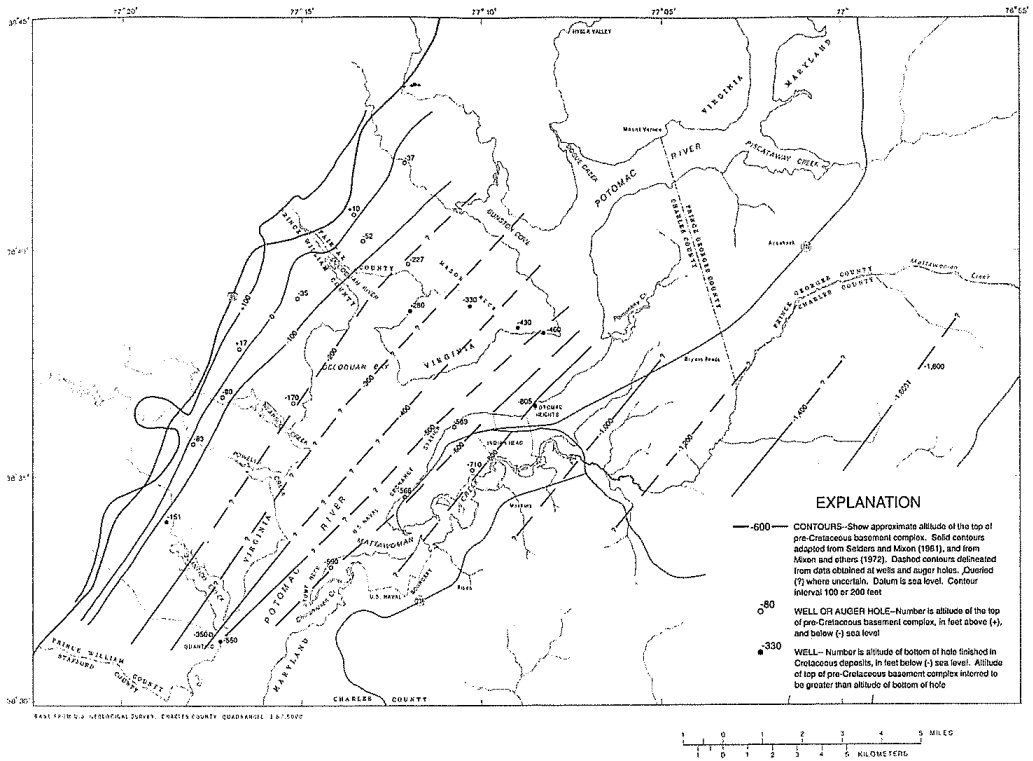


Figure 6. The approximate altitude and configuration of the top of the pre-Cretaceous basement complex.

from Wilson and Fleck (1990) and compiled from the files of the USGS, Towson, Md., office.

The surface of the basement complex underlying this region was extensively eroded before deposition of the Lower Cretaceous deposits. Mixon and others (1972) mapped the geology of the Piedmont and Coastal Plain in the Quantico quadrangle and noted a step-like steepening of the basement-rock surface near the Fall Line (pls. 3 and 4). This offset is generally aligned with the axis of the Stafford fault system. This fault consists of a series of en echelon, northeast-trending, high-angle reverse faults that parallel the Fall Line in Stafford and Prince William Counties, Va. (Seiders and Mixon, 1981). These observations indicate that tectonism could have affected the regional paleodrainage systems that distributed the Cretaceous sediments on the surface of the basement complex in this area. A northeast-striking, up-to-the-East reverse fault, which is part of the Brandywine fault system, trends through the Waldorf area of northwestern Charles County. The basement complex and the Lower Cretaceous units (Patuxent, Arundel, and Patapsco Formations) are offset across the fault, which has about 250 ft of throw in the Waldorf area (Wilson and Fleck, 1990, p. 12 and 13).

Cretaceous Potomac Group Deposits

The Potomac Group is the oldest sedimentary deposit cropping out in the inner belt of the Atlantic Coastal Plain. Potomac Group deposits rest unconformably on the eastern, seaward-sloping

margin of the ancestral Piedmont and Appalachian Mountain ranges. The Potomac Group is the product of fluviodeltaic sedimentation during the Early to Late Cretaceous Epochs (Glaser, 1969, p. 74).

In outcrop in the Maryland type area, the Potomac Group is divided into three formations (Brenner, 1963, p. 1): the basal Patuxent Formation, which is conformably overlain by the Arundel Formation, which is unconformably overlain by the Patapsco Formation (table 1). In the Potomac River lowlands of the Virginia Coastal Plain, deposits of the upper part of the Potomac Group have traditionally been divided into a clay facies and a sand facies because the Arundel Formation lacks sufficient surface exposure and is difficult to map and correlate. At Oak Grove, Va. about 30 mi south of Indian Head (fig.4), Reinhardt and others (1980) divided the Cretaceous deposits into a lower (zone I) and an upper (zone II) Potomac Formation on the basis of the stratigraphic palynological studies by Brenner (1963) in the Coastal Plain of Maryland. Brenner's zone I included the Patuxent and Arundel Formations, and his zone II, which was divided into three subzones, comprised the Patapsco Formation.

Overall, on the basis of continuous cores retrieved from well CH Bb 22 at Indian Head (fig. 5), the coarsest deposits of the Potomac Group, representing the depositional environment of highest energy, are in the basal Patuxent Formation. During Early Cretaceous time, terrigenous sediments were shed from an uplifted Piedmont-Blue Ridge Province and distributed seaward by rivers (Glaser, 1969, p. 60). Sea-level rises shifted the location of the nearshore and deltaic deposition landward, whereas periods of falling sea levels shifted the location of fluvial and deltaic deposition seaward. Migration and lateral shifting of paleodrainage systems resulted in facies changes within contemporaneous depositional units. Thus, major changes in the lithology of the Potomac Group deposits at Indian Head reflect major changes in depositional environments and sediment loads.

Slaughter and Otton (1968), in an earlier report about the hydrogeology of Charles County, Md., used the name "Patapsco-Raritan" to designate the lithologic interval in the Potomac Group above the Arundel Formation. In this report, the same lithologic interval in the Indian Head area is called the "Patapsco Formation." Although determination of the presence or absence of Upper Cretaceous deposits in this area was beyond the scope of this study, all available geologic maps indicate that Upper Cretaceous deposits are absent along the Potomac River in northwestern Charles County and adjacent areas in Virginia.

The generalized geology of the surficial deposits in the Indian Head area is shown in figure 7 as adapted and generalized from Seiders and Mixon (1981), Mixon and others (1972), Froelich and others (1978), Glaser (1978), and McCartan (1989). In Fairfax and Prince William Counties, Va., the Potomac Group crops out in a 4- to 6-mile-wide belt between the Potomac River and the Fall Line. In northwestern Charles County, the few surface exposures of the Potomac Group are primarily in the bluffs overlying the Maryland shore of the Potomac River (fig 7).

Patuxent and Arundel Formations

The basal part of the Potomac Group in Maryland has been divided into the Patuxent and Arundel Formations. According to Glaser (1969), in the type area, the Patuxent Formation is composed primarily of medium-grained to coarse-grained sand or pebbly sand and gravel interbedded with relatively thin, pale-gray clays. The Arundel Formation is predominantly a tough, dark-gray to maroon, massive clay containing abundant lignite and sideritic concretions. In the Indian Head area, the clays of the Arundel Formation are useful as a lithologic marker that separates the Patuxent from the Patapsco Formations. The clay is very dense and generally requires more time to penetrate with a hydraulic rotary drill rig than do overlying and underlying strata.

Although the sediment source for the Patuxent and Arundel Formations was continental in origin, the Patuxent sediments were generally deposited in high-energy fluvial and deltaic environments. According to Glaser (1969, p. 71), in the type area, the general lack of silt and clay throughout the lower part of the Patuxent Formation attests to the predominance of bedload deposition. In the Indian Head area, thick fine-grained layers generally

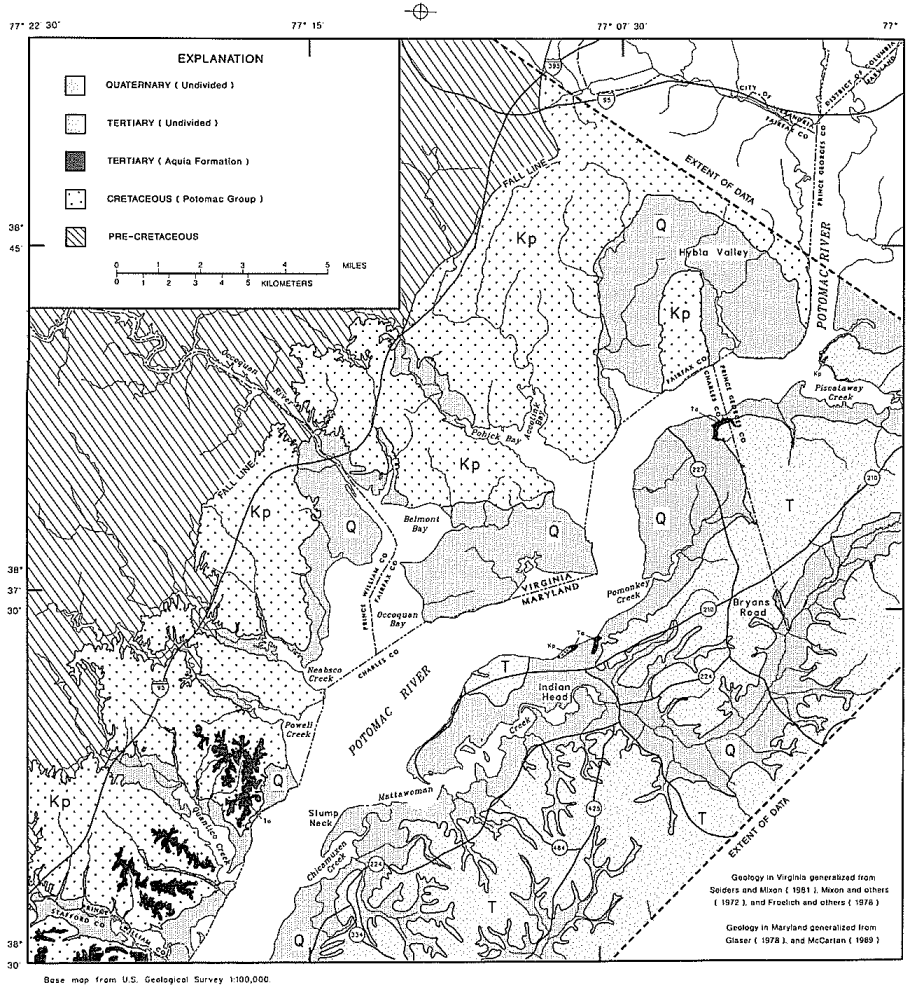


Figure 7. Surficial geology in the Indian Head area.

separate the major sand layers in the Patuxent Formation (pls. 3 and 4).

The Arundel Formation was probably deposited in a quiet, shallow, freshwater environment (Glaser, 1969, p. 72). Deposits of the Arundel Formation record a period of low-energy fluvial deposition. Glaser (1969, p. 72) stated that "The association of massive lignitic clays, logs and rooted stumps, terrestrial reptile bones, and the complete absence of marine fossils, points to deposition in shallow, probably discontinuous, backswamp basins maintained by ponded drainage and slow sediment influx."

The approximate altitude and configuration of the top of the Patuxent-Arundel Formations (undivided) in the Indian Head area is shown in figure 8. The regional dip of the Patuxent-Arundel Formations is to the east-southeast and ranges from about 80 to 100 ft/mi.

Patapsco Formation

The Patapsco Formation rests unconformably on the undivided Patuxent-Arundel Formations (Brenner, 1963, p. 38). In the Indian Head area, the Patapsco Formation consists of layers of fine to medium-grained sand and silt, separated by thick clay layers (pls. 3 and 4). The lithologic character

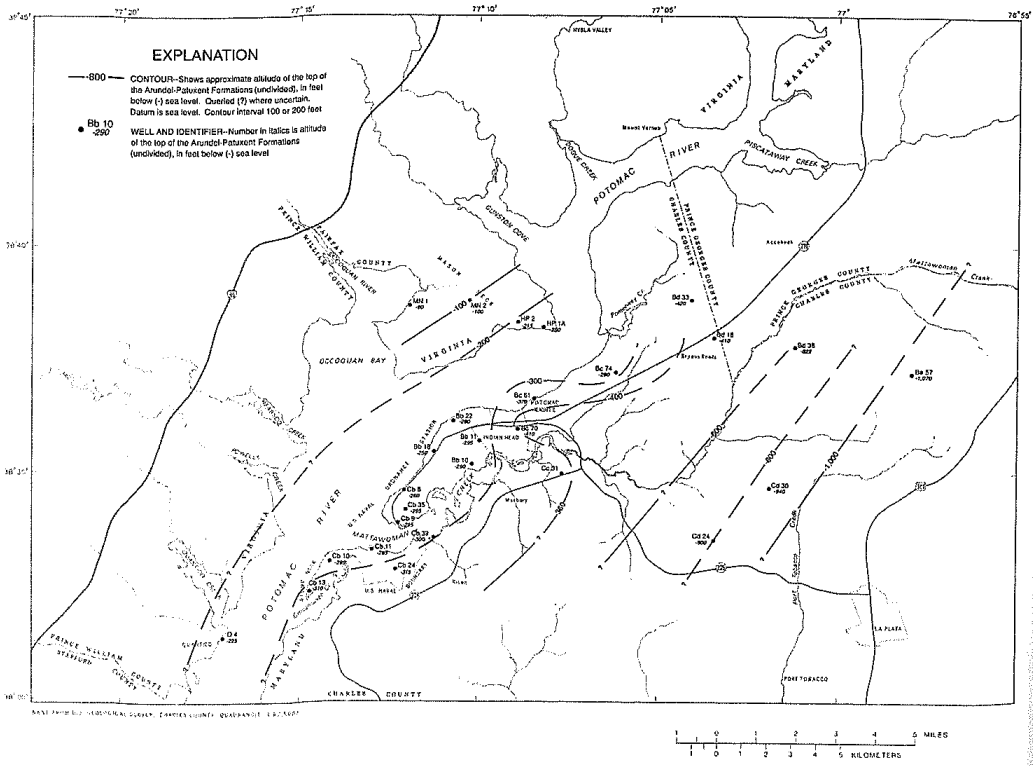


Figure 8. Top of the Arundel-Patuxent Formations (undivided).

of the sediments in the type area indicates deposition on a low deltaic plain by sluggish, low-gradient, perhaps meandering rivers (Glaser, 1969, p. 73). On the basis of continuous core samples from well CH Bb 22 (fig. 5) at Indian Head, the Patapsco Formation sand layers are generally finer-grained than the Patuxent Formation sand units. In addition, beds of lignitic plant remains are common in some of the Patapsco Formation deposits at Indian Head, and some of the upper sand layers are well cemented.

The deposits of the Patapsco Formation at Indian Head commonly grade upward from coarse-grained to fine-grained clasts. The basal part of these sequences typically consist of coarse-grained sand and interbedded gravel-pebble zones that represent the depositional environment of highest energy in the sequence. The coarse deposits grade upward to medium- or fine-grained sand and are overlain by finer sand and silt. These grade upward to silty, hard gray clay containing lignite and carbonaceous plant remains. Several repetitions of this coarse-to-fine upward-grading sedimentary sequences were observed in the continuous core from well CH Bb 22. The borehole-geophysical logs from well CH Bb 22 are shown in figure 9, and a condensed lithologic description of the core is given in table 5 (at the end of report). The coarse-to-fine sequences are also reflected in several of the electric borehole-geophysical logs shown in figure 9 and plates 3 and 4.

The approximate altitude and configuration of the top of the Patapsco Formation in the study area is shown in figure 10. This surface has been eroded, and in the lowland areas along the Potomac River near Indian Head, it is unconformably overlain by late Miocene to Quaternary fluvial and estuarine deposits. On the isolated upland of the Indian Head peninsula and throughout the inter-stream uplands to the east, the Patapsco Formation is unconformably overlain by the Tertiary Aquia Formation (David Powars, U.S. Geological Survey, written commun., 1989).

Tertiary and Quaternary Deposits

The principal focus of this report is the hydrogeologic conditions in the Potomac Group aquifer system. A brief discussion of the overlying Tertiary and Quaternary deposits is relevant because these deposits have modified the hydrogeologic framework and thus can influence recharge and ground-water flow in the underlying confined aquifers of the Potomac Group.

The Tertiary deposits are marine sedimentary units that unconformably overlie the eroded surface of the Potomac Group in the Indian Head area (table 1). Most of the upper Tertiary units have been eroded away except on the isolated upland at Indian Head, where the Tertiary Aquia Formation forms a veneer (20-30 ft thick) that overlies the eroded surface of the Patapsco Formation. On a regional scale, the Tertiary units generally thicken and dip to the east (pls. 3 and 4). The western extent of the upper Tertiary units, which are stratigraphically above the Aquia Formation, is several miles east of the Indian Head area (fig. 7). Hansen (1978, p. 10) attributes the regional pinch-out of Upper Cretaceous and Paleocene deposits in this area of the Coastal Plain to tectonic activity and antecedent basement-rock structure.

Deposits of the Aquia Formation are present in the study area on the top of the bluffs along the Maryland shore of the Potomac River and on several isolated hilltops in northeastern Prince William County, Va. (fig. 7). The Aquia Formation ranges from olive-black to olive-gray micaceous, glauconitic, fine- to coarse-grained quartz sand with a few beds of olive-gray silty clay and very fine silty sand (McCartan, 1989). These sediments are marine in origin and were deposited in middle- to shallow-shelf environments.

In the Indian Head area and throughout northwestern Charles County, the Tertiary Formations of the interstream uplands are unconformably overlain by a fluvial-sedimentary unit, which is composed of gravel, sand, and loam. Following Clark's usage, Hack (1955, p. 10) called these deposits the Brandywine Formation and estimated that they ranged in age from Miocene to Pliocene. On a regional scale, Bennett and Meyer (1952, p. 68) referred to these surficial sediments as the "upland deposits" of southern Maryland. Otton (1955, p. 103) points out that, when saturated to a sufficient thickness, these deposits are capable of yielding large quantities of water to hand-dug wells and that they constituted an important source of

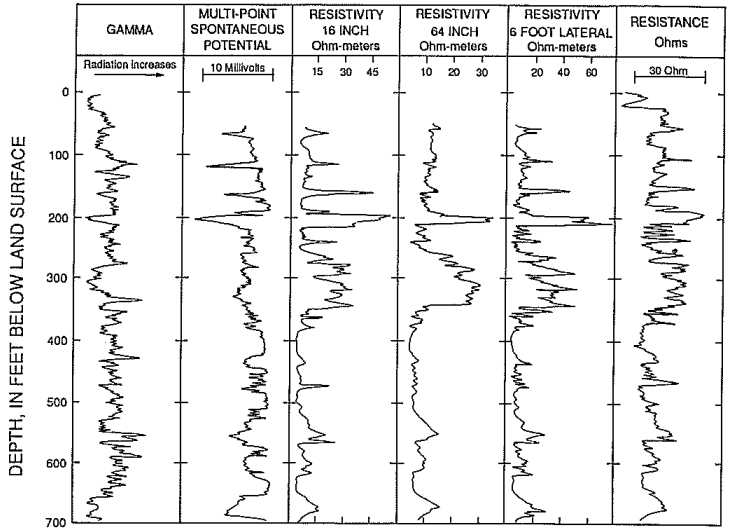


Figure 9. Borehole-geophysical logs of well CH Bb 22.

ground-water supply in rural southern Maryland. Mixon and Seiders (1981) mapped the location of these "upland deposits" in the Quantico and Occoquan quadrangles and proposed an age ranging from late Tertiary to early Quaternary. McCartan (1989) subdivided the Tertiary "upland deposits" in Charles County into the Upland Gravel 4, Upland Gravel 3, and the Park Hall Formation, which range in age from early to late Pliocene.

For this report, the surface outcrop area of the Tertiary and Quaternary units (fig. 7) was modified and generalized from the original maps. Except for the Paleocene Aquia Formation designated "Ta" on figure 7, all of the later Tertiary units have been grouped together and mapped as a single unit designated "T" on figure 7. Where distinguishable, the individual Tertiary units at sites used for geologic control are shown on plates 2 and 3. The single Quaternary unit designated "Q" on figure 7 represents individual Quaternary units grouped as a single map unit. McCartan (1989) subdivided the Quaternary sediments in Charles County into five map units that range in age from Lower Pleistocene to Holocene. Seiders and Mixon (1981) mapped Holocene terrace deposits (Qal), Wisconsinan and pre-Sangamon Pleistocene terraces (Qp1 and Qp2), and Miocene to Pleistocene terraces (QTs) in the lowlands along the Virginia side of the Potomac River. Detailed geologic mapping of these geologic units is available in the publications cited in figure 7.

Erosional History of Potomac Group Deposits

Chesapeake Bay is an estuary formed by the post-Wisconsin (Holocene) rise in sea level, which drowned the lower valley of the ancestral Susquehanna River system and its tributaries (Hack, 1957, p. 817). During the multiple glaciations of the Pleistocene, the rivers in the Chesapeake Bay region incised either new or deeper channels into unconsolidated Cretaceous and Tertiary deposits as they established new base levels with the lowered sea level. Colman and others (1990) document the presence of three

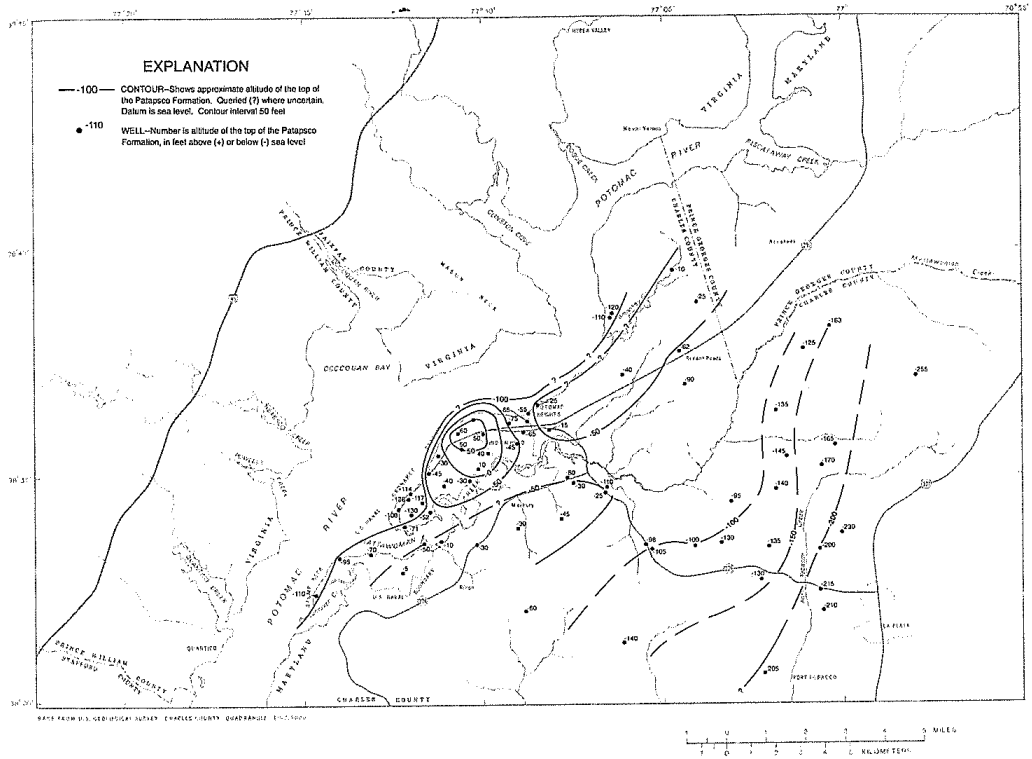


Figure 10. The approximate altitude and configuration of the top of the Patapsco Formation in the study area.

ancestral Susquehanna River channels in the deposits under the Chesapeake Bay and the Delmarva Peninsula.

Undifferentiated Quaternary deposits (fig. 7) are present in the major stream valleys and along the Potomac River lowlands. These fluvial and estuarine sediments were deposited in channels and valleys cut by the ancestral Potomac River system during the Quaternary. Several cycles of regression and transgression of the Quaternary seas occurred during the geomorphologic evolution of the Chesapeake Bay region (Kerhin and others, 1988). Because of the presence of several Pleistocene terrace deposits of differing age in Virginia (Seiders and Mixon, 1981) and in Charles County, Md. (McCartan, 1989), similar cycles of downcutting and subsequent channel filling probably occurred repeatedly along the Potomac River near the Fall Line in Maryland and Virginia.

Well logs show that in the vicinity of Indian Head, the Patapsco Formation was eroded by the ancestral Potomac River (fig. 10); however, the precise depth of erosion into the Potomac Group deposits under the modern Potomac River estuary is unknown. On the basis of an analysis of the lithology of foundation borings at the Woodrow Wilson Bridge on the Potomac River (about 20 mi upstream) near Alexandria, Va., Hack (1957) postulated a Wisconsinan age for the latest valley of the ancestral Potomac River. This valley cut downward into Tertiary and Cretaceous deposits to a depth of about 90 to 100 ft below sea level.

Knebel and others (1981) used marine surface-geophysical methods and borehole-lithologic data to establish the sedimentary depositional framework of the Potomac River estuary downstream from the Route 301 bridge at Morgantown in southern Charles County, Md. (fig. 1). They determined that the Wisconsinan valley of the Potomac River in that area has a sinuous trend, a flat bottom, relief of about 50 to 110 ft, and axial depths of about 125 to 175 ft below sea level. Chappelle and Drummond (1983, fig. 16, p. 37) showed the generalized location and approximate depth of the Wisconsinan channels of several rivers tributary to the Chesapeake Bay.

In 1978, the USGS cored several holes in Hybla Valley and on Mason Neck in eastern Fairfax County, Va., to determine the lithology and cross-sectional geometry of channel deposits of the ancestral Potomac River. The generalized land-surface altitude, depth, lithology, and geometry of deposits that fill a channel eroded into Cretaceous deposits in Hybla Valley, Va. is depicted in figure 11. This area is adjacent to the Potomac River, about 6 mi north of the Indian Head area. These paleochannel deposits range from fluvial to estuarine in origin and were deposited by an aggrading river system during a period of rising sea level (Froelich and others, 1978, p. 3).

The coring revealed an asymmetric valley floor and relatively thick, fluvial sand and gravel deposits at the base of the channel fill. The basal part of the paleochannel unconformably overlies deposits of the Potomac Group (undifferentiated). The coarse basal deposits are overlain by sequences of sand, silt, clay, and organic-rich sediments that grade upward from coarse to fine-grained. These sedimentary sequences represent the transition from point-bar to levee to overbank deposits (Froelich and others, 1978, p. 3). The basal paleochannel deposits consist of coarse-grained sand and gravel that is more permeable than the Cretaceous deposits that have been replaced; thus, throughout the Potomac River lowlands, similar paleochannel deposits could be hydraulically connected to the Potomac River.

Froelich and others (1978) concluded that the base of the paleochannel in central Hybla Valley ranges from at least 18 to more than 85 ft below modern sea level. They delineated areas along the Virginia Shore that were underlain by paleochannel deposits contiguous with the Potomac River as potentially favorable locations for wells designed to induce river-water recharge. They also inferred that other similar deposits of the ancestral Potomac River (designated "Q" in figure 7) are present on the Maryland shore of the Potomac, but noted that most of these deposits underlie the modern Potomac River (fig. 5) or its tributaries (Froelich and others, 1978, p. 1).

The topography and bathymetry of the Indian Head 7 1/2 minute quadrangle and the approximate extent of Potomac River paleochannel deposits in this area are shown in figure 12. The approximate margin of these deposits is outlined on either side by a slightly eroded, upland scarp that is approximately marked by the 50-ft topographic contour. The surficial deposits in this area are shown in figure 7 as undifferentiated Quaternary sediments, which includes all paleochannel and terrace deposits along the Potomac River lowlands. McCartan (1989) differentiates these deposits into five units that range in age from Lower Pleistocene to Holocene.

The upper surface of the paleochannel deposit that trends north-south through the town of Indian Head, forms a trough or wide, flat lowland that ranges from a maximum altitude of 30 to 40 ft above sea level, to a minimum of about 10 to 15 ft below sea level, where eroded by Mattawoman Creek (fig. 12). The altitude of the upper surface of the paleochannel deposit in Hybla Valley ranges from 30 to 40 ft above sea level (fig.11). These two paleochannels could be contemporaneous with the Pleistocene terrace unit (Qp2) mapped by Mixon and Seiders (1981) in theVirginia Coastal Plain. The lower surface of this deposit is an erosional unconformity on the Patapsco Formation that is at least 75 ft below sea level at Indian Head (fig. 10 and pl. 4). On the southwest end of the peninsula, the base of an associated paleochannel deposit is about 125 ft below sea level (fig. 10).

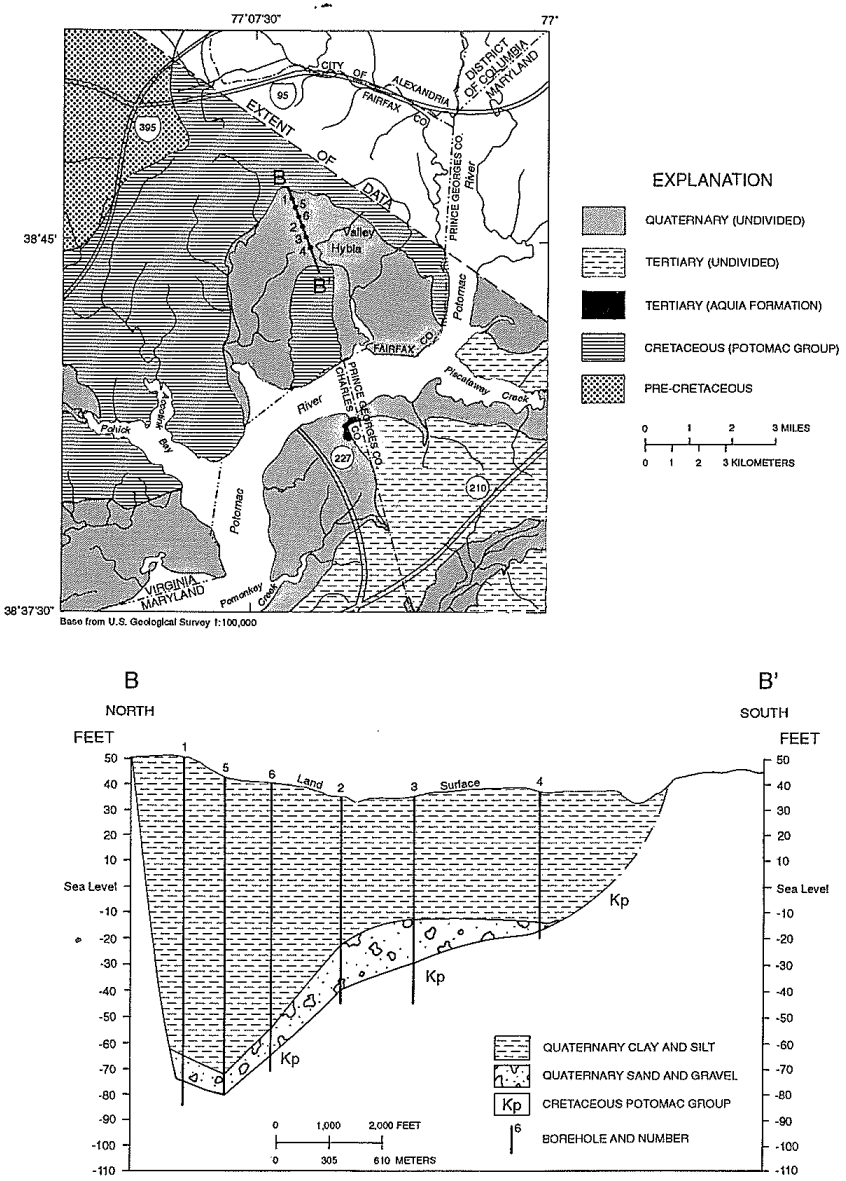


Figure 11. Generalized geologic map and section of Hybla Valley, Va.

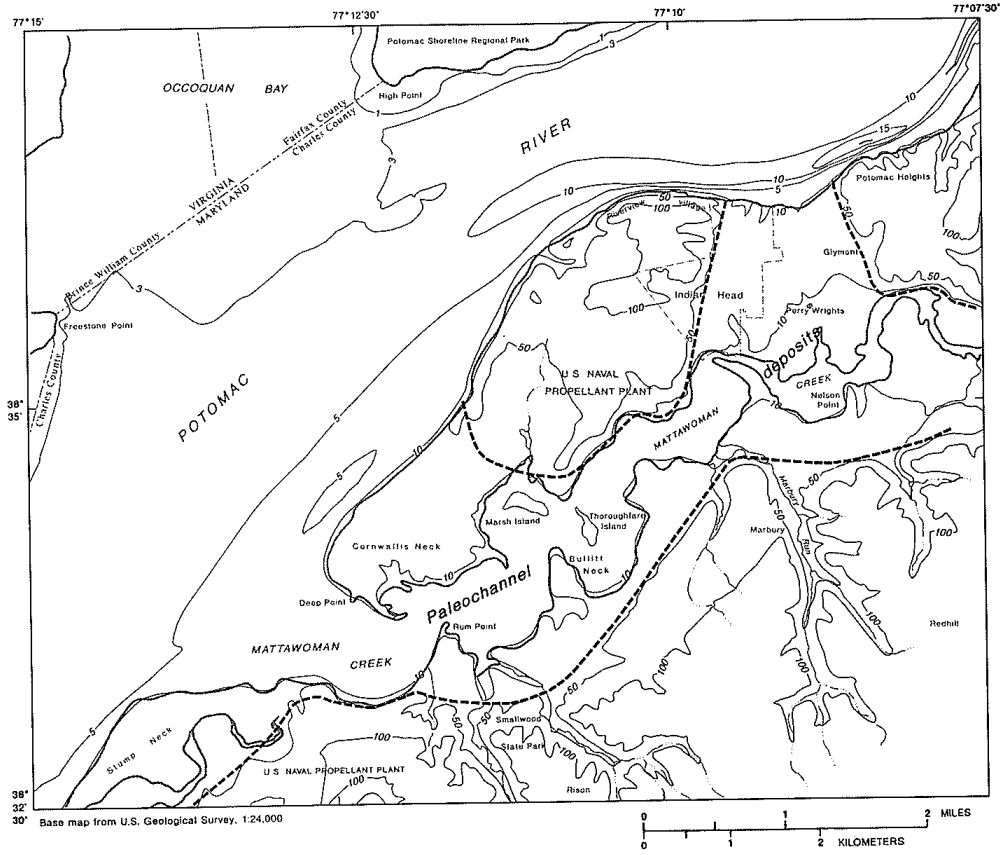


Figure 12. Approximate margins of Potomac River paleochannel deposits in the Indian Head area. (Topographic contours variable in feet; Bathymetric contours 5 meter interval.)

Bathymetric data for the modern Potomac River (fig. 12) indicate that geomorphologically, the river has a sinuous, deep channel with a wide, shallow shelf opposite bends in the river. The thalweg (path of the channel) of the modern Potomac River north of Indian Head probably represents a vestige of the drowned, late Wisconsinan Potomac River channel. Near Potomac Heights and Riverview Village (fig. 12), the thalweg is adjacent to the Maryland shore and ranges in depth from 65 to about 100 ft.

The approximate altitude and configuration of the top of the Patapsco Formation in the Indian Head area, was determined using well logs (fig. 10). At least two different Quaternary channels have been eroded to different depths in the Patapsco Formation at Indian Head. Furthermore, the Wisconsinan Potomac River could have incised a channel as deep as 125 or more feet below sea level (fig. 5). In Occoquan Bay (fig. 12), this deep channel is buried by Holocene deposits, which form a shoal at this location in the Potomac River estuary. These Holocene deposits could be 100 or

more feet thick. Thus, repeated downcutting by the ancestral Potomac River has probably removed or eroded upper geologic units in the Potomac Group.

Since the Holocene transgression, which submerged and buried the Wisconsinan channel with fluvial and estuarine sediments, the Potomac River estuary in the Indian Head area has become the site of deposition for an organic-rich gray to black clay or silty clay that blankets most of the earlier deposits (Callendar and others, 1984). River-bottom sediment deposited since the European settlement of the Potomac River basin reflects major increases in soil erosion and sedimentation rates. Much of the river bottom in the Indian Head area is covered by modern estuarine mud and clay layers that can range from about 3 m to more than 8 m in thickness (Jerry Glenn, U.S. Geological Survey, written commun., 1990).

In 1988, a reconnaissance, marine-seismic-reflection survey was conducted in the Potomac River and its tributaries near Indian Head. The intent of this reconnaissance survey was to try to delineate the geometry of the channel fill and other deposits beneath the river. However, the gas-laden, organic-rich layer of estuarine mud and clay that blankets much of the river bottom limited penetration of the source signal. Although the geometry and extent of paleochannels was not determined, the survey qualitatively confirmed the nearly ubiquitous presence of the estuarine mud and silt in this part of the river. This survey also located, and confirmed the depths of, several deep scour holes in the thalweg adjacent to Potomac Heights. In this area, the maximum depth of the thalweg ranges from 90 to 110 ft.

HYDROGEOLOGY

The geologic deposits that underlie an area collectively form the physical framework of the ground-water-flow system. Lithology, extent, and continuity of the deposits affect the characteristics of the ground-water-flow system. The Patapsco and Patuxent Formations in the Indian Head area each contain several confined aquifers consisting of saturated, poorly consolidated layers of sand and gravel deposits that can range from a few feet to about 20 ft in thickness (pls. 3 and 4). Compared to the interbedded confining units (clays), the sand and gravel deposits have relatively high hydraulic conductivities.

Ground-water flow in a confined aquifer is controlled chiefly by the quantity and location of recharge and discharge, by the hydraulic gradient, and the hydraulic conductivity of the aquifer. The rate of natural ground-water flow in the Patapsco and Patuxent aquifers is generally low and ranges from a few feet to several tens of feet per year (Otton, 1955, p. 109).

Aquifers

In this report, the aquifers and confining units in the Patapsco and Patuxent Formations are collectively referred to as the "Potomac Group aquifer system " (table 1). The Potomac Group deposits crop out along an extensive belt in the Virginia Coastal Plain, but their surface exposure in Maryland is very limited (fig. 7). In Virginia, precipitation on the outcrop area recharges the Potomac Group aquifer system, and water-table conditions prevail in the western updip margin. Along the Virginia shore of the Potomac River, the deeper sand layers of the Potomac Group are overlain by confining units.

Slaughter and Otton (1968) conducted aquifer tests in the Indian Head area using selected production wells screened in the Potomac Group aquifers. Transmissivities ranged from about 3,000 to 6,000 (gal/d)/ft or 400-800 ft^2/d and storage coefficients ranged from 0.0002 to about 0.004 (Slaughter and Otton, 1968, p. 49).

The Patapsco Formation in the Indian Head area contains three relatively continuous sand layers. These layers consist of medium- to fine-grained sand, separated by clay beds or lenses that locally function as confining units. The sand layers appear as deflections to the right in the electric logs shown on plates 3 and 4, and figure 9, whereas the clay appears as deflections to the left on the electric logs and as deflections to the right on the gamma logs. In this report, the term "Patapsco aquifer" refers to these prominent sand layers in a lithologic interval of the Patapsco Formation previously subdivided into the upper, middle, and lower Patapsco-Raritan Formation (Slaughter and Otton, 1968, p. 22).

In the Maryland part of the study area, the Patapsco Formation crops out along the shore and bluffs of the Potomac River, but is confined by overlying Tertiary sediments immediately to the east (fig. 7). Ground water in the outcrop area is under water-table or semiconfined conditions and is probably hydraulically connected to the shallow flow system in the overlying surficial gravel deposits. Ground water in the middle and lower parts of the Patapsco aquifer is confined in this area, and although less influenced by the shallow flow system, in this area these aquifers probably are hydraulically connected to the Potomac River indirectly through the Quaternary deposits beneath the Potomac River estuary (fig. 5).

The Arundel Formation consists almost entirely of hard clay and silt and is frequently referred to as the "Arundel Clay." It functions hydrologically as a confining unit, and, where present, it separates the Patuxent aquifers from the overlying Patapsco aquifers.

In this report, the term "Patuxent aquifer" refers to the two major sand layers of the Patuxent Formation, which show as major deflections to the right on the electric logs shown on figure 9 and plates 3 and 4. On a regional scale, the Patuxent Formation is a multiaquifer unit consisting of several sand layers of differing thickness and lateral extent. Ground water in the Patuxent aquifer is effectively confined by the Arundel Formation and other interbedded clay units in the Patuxent Formation.

Effects of Pumping

The confined aquifers in the Potomac Group have provided most of the ground water withdrawn in the Indian Head area during this century (Slaughter and Otton, 1968, p. 47). Long-term pumping in the Indian Head area has caused substantial reductions in the hydraulic head in the Patapsco and Patuxent aquifers. Early wells drilled into the Potomac Group aquifers flowed naturally when first drilled. These wells eventually ceased to flow when the ground-water levels declined because of pumping. In 1895, the water level in a well screened in the Patuxent aquifer at NOS was 13 ft above sea level (Darton, 1896). In 1989, water levels in wells in the same area are as much as 70 to 90 ft below sea level.

Most of the production wells in the Indian Head area are screened in two or more sand layers. Several production wells drilled after World War II were gravel walled, which also established a hydraulic connection to otherwise separate confined aquifers. At present, water levels are approximately equal in the confined aquifers in the Indian Head area because of the long-term pumping and use of multiscreen wells. The water levels indicate considerable hydraulic connection between the aquifers. They also indicate that the aquifers in this area have responded as a system to the pumping stress, and, possibly, that the ground-water-flow system is in approximate steady state (that is, in a slowly evolving equilibrium) with the pumping stresses.

Long-term pumping from multiscreen wells has possibly induced vertical leakage through confining units as well as increased lateral flow through the aquifers. Even unpumped multiscreen wells can provide a pathway for flow between two or more separate confined aquifers and can contribute to equalization of heads between aquifers. Slaughter and Otton (1968, p. 52) suggested that the sand units deeper than about 200 ft below sea level were in hydraulic continuity in the Indian Head area because of the use of multiscreen wells.

History of Pumping

Darton (1896, p. 134) described a well drilled at NOS in 1895 that was screened in the Patuxent aquifer, yielded 11 gal/min, and had an initial static water level of about 10 ft above sea level. The first large-capacity production well in the area was drilled at NOS in 1899. This well was screened in the lower part of the Patapsco and the upper part of the Patuxent aquifers. The well yielded 104 gal/min and had an initial static water level of 13 ft above sea level (Slaughter and Otton, 1968, p. 45).

By 1938, 14 production wells had been drilled at NOS, and pumpage had increased from about 0.28 Mgal/d in 1899 to about 1.0 Mgal/d in 1938 (Fiedler and Jacob, 1939). Slaughter and Otton (1968, p. 47) estimated that 60 percent of the total pumpage from 1899 to 1954 at NOS was withdrawn

from the Patapsco aquifer, the remainder being withdrawn from the Patuxent aquifer.

Fiedler and Jacob (1939) published data on ground-water levels and aquifer and well characteristics based on extensive pumping tests of production wells at NOS during 1938. At that time, most of the wells at NOS were about 1,000 ft southeast of the powerplant, in what was known as "well group no. 1" (see location shown for wells CH Bb 1-10, 14, and 15 on pl. 1). In 1933, static ground-water levels at NOS ranged from 35 to 102 ft below sea level, and pumping water levels ranged from 64 to 160 ft below sea level (Fiedler and Jacob, 1939, p. 13). Well yields at NOS in 1933 ranged from 86 to 304 gal/min, and specific capacities ranged from 2.1 to 10.2 (gal/min)/ft (Fiedler and Jacob, 1939, p. 13).

During the 1950's and 1960's, several production wells were drilled at NOS and, to the east, in the Indian Head-Glymont area. The new wells at NOS were drilled some distance away from the former locus of pumping at well group no. 1. The production wells drilled in the towns of Indian Head and Potomac Heights, are several thousand feet east of the former NOS pumping center. Thus, although the pumping stress in the Indian Head area has gradually increased with time, the pumping is now more decentralized than before the 1950's.

Locations and amounts of pumpage for the production wells active in the Indian Head area during 1988 are shown in figure 13. Annual average daily withdrawal of ground water at NOS and reported pumpage from NOS and the towns of Indian Head and Potomac Heights from 1980 through 1988 are shown in figure 14. Substantial increases in pumpage at NOS have generally corresponded to periods of increased ordnance production during major military conflicts (fig. 14). Pumpage at NOS during the 1980's was considerably less than in the previous several decades. During the 1980's, pumpage at NOS remained relatively stable and averaged about 1.4 Mgal/d. The combined pumpage of the towns of Indian Head and Potomac Heights also remained relatively stable during the 1980's and averaged about 0.5 Mgal/d.

Trends in ground-water use in Charles County and the percentage of each type of use for the years 1950, 1960, 1970, and 1980 are shown in figure 15. Total ground-water withdrawals in Charles County have more than quadrupled from 1950 to 1980. During this period, however, total pumpage in the Indian Head area remained relatively stable. Although pumpage at NOS accounted for about 43 percent of the total pumpage in the county in 1950, it accounted for about 11 percent of the total in 1980 (fig. 15).

Ground-water withdrawals have increased substantially in the central and north-central parts of Charles County because of population growth and the associated increased demand for water. Regional changes in the amount and extent of ground-water withdrawals in Charles County during 1950-80 are shown in figure 16. Pumpage along the Route 210 corridor northeast of the Indian Head area is now substantial, whereas little or no ground water was withdrawn in these areas in the 1950's. Currently, ground-water withdrawals in the Waldorf area are the largest in Charles County (fig. 16). Although some ground water withdrawn in the northwestern and north-central part of the county in 1980 was from the Patuxent aquifer, most withdrawals were from the Patapsco and overlying Magothy aquifers (Wheeler and Wilde, 1989, p. 55).

Ground-Water Levels and Flow

Water levels in the Potomac Group aquifer system began to decline with the operation of the first production wells. Most of the water that was initially withdrawn was probably derived from reductions in the volume of water stored in the aquifer. Storage in an aquifer is depleted while the cone of depression around the pumping wells expands; once the cone stabilizes, ground-water withdrawals are balanced either by a reduction in the natural discharge or by an increase in the rate of recharge or a combination of both (Heath, 1983, p. 32).

By 1933, continued pumping at NOS had created a cone of depression in the potentiometric surface of the Potomac Group aquifer system. The center of the cone was near well group no. 1, and

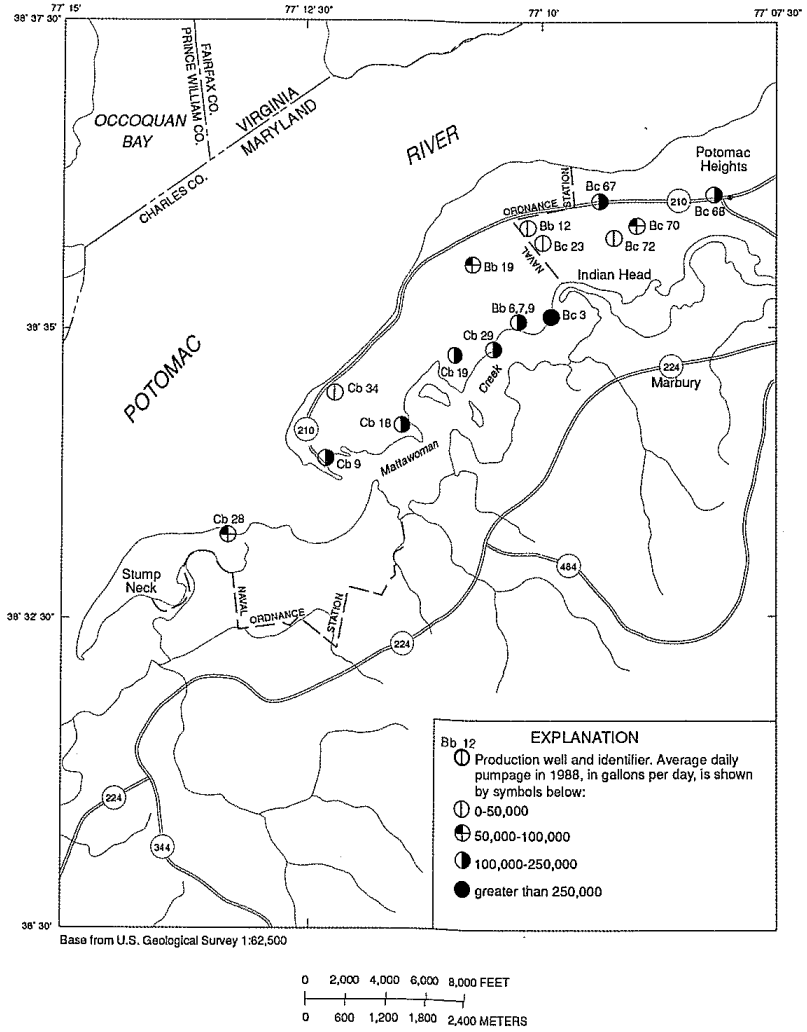


Figure 13. Location of production wells in the Indian Head area and average daily pumpage during 1988.

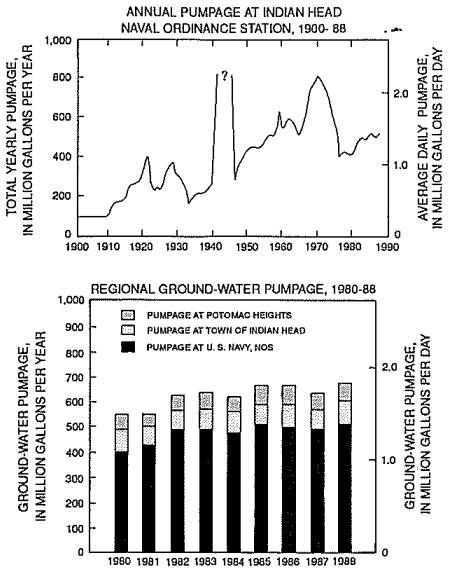


Figure 14. Ground-water pumpage from the Potomac Group aquifer system, at (A) Naval Ordnance Station, 1900-1988 and pumpage in the (B) Indian Head area, 1980-88.

static water-level altitudes at NOS ranged from 35 to 102 ft below sea level (Fiedler and Jacob, 1939, p. 13). This cone of depression represented a considerable change from the prepumping hydraulic gradients and indicated changes in velocity and direction of ground-water flow. Water-level data collected from observation wells in the Indian Head area during 1981-89 are summarized in tables 6 and 7 (at end of report).

Hydrographs based on water-level measurements in observation wells in the Indian Head area are shown in figure 17. Long-term water-level records for wells CH Bc 71, CH Bc 17, and CH Cb 7 show that, although water levels in these wells have fluctuated as much as 45 ft during the period of record (1952-89), the potentiometric surface in this area generally has been at least 60 ft below sea level during the period.

The water level in well CH Bb 17 is affected substantially by tidal fluctuations in the nearby Potomac River (fig. 18). This well is about 600 ft from the river and is screened in the Patapsco aquifer from 188 to 242 ft below sea level. The tidal fluctuations, along with the elevated

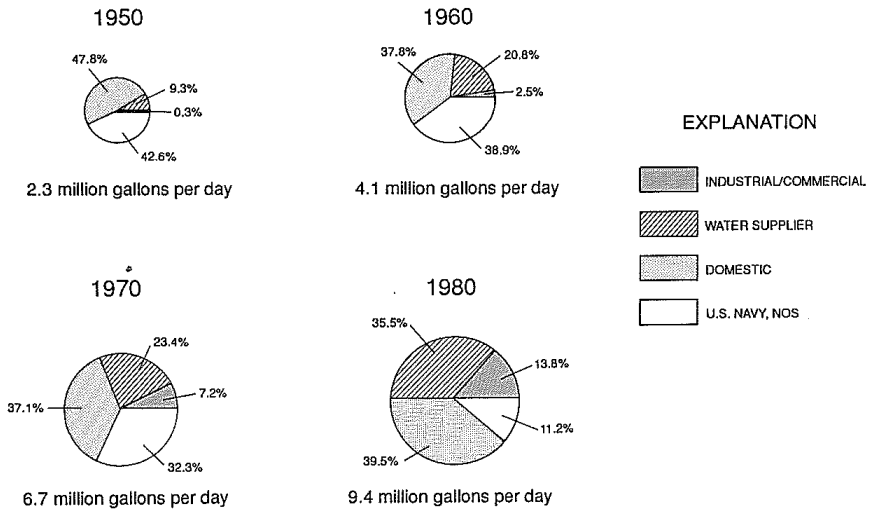


Figure 15. Ground-water use in Charles County, Md., and percentage of each type of use, 1950, 1960, 1970, and 1980. (From Wheeler and Wilde, 1989, p. 57).

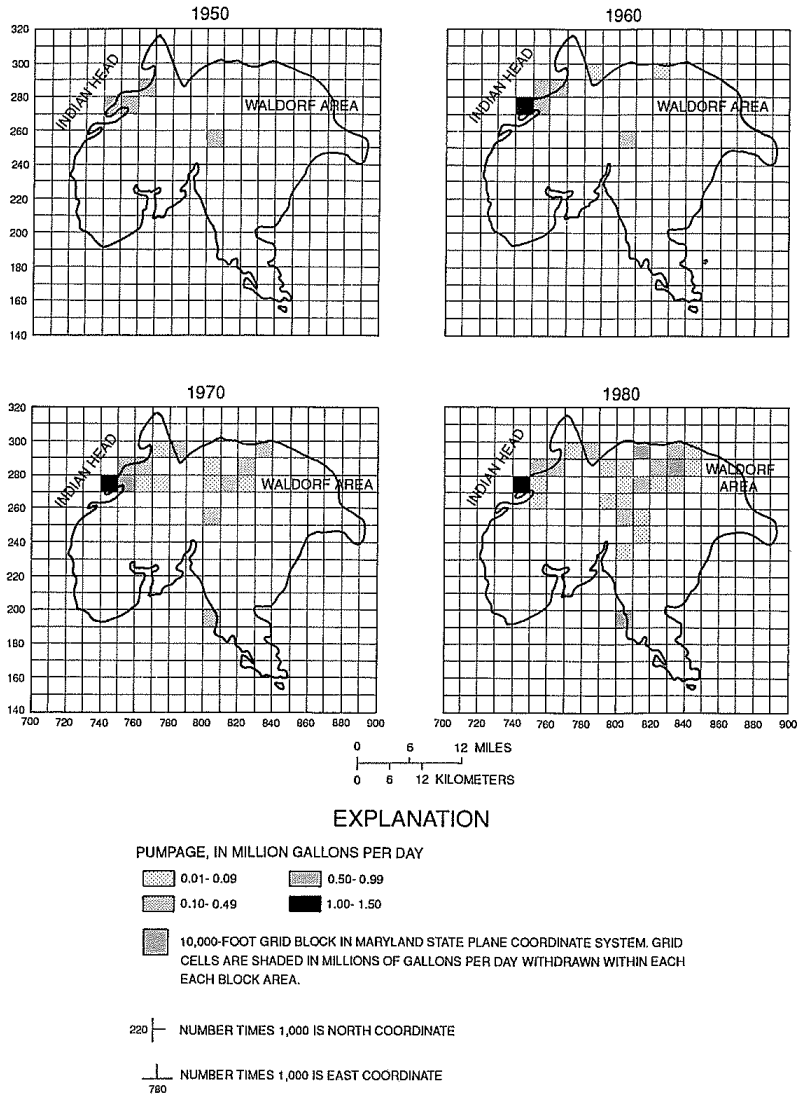


Figure 16. Regional pumping centers and ground-water withdrawals in Charles County, Md., 1950, 1960, 1970, and 1980. (From Wheeler and Wilde, 1989, p. 59).

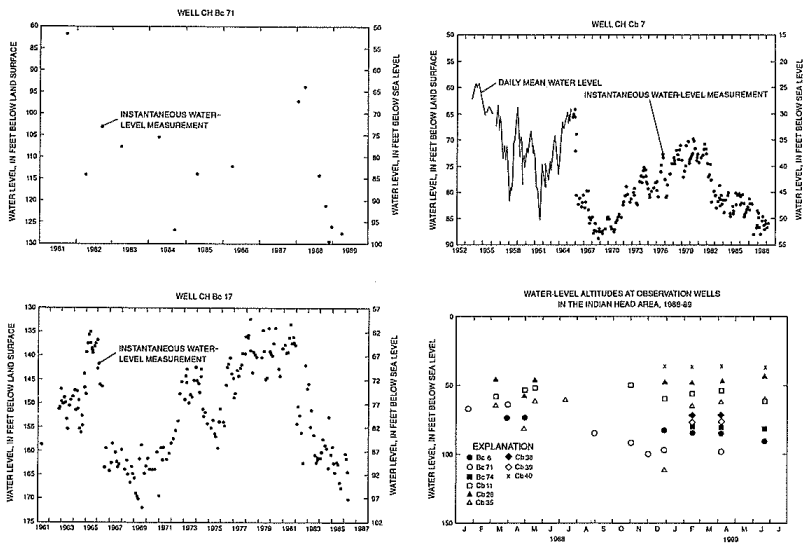


Figure 17. Water-level altitudes in observation wells in the Indian Head area measured periodically, 1952-89.

concentration of river-water indicator constituents (see section on Ground-Water Quality), indicate that this part of the Patapsco aquifer is indirectly hydraulically connected to the Potomac River through the overlying channel fill and river-bottom deposits.

The greatest pumping stresses in the Indian Head area from 1900 to 1989 occurred during World War II (1940-45) and the period 1965-75 (fig. 14). Water levels declined substantially in observation wells CH Bc 17 and CH Cb 7 in response to the pumping stresses that peaked around 1970 (fig. 17). During 1975-80, pumpage from NOS was less than that of the previous 10 years, and the water levels in wells CH Bc 17 and CH Cb 7 partially recovered as a result of the reduced withdrawals (figs. 14 and 17).

Pumpage from NOS during the 1980's increased only slightly from that during 1975-80 (fig. 14). Pumpage at the towns of Indian Head and Potomac Heights totaled about 0.5 Mgal/d during the 1980's. Continued population growth in the Indian Head and Potomac Heights areas will probably lead to gradual increases in ground-water withdrawals in the immediate area northeast of NOS. Ground-water withdrawals for small-community and domestic supplies along the Route 210 corridor have gradually increased in the past several decades 1970's-80's (fig. 16).

During the years prior to the 1980's, water levels in observation wells at Indian Head

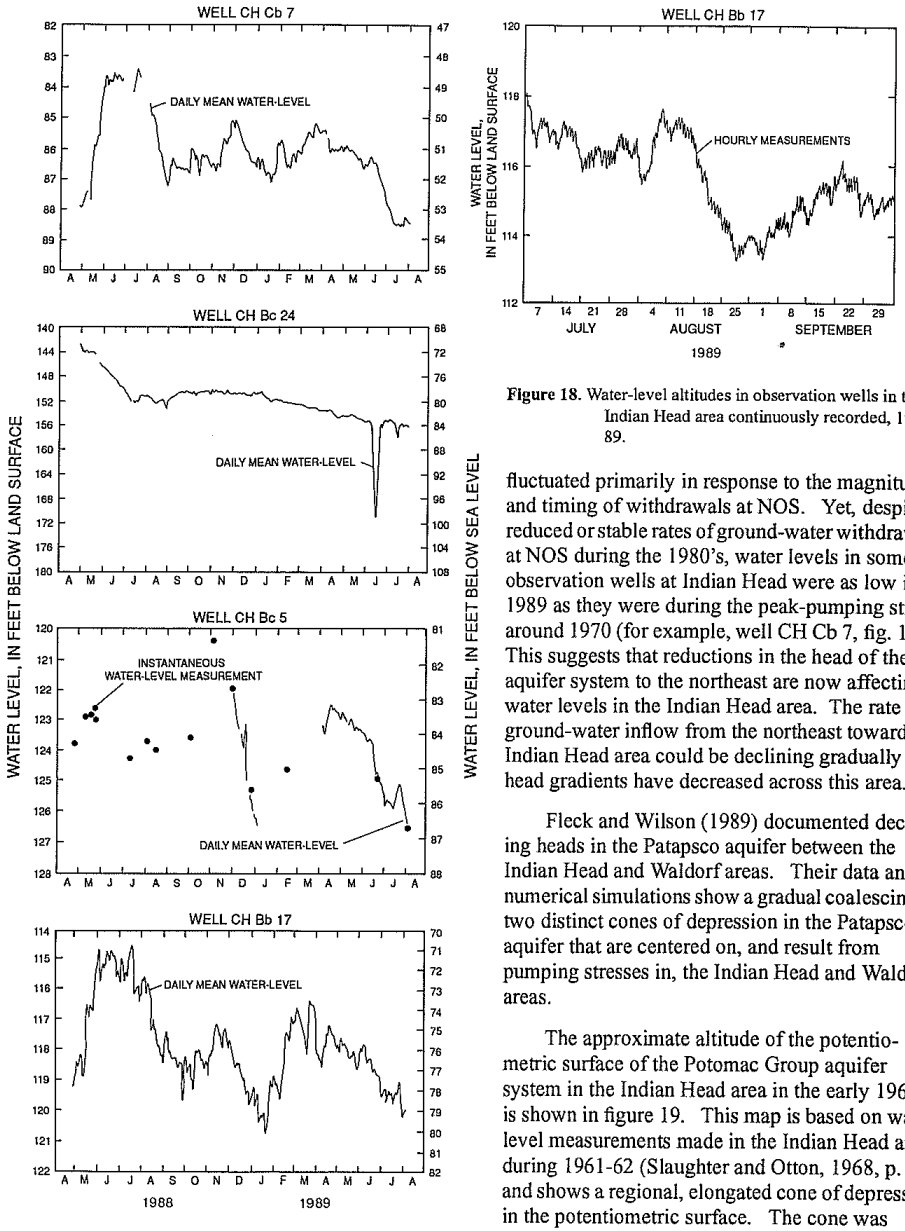


Figure 18. Water-level altitudes in observation wells in the Indian Head area continuously recorded, 1988-89.

fluctuated primarily in response to the magnitude and timing of withdrawals at NOS. Yet, despite reduced or stable rates of ground-water withdrawals at NOS during the 1980's, water levels in some observation wells at Indian Head were as low in 1989 as they were during the peak-pumping stress around 1970 (for example, well CH Cb 7, fig. 17). This suggests that reductions in the head of the aquifer system to the northeast are now affecting water levels in the Indian Head area. The rate of ground-water inflow from the northeast toward the Indian Head area could be declining gradually as head gradients have decreased across this area.

Fleck and Wilson (1989) documented declining heads in the Patapsco aquifer between the Indian Head and Waldorf areas. Their data and numerical simulations show a gradual coalescing of two distinct cones of depression in the Patapsco aquifer that are centered on, and result from pumping stresses in, the Indian Head and Waldorf areas.

The approximate altitude of the potentiometric surface of the Potomac Group aquifer system in the Indian Head area in the early 1960's is shown in figure 19. This map is based on water-level measurements made in the Indian Head area during 1961-62 (Slaughter and Otton, 1968, p. 51) and shows a regional, elongated cone of depression in the potentiometric surface. The cone was roughly centered on well group no. 1 at NOS, and

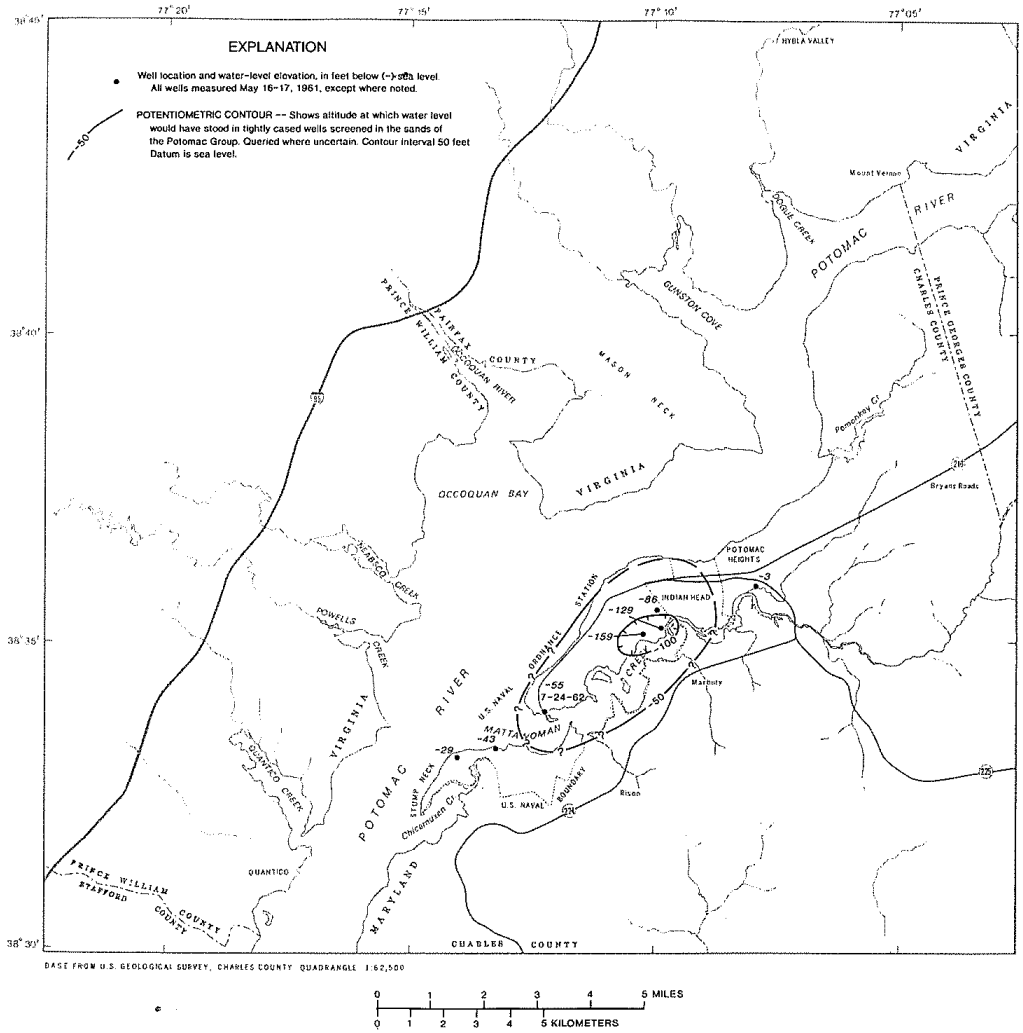


Figure 19. The altitude of the potentiometric surface of the Potomac Group aquifer system in the Indian Head area, 1961-62. (From Slaughter and Otton, 1968, p. 51).

pumping water levels as deep as 159 ft below sea level were measured at the center of the cone.

Figure 20 is a similar map of the potentiometric surface compiled from synoptic water-level measurements made in some of the same wells in the Potomac Group aquifer system during 1989. Although not all of the observation wells measured in 1961-62 were measured during 1989, data were included for several wells drilled after 1962. Comparison of figures 19 and 20 clearly shows the persistence of a regional cone of depression in the potentiometric surface of the Potomac Group aquifer system. The cone is centered on the Indian Head peninsula, extends several miles in all

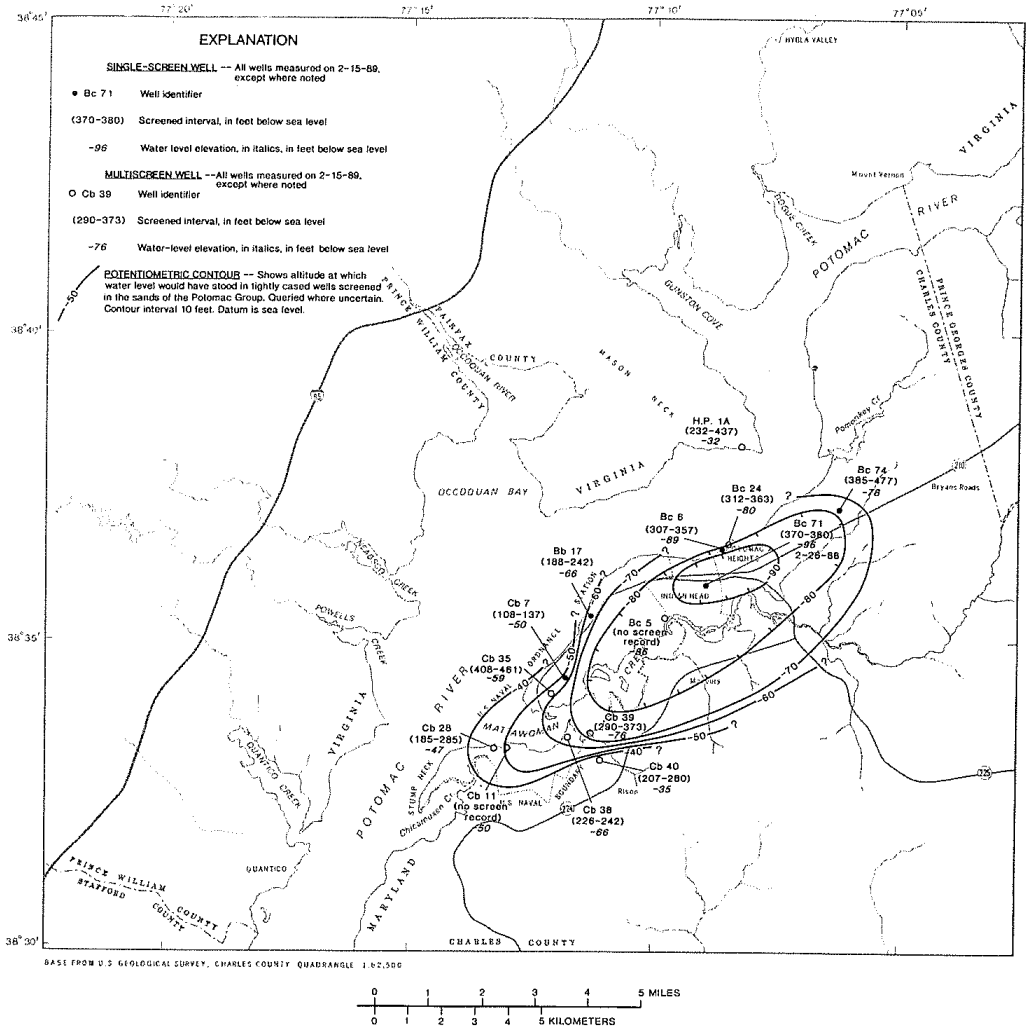


Figure 20. The altitude of the potentiometric surface of the Potomac Group aquifer system in the Indian Head area, 1989.

directions, and probably extends several hundred feet under the Potomac River. The cone of depression is broader and extends farther to the northeast because the hydraulic head in the aquifer system northeast of NOS is lower now than in the 1960's (figs. 19 and 20). Pumping levels greater than 200 ft below sea level were measured again in several production wells in the area during 1990. Ground-water levels in the Stump Neck area and the southwestern end of the Indian Head peninsula (figs. 19 and 20) are still very near the levels measured in the 1960's. This suggests that a recharge boundary (the Potomac River) has been intercepted to the southwest and that ground-water

recharge from the southwest could be in equilibrium with pumping stresses in this area.

In 1960, pumpage from wells at NOS accounted for about 40 percent of the total withdrawals in Charles County (fig. 15) and NOS was the location of the largest pumping stress in the county (fig. 16). By 1980, however, pumpage at NOS was only about 11 percent of the total ground-water withdrawals in the county. Some of the increased pumpage was along the Route 210 corridor to the northeast of NOS (fig. 16), but most of the new withdrawals were in the Waldorf area, about 12 to 15 mi east of the Indian Head area (fig. 1). Thus, the map of the potentiometric surface in the Indian Head area in 1961-62 (fig. 19) shows conditions before the development of pumping stresses in the northwestern and central parts of the county.

In summary, under natural, prepumping conditions, ground-water flow was generally downdip in the aquifers and head gradients were probably favorable for upward leakage from the aquifers to the Potomac River. However, pumpage from the Potomac Group aquifers has altered the natural ground-water-head gradients and reversed the ground-water-flow direction in the aquifer subcrop beneath the river. It appears that, since the development of area ground-water supplies, water from the Potomac River has provided recharge to the Potomac Group aquifer system in the Indian Head area.

GROUND-WATER QUALITY

In the previous section on ground-water flow, the concept of the Potomac Group aquifer system was used to describe, and draw generalizations about, the flow of ground water in the Indian Head area. In areas affected by the pumping stresses of multiscreen wells, the hydraulic-head distribution is similar in Patapsco and Patuxent aquifers. Originally, the natural chemical quality of water in the two aquifers probably differed slightly because of differences in flow paths, aquifer composition and residence times. However, because most production wells in this area have multiple-screen intervals that admit water from different aquifers tapped by the well bore, data are generally unavailable to compare or contrast the variations in natural chemical quality of water between the Patapsco and Patuxent aquifers. Thus, the following sections of the report will focus on the areal extent of water-quality changes in the aquifer system as a whole, as evaluated by analysis of composite samples of water from multiple-screen wells.

Prepumping Water Quality

The natural chemical quality of water in a ground-water system is determined by the types and concentrations of solutes that it contains. In general, the types and concentrations of solutes in ground water reflect the chemical quality of the recharge water, the types and solubilities of minerals in the geologic medium, and the amount of time the water has been in the system.

Water-quality data for the Potomac Group aquifer system prior to development in the Indian Head area are lacking. However, chemical analyses of the water collected from several wells by the USGS in 1937 indicate that the water in the Potomac Group aquifer system was a very soft, sodium bicarbonate type with dissolved-solids concentrations of less than 250 mg/L (Fiedler and others, 1937). Wells CH Bb 1, 5, 6, 8, and 9 were sampled, and the samples were analyzed for bicarbonate concentration. Only the sample from well CH Bb 1 was analyzed to determine the concentrations of the major dissolved ions. Bicarbonate concentrations in the five samples ranged from 139 to 156 mg/L, and the mean concentration was 146 mg/L. The narrow range in bicarbonate concentration suggests that the samples were similar in major-anion chemistry (Fiedler and others, 1937).

In the water from well CH Bb 1, the total hardness (as $CaCO_3$) was 4.5 mg/L; thus, the water would be classified as soft (Heath, 1983, p. 65). Because of the relatively low dissolved-solids concentration (less than 250 mg/L), the water also was relatively unmineralized. The chemical character of the water indicates that sodium and bicarbonate are the major dissolved ions in solution. Concentrations of major inorganic constituents (in mg/L) in the water sample are:

Chemical concentration of major dissolved ions in water from well CH Bb 1, June 12, 1937, in milligrams per liter

Silica (SiO_2)	39	Carbonate (CO_3)	0.1
Iron (Fe)	0.04	Bicarbonate (HCO_3)	156
Calcium (Ca)	.8	Sulfate (SO_4)	9.9
Magnesium (Mg)	.6	Chloride (Cl)	8.0
Sodium (Na)	66	Fluoride (F)	1.2
Potassium (K)	1.7	Nitrate (NO_3)	.18
Total dissolved solids	210	Total hardness ($CaCO_3$)	4.5

Previously published data on the quality of ground water in the Potomac Group aquifer system in the Indian Head area were compiled for this report and are presented in table 8 (at end of report). The data shown in table 8 also include previously unpublished chemical analyses of ground water from the files of the town of Indian Head and NOS. Selected chloride-concentration data from some wells listed in table 8 are presented later in figures 22 and 25.

On the basis of previously collected ground-water-quality data, most water withdrawn from the Potomac Group aquifer system in the Indian Head area has been a relatively soft, unmineralized water that is potable without chemical treatment. Municipal water supplies have customarily been chlorinated, however, to safeguard against possible pathogens. In general, the background or native quality of ground water in the Potomac Group aquifer system in northwestern Charles County is characterized by low (less than 250 mg/L) dissolved-solids concentrations and chloride concentrations less than about 20 mg/L.

Historical well records and water-quality data compiled for this study document several test wells in the Patapsco aquifer that yielded water with objectionably high dissolved-iron concentrations. Several test wells were drilled and abandoned at NOS in the 1970's because of undesirable concentrations of dissolved solids, iron, and chloride.

Changes in Water Quality Since Development

Ground-water quality in the Indian Head area has gradually changed in a zone of the aquifer that is adjacent and parallel to the Potomac River. The chemical quality of water in this zone has changed from the native sodium bicarbonate-type water with a low dissolved-solids concentration (less than 250 mg/L) to a sodium chloride-type water with a comparatively higher dissolved-solids concentration (greater than 500 mg/L). The observed changes are restricted to the western and northwestern, or riverward side, of the Indian Head peninsula. These changes indicate the intrusion of river water, which can have much higher chloride, sodium, dissolved-solids, and organic-carbon concentrations than the native ground water.

Unlike the main body of Chesapeake Bay, which is almost always either brackish or saline, the water in the Indian Head area of the Potomac River varies from fresh to brackish depending primarily on the magnitude of freshwater inflow, which controls the dissolved-solids concentration. Water containing dissolved-solids concentrations less than about 1,000 mg/L is generally considered to be fresh. Concentrations between 1,000 and 10,000 mg/L are considered brackish, whereas water containing more than 10,000 mg/L of dissolved solids is considered saline (Heath, 1983, p. 65).

Typical concentration ranges for selected indicator chemical constituents in the Potomac River and the ground-water system are shown in table 2. The ground-water-quality data were collected as part of this study and the river-water-quality data for the Potomac River were previously collected by USGS personnel. In general, ground water in a zone of the aquifer near the river, has concentrations of river-water indicator constituents that are intermediate between concentrations in the native ground water and those in the Potomac River.

Because of the variable river-water quality and the interaction between the surface-water and ground-water systems, knowledge of the bathymetry, geomorphology, and water-quality characteristics of river-bottom sediments and the Potomac River is necessary in understanding the controls on the location and extent of river-water intrusion. Water in the Potomac River at Indian Head can range from fresh during periods of high streamflow to brackish during extended low-flow periods when saltwater moves upriver from Chesapeake Bay.

Table 2. *Typical concentration range of selected chemical constituents in the ground-water system and the Potomac River*

[mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; >, greater than]

	Chloride, dissolved (mg/L)	Total dissolved solids (mg/L)	Total organic carbon (mg/L)	Sodium, dissolved (mg/L)	Alkalinity, dissolved (mg/L)	Barium, dissolved (µg/L)	Strontium, dissolved (µg/L)
Native ground water	<20	<250	<0.5	50 - 80	100 - 150	< 10	< 10
Ground water near river	100 - 200	>500	1.0 - 5.0	80 - 250	150 - 350	50 - <100	50 - <100
Potomac River water	20 - 1,000	150 - 3,000	2.0 - 8.0	20 - 1,000	>40	100 - 300	100 - 300

Specific conductance is often used as an indicator of the dissolved-solids concentration because the electrical conductivity of water increases with increasing dissolved solute concentrations. The highest specific conductances occur primarily during extended periods of low streamflow in the Potomac River (fig. 21). Daily mean streamflow in the Potomac River at Washington, D.C., and daily mean specific conductance of water in the Potomac River at Indian Head during 1978-81 are shown in figure 21.

Thus, the chloride concentration in the Potomac River estuary near Indian Head can also vary because of extreme meteorologic and climatic events. The chloride concentration in the river decreased from 1,200 mg/L on October 9 to 13 mg/L on October 20, 1954, because of a large inflow of freshwater associated with runoff from a hurricane (Durfor, 1961). During the drought years of 1930-31, the chloride concentration was 3,220 mg/L on November 12, 1930 (Fiedler and Jacob, 1939, p. 50).

Laboratory analytical results for six river-water samples collected in the Potomac River near Indian Head during 1988 are listed in table 9 (at end of report). The locations of the river sampling sites are shown in figure 3. These river-water samples represent the spatial variation in the concentration of the major dissolved inorganic constituents.

From 1977 to 1982, the USGS conducted an interdisciplinary study of the Potomac River estuary. Samples of the river-bottom sediments and the water column were collected for analysis and determination of a number of chemical, physical, biological, and chronological properties and characteristics. A series of twelve 1-meter-long and three 12-meter-long cores of the river-bottom sediments were collected in the estuary near Indian Head. Pore fluids were extracted and analyzed for concentrations of chloride and other selected chemical constituents. Chloride concentrations in pore water averaged about 500 mg/L in the twelve 1-meter-long cores (Goodwin and others, 1984, p. 110), and probably represents the average concentration of chloride in the river water recharging the aquifer system.

Slaughter and Otton (1968, p. 20) stated that because of the pumping-induced hydraulic gradients in the Indian Head area, the ground-water system in the area was at risk from brackish-water intrusion into aquifers extending under the river. They reported that a well located at NOS 75 ft from the river had a chloride concentration of 160 mg/L and was abandoned in 1963. By the early 1970's, water from several wells near the river had elevated chloride and dissolved-solids concentrations.

Chloride concentrations during 1970-75 in water from selected wells in the Indian Head area

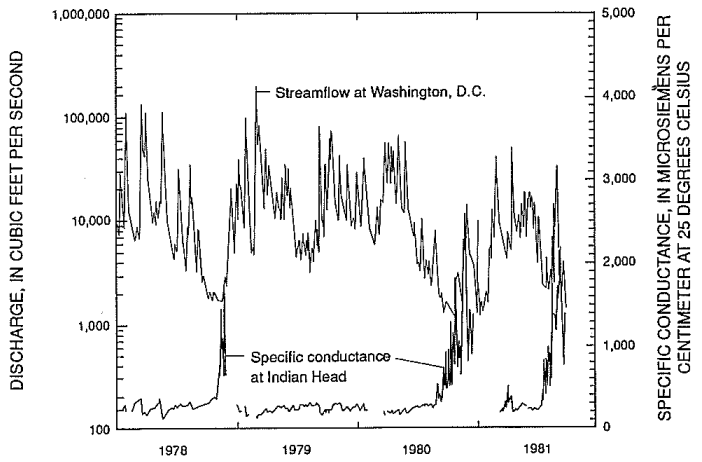


Figure 21. Daily mean streamflow of the Potomac River at Washington, D.C., and daily mean specific conductance of the Potomac River at Indian Head, Md., 1978-81.

are shown in figure 22. The lines on the map connect points of approximately equal chloride concentration. The interpretations are imprecise because of the paucity of data and the extended period over which the concentrations were measured. For the purposes of this map, it is assumed that concentrations of chloride in the ground-water system changed slowly during 1970 to 1975. The lines of equal chloride concentration in figure 22 represent the maximum values measured during the period (table 8).

River water probably began to recharge the aquifer system only after large-scale ground-water withdrawals had reversed the flow direction in the aquifer subcrop. A zone of elevated chloride concentration in ground water adjacent to the river indicates that river water gradually mixed with, or displaced, the native ground water in this part of the aquifer system before the early 1970's. The maximum observed chloride concentration in ground water during 1970-75 was 176 mg/L in a well on the south-western end of the Indian Head peninsula (fig. 22).

The analytical results for ground-water samples collected in 1988 from 26 wells in the Indian Head area are compiled in table 10 (at end of report). The locations of sampling sites are shown in figure 23. Four of the twenty-six wells are water-level observation wells and were sampled only once. The remainder are multiscreen production wells, which were all sampled at least four times. Water samples from all 26 wells were

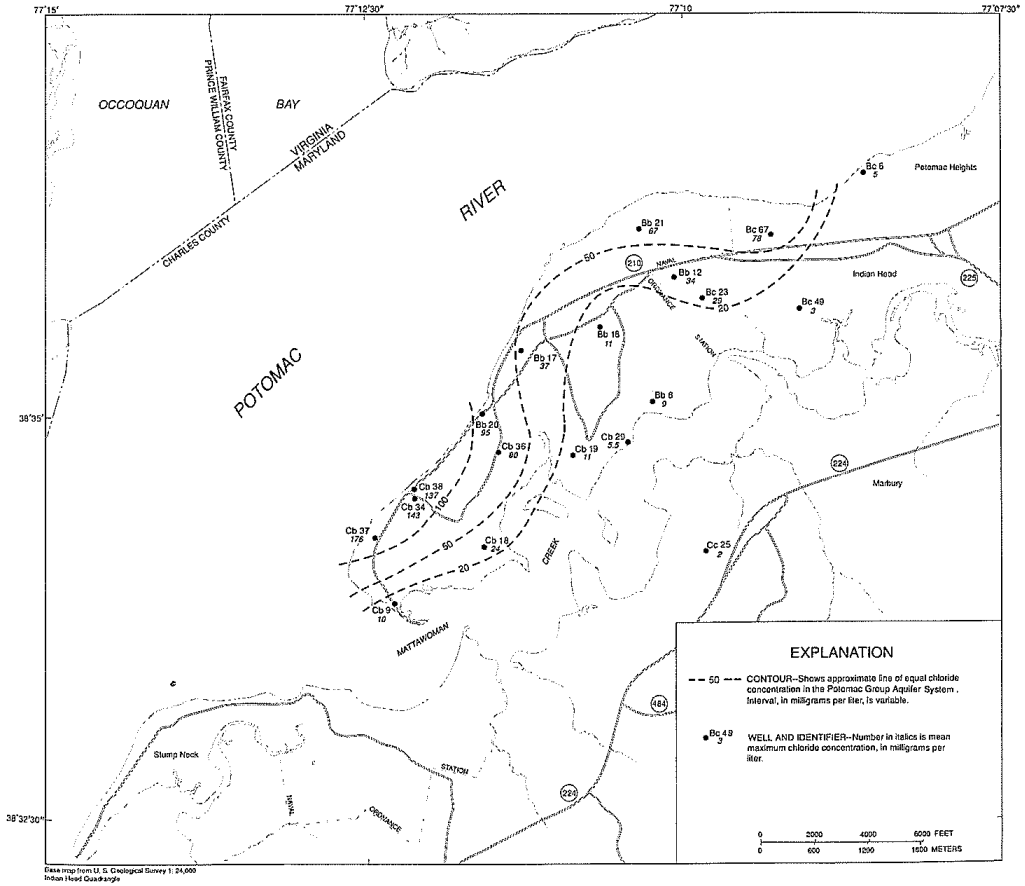


Figure 22. Maximum concentrations of dissolved chloride in water from wells sampled during 1970-75.

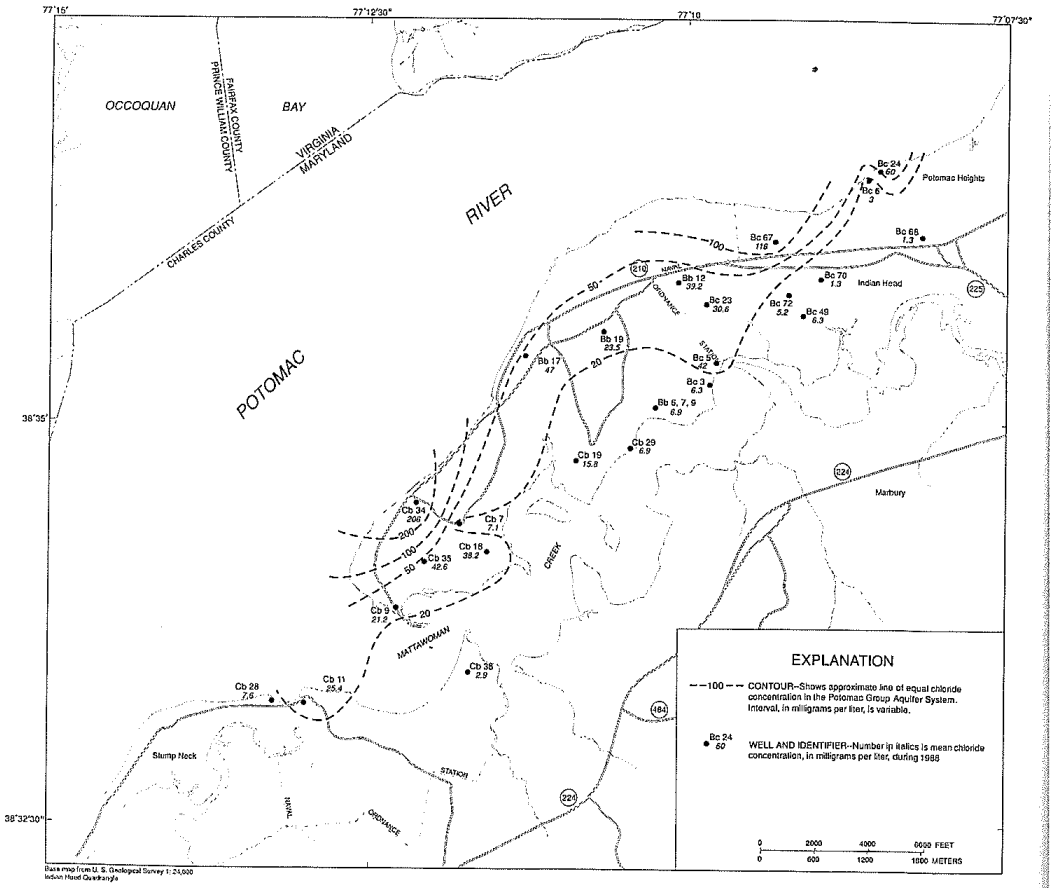


Figure 23. Mean concentrations of dissolved chloride in water from wells sampled during 1988.

analyzed to determine the concentrations of major dissolved inorganic constituents, selected trace elements, and total organic carbon. In addition, samples from 11 selected wells were also analyzed for tritium. Tritium is a radioisotope of hydrogen and has been used for estimating the approximate age of water in ground-water systems.

The statistical distribution and range of concentrations for selected chemical constituents and properties of ground water in the Indian Head area during 1988 are shown in figure 24. The median dissolved-solids concentration was 215 mg/L and the median alkalinity was about 160 mg/L (fig. 24). These concentrations are similar to those measured in well CH Bb 1 in 1937, which indicates that the water in many of the wells still has chemical-constituent concentrations that resemble background conditions.

Relating the median value to the upper and lower quartiles of the concentration distribution for a constituent indicates the skewness of the statistical population. The shape of the box plot depicts the range of concentration values in the various parts of the sample population. The extreme values represent constituent concentrations that are considerably greater, or less, than the rest of the sample population (fig. 24).

In general, most water in the Potomac Group aquifer system is not highly mineralized and is predominantly a sodium bicarbonate type. However, the data indicate elevated river-water indicator constituent concentrations in the water in some wells, particularly sodium, chloride, and dissolved-solids concentrations, which skew these constituent distributions upwards in the plots. Water from production wells CH Cb 34 and CH Bc 67 consistently contains the maximum concentration of the chemical constituents shown in figure 24.

Selected data on chloride concentrations in water from selected wells in the Indian Head area from 1938 to 1988 are summarized in figure 25. Concentrations began to increase in some wells in the mid-1970's, even though no increases were apparent in other wells in the same general area. Two groups are evident on this figure, one with background chloride concentrations clustered in the 1 to 20 mg/L range and one with chloride concentrations substantially elevated above background. The maximum chloride concentration in ground water observed during 1988 was 210 mg/L at well CH Cb 34, which is screened in the Patapsco aquifer from 180 to 202 ft below sea level (table 3). The secondary maximum contaminant level for chloride in drinking water is 250 mg/L; above this concentration, some aesthetic impairment of water quality may be perceived (U.S. Environmental Protection Agency, 1988).

Mean chloride concentrations in water from wells sampled during 1988 are shown in figure 23. Comparison of the lines of equal chloride concentration in figures 22 and 23 generally shows the same zone of elevated concentrations. On both maps, the wells with the highest chloride concentrations are in the same area, along the Potomac River shoreline on the western side of the Indian Head peninsula. Most of these wells are screened in the middle and lower sands of the Patapsco aquifer. The well-screen depths generally range from about 200 to 300 ft below sea level, except for well CH Bc 67, which is screened in the Patuxent aquifer from 458 to 492 ft below sea level (table 3). In most instances where data are available for the same well, the mean chloride concentration in 1988 is greater than the maximum concentration measured in the 1970's (figs. 22 and 23).

Mean concentrations of total dissolved solids in water from wells in the Potomac Group aquifers during 1988 in the Indian Head area are shown in figure 26. The contours represent lines of approximately equal dissolved-solids concentration. The zone of elevated dissolved-solids concentration corresponds generally to the zone of elevated chloride concentration in the aquifer (fig. 23). Because most of the wells are screened at multiple intervals (table 3), it is difficult to determine the precise vertical distribution of water having the elevated concentrations of chloride and dissolved solids. The close proximity of the wells with the highest chloride and dissolved-solids concentrations to the Potomac River indicates that the river is the recharge source for this zone of the aquifer system (figs. 23 and 26). The secondary maximum contaminant level for dissolved

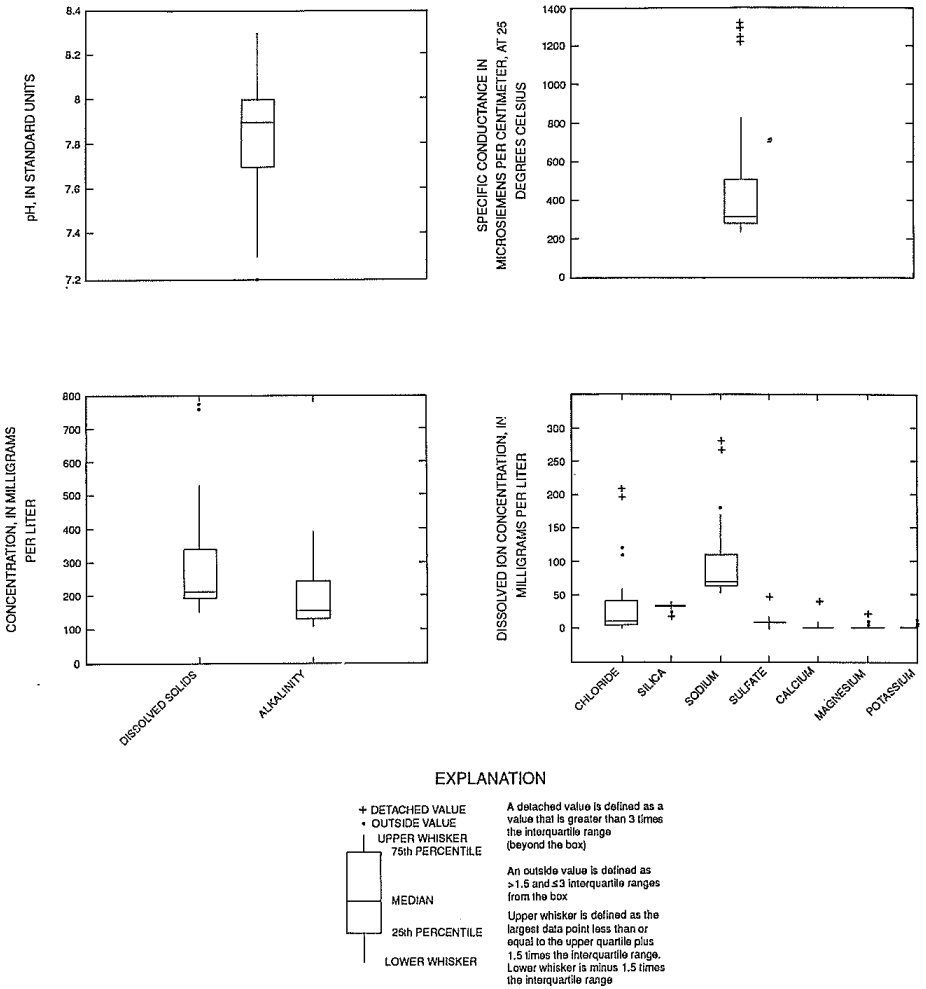


Figure 24. Statistical distributions of concentrations of selected chemical constituents and physical properties of water from 26 wells in the Indian Head area, 1988.

solids in drinking water is 500 mg/L; above this concentration, some aesthetic impairment of water quality can be perceived (U.S. Environmental Protection Agency, 1988).

Boxplots of the concentration of total organic carbon (TOC) in ground water collected during 1988 and TOC in surface water collected by the USGS from the Potomac River at Indian Head during 1975-88 are shown in figure 27. The median TOC concentration in the ground water is less than about 0.5 mg/L, whereas the median concentration in river water is close to 6 mg/L.

Ground water typically has lower organic-carbon concentrations than surface water because (1) the longer residence times of water in the aquifer system allow organic carbon to be adsorbed onto aquifer matrix materials or oxidized to carbon dioxide and water, and (2) the aquifer matrix generally contains only trace amounts of water-soluble organic carbon (Thurman, 1986, p. 15). The source of much of the organic carbon in rivers and streams is the organic carbon derived from plants and soil matter (Thurman, 1986, p. 85). Consequently, the median TOC concentration in the Potomac River near Indian Head is about 10 times greater than the median TOC concentration in water in the Potomac Group aquifer system (fig. 27).

Mean TOC concentrations during 1988 in water from wells in the Potomac Group aquifer in the Indian Head area are shown in figure 28. The lines of equal concentrations delineate locations of approximately equal TOC concentration. The general location and spatial distribution of elevated TOC concentrations in the aquifer correlates well with the spatial distribution and extent of elevated chloride (fig. 23) and dissolved solids (fig. 26) concentrations in the aquifer. In the confined aquifers at Indian Head, TOC concentrations greater than about 1 mg/L indicate the presence of river water (fig. 27).

Chlorination of water with a significant dissolved-organic carbon concentration produces chloroform and other trihalomethanes (THM) and, in the presence of bromide at concentrations greater than about 0.2 mg/L, brominated species of THM become an important fraction of the total THM production (Thurman, 1986, p. 227). The bromide concentration during 1989 in water from area wells ranged from less than 0.010 to 0.49 mg/L (table 8). The water-treatment industry has developed treatment technologies, such as the addition of ammonia, for water supplies containing significant amounts of dissolved organic carbon. Use of ammonia and chlorine during production of finished water supplies reduces the level of THM production due to the formation of chloroamines, which react more slowly than free chlorine with the organic carbon (Thurman, 1986, p. 228).

Tritium is a radioisotope of hydrogen. It decays purely by beta-particle emission and has a half-life of 12.3 years; it is produced naturally, in very small quantities, by cosmic-ray spallation and by interaction of fast neutrons and nitrogen in the upper atmosphere (Thatcher and others, 1977). Tritium is also a product of thermonuclear-weapons testing that occurred primarily during the late 1950's and early 1960's. By 1954, the concentration of the thermonuclear tritium in the atmosphere was significantly greater than the natural concentration (Thatcher and others, 1977, p. 7).

Ground water entering an aquifer after 1952 can be chronologically dated by correlation of tritium concentrations in the ground water with peak concentrations of fallout (Thatcher and others, 1977, p. 7). The dating of ground water originating as recharge before 1952 is based on computations of the radioactive decay of the natural, original tritium concentration in water. Tritium concentration of the Potomac River at the USGS gage at Point of Rocks, Md., 1961-84, is shown in figure 29. Tritium concentrations in the Potomac River during this period peaked around 1963 and have steadily declined since then. To determine the relative age of ground water with elevated chloride concentrations, water samples were collected from 11 wells in the Indian Head area on August 29, 1988, and analyzed for tritium concentrations: wells CH Bb 9, Bb 12, Bb 19, Bc 6, Bc 23, Bc 67, Cb 9, Cb 11, Cb 28, Cb 34, and Cb 35. These wells were selected for sampling because chloride and dissolved-solids concentrations in water from these wells were higher than background concentrations (table 8) or because the wells were near the Potomac River. The well locations are shown in

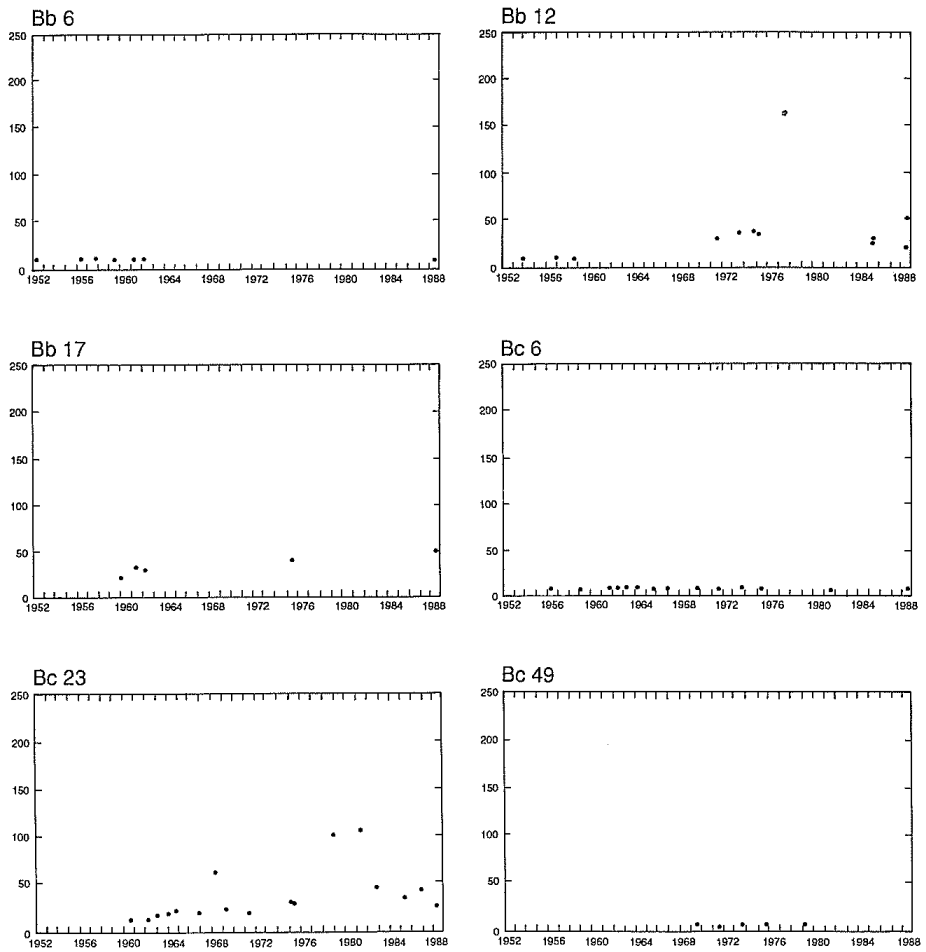


Figure 25. Chloride concentrations in water from selected wells in the Indian Head area, 1938-88.

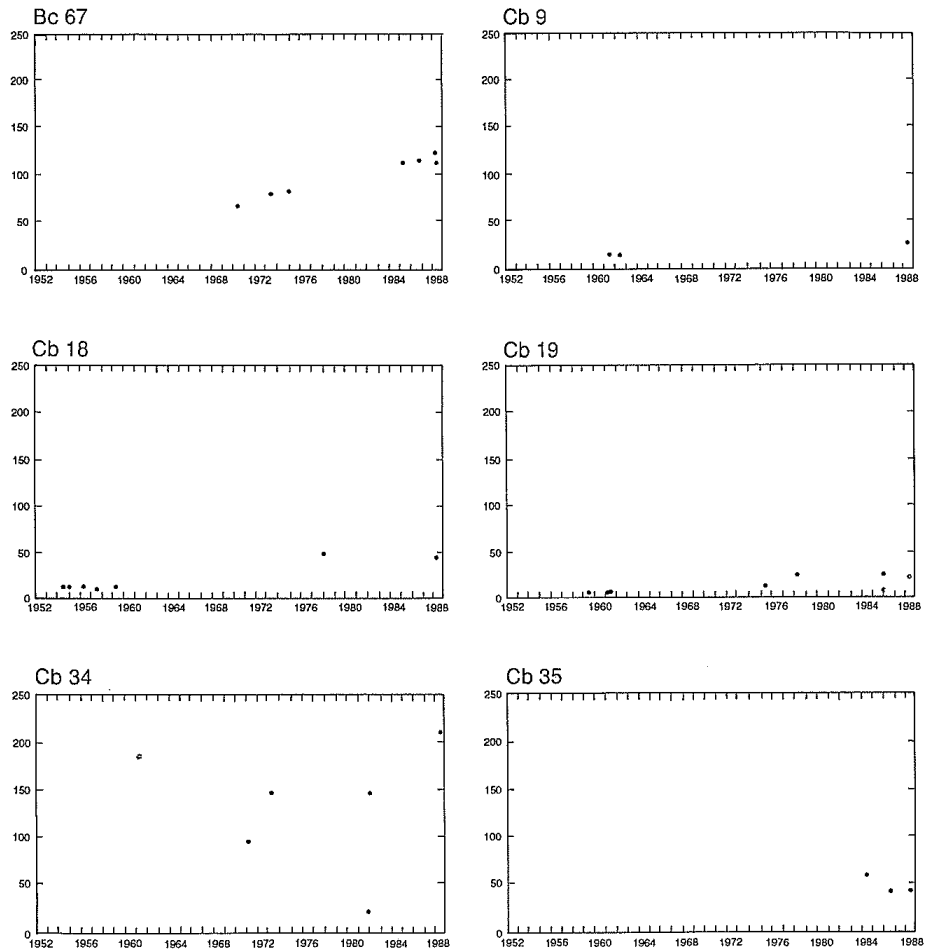


Figure 25. Chloride concentrations in water from selected wells in the Indian Head area, 1938-88--Continued.

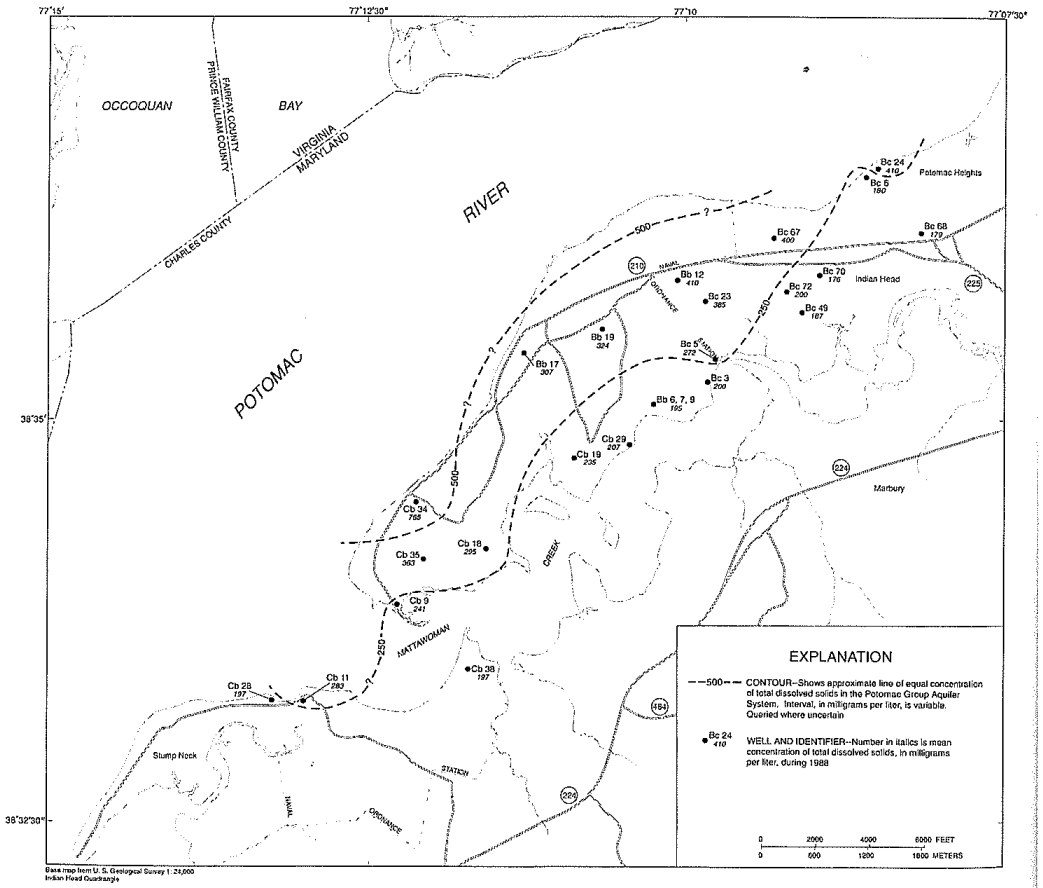


Figure 26. Mean concentration of total dissolved solids in water from wells sampled during 1988.

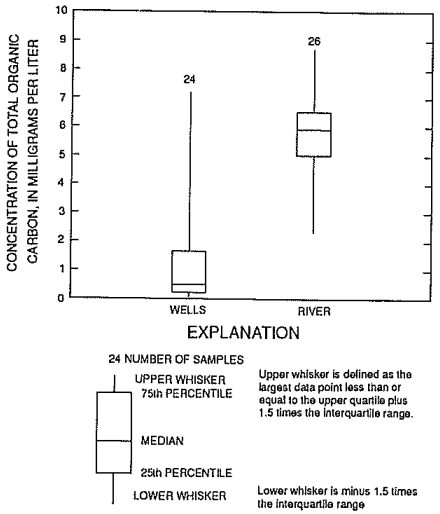


Figure 27. Statistical distribution of concentrations of total organic carbon in water from wells in the Indian Head area during 1988 and in water from the Potomac River at Indian Head during 1975-88.

figures 23, 26, and 28. The tritium concentration in the water from all wells was below the detection limit. This indicates that the high-chloride water withdrawn from these wells in 1988 probably entered the aquifer system before 1952.

On the basis of the low tritium concentrations, the high-chloride ground-water/river-water mixture withdrawn from these wells in 1988 probably entered the aquifer after the regional pumping stresses altered hydraulic gradients (which started the intrusion process), prior to the mid-1950's. Large-scale pumping in this area began about 1920 (fig. 14), and the first evidence of changing ground-water quality was apparent by about 1970 (fig. 22). Therefore, it has taken at least 40 years, and perhaps more than 50 years, for the river water to travel from the point of recharge to the point of discharge at the well. This suggests that even a complete cessation of ground-water withdrawals from the Potomac Group aquifers in the Indian Head area would not have an immediate effect on the spatial distribution and extent of the river-water zone in the ground-water system.

Effects of Erosion of Confining Units

On the basis of borehole data from the Fort McHenry tunnel construction in Baltimore, Md., Chapelle (1985, p. 21) reported that the Pleistocene Patapsco River had eroded and truncated the Arundel Formation in the harbor area. The sediments that were subsequently deposited in the eroded channel were gravel-, sand-, and silt-sized material. Chapelle (1985, p. 67) concluded that the Pleistocene erosional channel provided a conduit for water to leak out of, or into, the underlying Patuxent aquifer because the paleochannel deposit is much more permeable than the Arundel Formation deposits that had been removed. As a consequence of intensive pumping of the Patuxent aquifer near the permeable paleochannel, brackish water intruded the aquifer near the Baltimore industrial area, and, by 1945, a zone of brackish water about 4 mi wide extended into the aquifer near the harbor (Bennett and Meyer, 1952).

In a similar hydrogeologic setting, Phillips (1987) reported that the extent of brackish-water intrusion into the Potomac aquifers in northern Delaware was controlled, in part, by the presence of Pleistocene erosional channels that had truncated aquifer system confining units near centers of large pumping stress. On the basis of core samples from borings in the Delaware River, Phillips (1987) was able to delineate zones where the confining unit in the upper part of the Potomac aquifers had been eroded and replaced by more permeable paleochannel deposits.

Near the Fall Line of Maryland and Virginia, substantial episodes of major erosion and downcutting into the Potomac Group deposits occurred in the vicinity of the Potomac River lowlands. The top of the Patapsco Formation is an erosional surface with local relief greater than 150 ft in the Indian Head area (fig. 10). Hack (1957) and Froelich and others (1978) have shown that, in this area, the ancestral Potomac River incised channels and valleys into the underlying Tertiary and Cretaceous

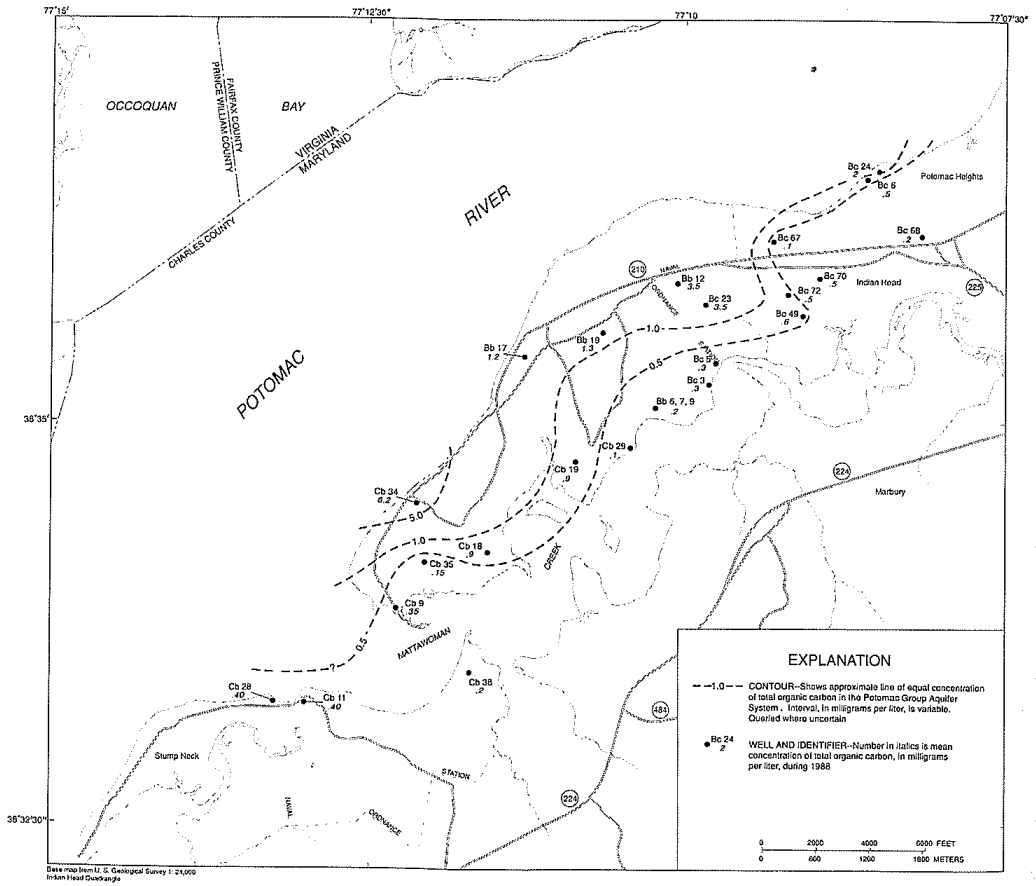


Figure 28. Mean concentration of total organic carbon in water from wells sampled during 1988.

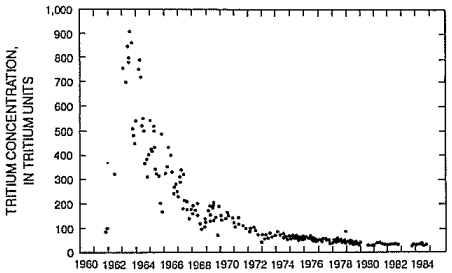


Figure 29. Tritium concentration in water from the Potomac River at Point of Rocks, Md., 1961-84.

sediments that range from 90 to 100 ft below sea level. Knebel and others (1981) have shown that, after the Wisconsinan Potomac River channel was drowned by the rising Holocene sea, it was subsequently filled by sandy and silty fluvial and shallow estuarine sediments.

The contours representing the altitude of the top of the Patapsco Formation (fig. 10) can also be interpreted to represent lines of equal altitude on the base of the paleochannel deposit delineated in the Indian Head area by figure 12. These contours indicate the presence of two erosional channels, cut to different depths, in the Patapsco Formation at Indian Head. This observation supports Hack's (1957, p. 826) earlier conclusion that at least two periods of low sea level were involved in the cutting and filling of drowned tributary valleys of Chesapeake Bay.

The sedimentary framework beneath the Potomac River near Indian Head is not well known. However, a generalized picture of the framework can be constructed using information on paleochannel and modern estuary deposits elsewhere as reported by Froelich and others (1978), Chapelle (1985), and Phillips (1987). During 1978-79, the USGS collected three 12-m-long cores of the river-bottom sediment in the Indian Head area of the Potomac River. The coarse-grained Holocene deposits under the Potomac River near Indian Head are blanketed by a layer of estuarine mud and clay that could function as a confining unit for the underlying deposits. The thickness of the estuarine mud and clay in the cores ranged from 1 m to more than 8 m (Jerry Glenn, U.S. Geological Survey, written commun., 1990).

Dredging operations were conducted in the Potomac River during the mid-1960's at Mattawoman shoal, about 3/4 mi southwest of NOS. The reported depth of dredging was about 21 ft below sea level (fig. 12). Dredging of the river bottom at this shoal could have exposed more permeable deposits at depth under the riverbed; thus, dredging of the Mattawoman shoal could have improved the hydraulic connection between the river and the underlying deposits, possibly increasing the rate of river-water recharge to the confined aquifers in this area.

In 1988, a smaller dredging operation was conducted adjacent to Sweden Point Marina, near the mouth of Mattawoman Creek (fig. 12). This activity could have changed the permeability of the creek bottom. The head difference between the surface-water and ground-water systems is 40 to 50 ft (fig. 20) indicating the potential for downward flow from the creek to the underlying aquifers.

Slaughter and Otton (1968, p. 20) concluded that brackish-water intrusion into the ground-water system had not occurred because the layer of estuarine mud and clay blanketing the river bottom probably had sealed the aquifers from direct contamination by downward movement of river water. However, elevated chloride concentrations were measured in water from several test wells drilled adjacent to the river on the Indian Head peninsula in the mid-1970's (fig. 22).

Most wells that have water with elevated chloride concentrations (fig. 23) are screened in the lower and middle parts of the Patapsco aquifer from about 200 to 300 ft below sea level (table 10). Thus, the elevated chloride concentration in water from well CH Bc 67 (120 mg/L) is anomalous because this well is screened in the deeper Patuxent aquifer, from 458 to 492 ft below sea level (table 3). The elevated concentration of chloride and other river-water indicator constituents in water from well CH Bc 67 indicates that river water is recharging the

Patuxent aquifer in this location, although recharge from a deep source of brackish ground water is not precluded. Similarly, in nearby Mason Neck, Va., a production well (HP 2, see table 4) adjacent to the Potomac River and screened from 400 to 430 ft below sea level yielded water with a chloride concentration of 163 mg/L in 1989 (Craig Cameron, Laboratory Director, Fairfax County Water Authority, written commun. 1990). High-chloride water in the Patuxent aquifer on either side of the river suggests that, in some locations, the Patuxent aquifer is also recharged by downward leakage of river water through overlying deposits.

Well CH Bc 67 is about 1,250 ft south of the Potomac River shoreline (pl. 1) in an area underlain by a paleochannel deposit that fills a valley eroded at least 75 ft below sea level into the Patapsco Formation (figs. 7 and 10). This deposit could be lithologically and hydrologically similar to the paleochannel deposit about 6 mi to the north in Hybla Valley, Va. (Froelich and others, 1978). Well HP 2 is about 1,000 ft north of the river in an area underlain by paleochannel deposits, the base of which ranges from 30 to 80 ft below sea level (Froelich and others, 1978, p. 32-37).

Another possible contributing factor for the elevated chloride concentration in water from well CH Bc 67 is that the axial channel (thalweg) of the modern Potomac River is at least 65 ft to as much as 100 ft deep, and in this area is close to the Maryland shore (fig. 12). This modern deep channel segment is a relatively unburied vestige of the late Wisconsinan Potomac River channel, which was incised during the low stand of sea level associated with the last glacial period.

In the area of Occoquan Bay, to the west of Indian Head (fig. 12), this Wisconsinan channel was subsequently buried by late Pleistocene and Holocene fluvial and estuarine sediments. The 12-meter-long cores collected by the USGS in this area of the estuary provide some rough quantitative knowledge of the type and extent of Holocene and modern estuarine deposits.

In a similar geomorphic region in Delaware, Phillips (1987, p. 26) reported that the vertical hydraulic conductivity of sand and gravel (basal paleochannel deposits) ranged from about 3.8×10^{-4} to 3.3×10^{-2} ft/s. The overlying Holocene deposits in the Delaware River are primarily silt, silty sand, and some gravel and peat. These materials form confining units with vertical hydraulic conductivities that range from 2.9×10^{-10} to 3.3×10^{-5} ft/s (Phillips, 1987, p. 26).

In addition to dredging, large-magnitude floods in the Potomac River can occasionally scour the river bottom in the deep channel near Potomac Heights or in the shoal area of Occoquan Bay (pl. 1). Most surficial river-bottom deposits are estuarine, and consist of organic-rich mud and clay, which could function as a confining unit between the river and the underlying deposits (Slaughter and Otton, 1968, p. 20). Periodic removal or nondeposition of these estuarine river-bottom deposits probably exposes the more permeable paleochannel deposit near the bottom and wall of the modern Potomac River channel (fig. 12). Consequently, the rate of river-water recharge in this part of the estuary could increase if scouring exposes more of the paleochannel deposit below the estuarine mud and clay.

Comparison of the contour values and the zone of ground water with the maximum chemical concentration shown in figures 23, 26, and 28 with the location of the paleochannel deposits shown in figure 12 indicates that the most extensive areas of river-water intrusion at Indian Head are where the paleochannel deposits are contiguous with and adjacent to the Potomac River. The paleochannel deposits are considerably more permeable than the eroded confining units, and the hydraulic connection between the paleochannel deposits and the river would allow substantial river-water inflow in this area. Froelich and others (1978) suggested that pumping of wells drilled into paleochannel deposits contiguous with the Potomac River would probably induce river-water recharge to the aquifer.

SUMMARY AND CONCLUSIONS

This report presents information and data on the hydrogeology of the Coastal Plain deposits in the Indian Head area of northwestern Charles County, Maryland. These data were used to refine the geologic framework of the Potomac Group aquifer system and to estimate the extent of chemical-quality changes in the confined ground-water system in this area. The data are presented in maps and figures that describe the regional hydraulic gradients, chemical quality, and hydrogeologic and stratigraphic framework of the Potomac Group aquifer system. Compilations of data include well characteristics, water-level measurements, and water-quality data for wells in northwestern Charles County, Md., and adjacent areas in Fairfax and Prince William Counties, Va.

Ground-water withdrawals from the Potomac Group aquifer system began in the Indian Head area around 1900. Continual ground-water withdrawals in the Indian Head area during this century, combined with more recent withdrawals immediately to the northeast, have substantially lowered the potentiometric surface of the Potomac Group aquifer system in northwestern Charles County. In 1989, the static water level in the confined aquifers at Indian Head ranged from about 55 to 100 ft below sea level. The cone of depression in the potentiometric surface is roughly centered on the Indian Head peninsula, extends several miles in a northeast-southwest direction, and probably extends a distance of several hundred feet under the Potomac River.

The prepumping water levels in the confined aquifers were above sea level; thus, it is unlikely that the Potomac River was originally a source of recharge to the confined aquifer system. However, continued ground-water withdrawals have altered the natural head gradients and reversed the ground-water-flow direction in the aquifer subcrop area beneath the river. It appears that, during much of this century, water from the Potomac River has provided recharge to the Potomac Group aquifer system in the Indian Head area.

Estimates of the age of the high-chloride ground water, on the basis of low tritium concentrations, indicate that the water withdrawn from wells in 1988 probably recharged the confined aquifer system before 1952. Qualitatively, over the past half century, the river water has gradually mixed with and displaced much of the native ground water in a zone of the aquifer adjacent to the Potomac River shoreline. On a regional scale, a dynamic equilibrium probably exists between the present pumpage which changes slowly from year to year, and the extent and spatial distribution of the river-water zone in 1988. Substantial changes in pumpage magnitude or location can be expected to slowly modify the extent and location of the river-water zone until a new equilibrium is reached.

The specific location of river-water recharge to the confined aquifers is controlled, in part, by the hydraulic gradients, the depth and location of the present-day Potomac River channel, and the type of surficial river-bottom sediment near Indian Head. Another important factor that appears to intensify river-water recharge is the presence of paleo-channel deposits, which fill valleys previously eroded into the underlying Potomac Group aquifer system. There is considerable indirect evidence for preservation of two or more systems of buried channel deposits under and adjacent to the Potomac River estuary or its tributaries in the Indian Head area. The magnitude of river-water recharge to the aquifer system could also be increased in some areas as a result of recent scouring (that is, removal) of low permeability surficial river-bottom deposits by floods or by dredging in the shipping channels.

The background chloride concentration in water in the Potomac Group aquifer system in northwestern Charles County ranges from about 1 to 20 mg/L. In 1988, water in several wells near the Potomac River on the Indian Head peninsula had chloride and dissolved-solids concentrations elevated above background concentrations. The maximum chloride concentration measured in the Potomac Group aquifer system during 1988 was 210 mg/L in water from well CH Cb 34. The

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DATA TABLES

Compiled by Daniel D. Edwards

Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*

[USGS, U.S. Geological Survey; ft asl, feet above sea level; ft, feet; in., inches; ft bls, feet below land surface; gal/min, gallons per minute; hrs, hours; (gal/min)/ft, gallons per minute per foot; <, before; -, no information available]

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-	CH-										
Bb 1	-	U.S. Navy	1899	Cable	29	388	8	0-206	8	206-218	Patapsco
							8	218-331	8	331-345	
							8	345-372	8	372-388	
Bb 2	-	U.S. Navy	1902	Cable	27	409	8	0-207	8	207-226	Patapsco
							8	226-293	8	293-333	
							8	333-369	8	369-390	
Bb 3	-	U.S. Navy	1910	Cable	33	432	8	-	-	-	-
Bb 4	-	U.S. Navy	1910	Cable	34	394	8	0-265	8	265-276	Patapsco
							8	276-312	8	312-323	
							8	323-365	8	365-381	
							8	381-385	8	385-394	
Bb 5	-	U.S. Navy	1910	Cable	43	395	8	0-271	8	271-281	Patapsco
							8	281-320	8	320-332	
							8	332-381	8	381-391	
Bb 6	-	U.S. Navy	1915	Cable	38	398	8	0-251	8	251-261	Patapsco
							8	261-301	8	301-311	
							8	311-376	8	376-397	
Bb 7	-	U.S. Navy	1915	Cable	39	419	8	0-255	8	255-265	Patapsco
							8	265-308	8	308-317	
							8	317-377	8	377-399	
Bb 8	-	U.S. Navy	1915	Cable	36	397	8	0-223	8	223-231	Patapsco
							8	231-262	8	262-273	
							8	273-310	8	310-321	
							8	321-372	8	372-394	
Bb 9	-	U.S. Navy	1915	Cable	32	399	8	0-185	8	185-195	Patapsco
							8	195-235	8	235-245	
							8	245-285	8	285-294	
							8	294-355	8	355-376	

Water level			Yield test							USGS local well no.
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	
1933	102	173	150	-	2.1	D	A, C	A	U.S. Navy; well group no. 1; well no. 1	CH-Bb 1
1945	-	220	-	-	-					
1910	-	-	145	-	-	D	A, C	A	U.S. Navy; well group no. 1; well no. 2	Bb 2
1933	97	129	134	-	4.2					
1944	-	-	70	-	-					
1956	-	-	60	-	-					
1910	-	-	35	-	-	-	-	A	U.S. Navy; well group no. 1; well no. 3; former observation well	Bb 3
1952	184.12	-	-	-	-					
1910	-	-	140	-	-	D	B, C	A	U.S. Navy; well group no. 1; well no. 4	Bb 4
1933	118	167	143	-	2.9					
1944	-	-	80	-	-					
1956	-	-	60	-	-					
1910	-	-	140	-	-	D	A, C	A	U.S. Navy; well group no. 1; well no. 5	Bb 5
1933	116	155	124	-	3.2					
1953	-	-	125	-	-					
1954	-	-	127	-	-					
1956	-	-	115	-	-					
1961	-	-	85	-	-					
1981	138.25	-	-	-	-					
1933	130	199	248	-	3.6	D	B, C	P	U.S. Navy; well group no. 1; well no. 6	Bb 6
1945	-	220	-	-	-	E				
1953	-	-	100	-	-					
1956	-	-	90	-	-					
1959	146	212	-	-	-					
1960	-	-	100	-	-					
1981	-	-	50	-	-					
1933	134	196	154	-	2.5	D	A, C	P	U.S. Navy; well group no. 1; well no. 7	Bb 7
1945	-	-	120	-	-	E				
1953	-	-	120	-	-					
1956	-	-	120	-	-					
1960	-	-	117	-	-					
1961	-	-	95	-	-					
1980	-	-	90	-	-					
1933	127	173	212	-	4.6	D	B, C	A	U.S. Navy; well group no. 1; well no. 8	Bb 8
1945	-	-	155	-	-	E				
1953	-	-	80	-	-					
1956	-	-	100	-	-					
1960	178	226	-	-	-					
1981	120	-	-	-	-					
1933	134	150	126	-	7.9	D	A, C	P	U.S. Navy; well group no. 1; well no. 9	Bb 9
1945	-	-	110	-	-	E				
1953	-	-	95	-	-					
1956	-	-	110	-	-					
1960	150	246	110	-	-					

EXPLANATION OF CODES

Well-log codes:
C, caliper
D, descriptive
E, electric
G, gamma
O, other

Chemical analyses reference codes:
A, Otton (1955)
B, Slaughter and Laughlin (1966)
C, Weigle and Webb (1970)
D, Woll (1978)
E, office files, USGS, Towson, Md.

Well status or use codes:
A, abandoned
D, domestic
I, industrial
O, observation
P, public supply
T, test hole

Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-Bb 10	CH- -	U.S. Navy	1920	Cable	26	1,200	-	-	-	-	-
Bb 11	11906	U.S. Navy	1952	Cable	82	542	8 8	1-263 279-347	8	263-279 347-378	Patapsco
Bb 12	13284	Town of Indian Head	1953	Rotary	95	515	10 10 10	2-238 245-248 260-288	10 10	238-245 248-260 288-298	Patapsco
Bb 13	14260	U.S. Navy	1953	Rotary	19	456	-	-	-	-	-
Bb 14	11907	U.S. Navy	1952	Cable	29	452	8 8 8	0-209 234-336 350-437	8 8 8	209-234 336-350 437-452	Patapsco
Bb 15	21710	U.S. Navy	1955	Rotary	29	600	-	-	-	-	-
Bb 16	22351	U.S. Navy	1956	Rotary	52	600	-	-	-	-	-
Bb 17	-	U.S. Navy	1957	Rotary	52	330	16 10	0-230 230-240	10	240-294	Patapsco
Bb 18	710023	U.S. Navy	1970	Rotary	88	405	6	0-320	6	320-360	Patapsco
Bb 19	720122	U.S. Navy	1972	Rotary	90	405	20 12	0-250 250-270	12	270-380	Patapsco
Bb 20	710057	U.S. Navy	1971	Rotary	50	408	6	0-199	6	199-224	Patapsco
Bb 21	710021	U.S. Navy	1970	Rotary	115	405	6	0-200	6	200-230	Patapsco
Bb 22	880847	U.S. Navy	1989	Rotary	98	700	2	0-200 205-220	2	200-205	Patapsco
Bc 1	-	U.S. Navy	1918	Cable	14	396	-	-	-	-	-
Bc 2	-	U.S. Navy	1918	Cable	17	409	8	-	-	-	-

Water level			Yield test							USGS local well no.
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	
-	-	-	-	-	-	D	-	A	U.S. Navy; well group no. 1; well no. 15A; test hole drilled to basement	CH-Bb 10
1952	156.96	-	25	-	-	D	-	A	U.S. Navy; well no. 20	Bb 11
1953	149	203.5	220	8	4.0	D	E	P	Owner's well no. 1	Bb 12
-	-	-	-	-	-	D	E	A	U.S. Navy; well no. 6; test hole	Bb 13
1952	159	340	128	24	.7	D	A, C	A	U.S. Navy; well group no. 1; well no. 1A	Bb 14
1955	195	-	25	4	-	D	C	A	U.S. Navy; well no. 13; test hole D	Bb 15
1956	100	-	300	4	-	D	A,C	A	U.S. Navy; well no. 23A; test hole E	Bb 16
1957	105	-	500	24	-	C, D	B, D	O	U.S. Navy; well no. 23B; observation well, May 1988 to present	Bb 17
1960	-	-	450	-	-	G	E			
1963	200	-	-	-	-					
1970	128	227	226	24	2.3	D, E	E	A	Matz-Childs & Assoc.; test well no. 2; aquifer-test results available	Bb 18
1972	150	248	500	24	5.1	D, E	E	P	U.S. Navy; well no. 2A	Bb 19
1971	83	182	250	24	2.5	D	-	A	Matz-Childs & Assoc.; test well no. 3A	Bb 20
1970	150	199	100	24	2.0	D, E	E	A	Matz-Childs & Assoc.; test well no. 4; aquifer-test results available	Bb 21
1990	130	-	-	-	-	C, D, E, G, O	-	O	Continuous core drilled by USGS	Bb 22
1933	-	-	86	-	6.6	-	-	A	U.S. Navy; well group no. 2; well no. 10	Bc 1
1952	152	-	-	-	-					
1961	133	-	-	-	-					
1981	81	-	-	-	-					
1933	-	-	100	-	-	-	B, D	A	U.S. Navy; well group no. 2; well no. 11; water-level records for the period 1961-75; well sealed Nov. 20, 1975	Bc 2
1938	-	-	132	-	10.2	-	E			
1942	124	-	-	-	-					
1953	-	-	100	-	-					
1956	-	-	100	-	-					

EXPLANATION OF CODES

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Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-Bc 3	CH- -	U.S. Navy	1918	Cable	19	390	8	-	-	-	-
Bc 4	-	U.S. Navy	1918	Cable	33	393	8	-	-	-	-
Bc 5	-	U.S. Navy	1918	Cable	39	430	8	-	-	-	-
Bc 6	-	Potomac Heights Mutual Home Owners Association	1941	Rotary	65	417	18 8	0-350 350-362	8	362-412	Patapsco
Bc 7	-	R.L. Teates	1939	Cable	-	290	3	-	-	-	-
Bc 8	-	E.G. Dodd	1917	Cable	38	90	3	-	-	-	-
Bc 9	-	Harry N. Rees	<1938	Cable	125	-	-	-	-	-	-
Bc 10	-	Louise Brown	1919	Dug	125	39	36	-	-	-	-
Bc 11	-	-	-	Dug	20	13	-	-	-	-	-
Bc 1	4720	Ford's Wonder Bar	1949	Rotary	156	234	6	0-228	-	-	-
Bc 13	8452	Aubry W. Posey	1951	Cable	130	260	6	0-260	-	-	-
Bc 14	8742	John W. Jenkins	1952	Cable	170	500	6	0-500	-	-	-
Bc 15	11904	U.S. Navy	1952	Cable	77	258	8 8	0-242 250-258	8	242-250	Patapsco
Bc 16	11905	U.S. Navy	1952	Cable	80	450	8	-	8	345-361	Patapsco
Bc 17	11905	U.S. Navy	1952	Cable	73	450	8 8	0-345 361-450	8	345-361	Patapsco
Bc 18	-	Edward Taylor	1940	-	145	267	6	-	-	-	-

Water level			Yield test							USGS local well no.
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	
										CH-
1938	-	-	242	-	4.7	-	A, D	P	U.S. Navy; well group	Bc 3
1953	-	-	133	-	-			E	no. 2; well no. 12	
1956	-	-	120	-	-					
1960	-	251	115	-	-					
1968	-	-	87	-	-					
1938	-	-	304	-	4.9	-	-	A	U.S. Navy; well group	Bc 4
1952	67.2	-	-	-	-				no. 2; well no. 13	
1953	-	-	100	-	-	C, G	A, D	O	U.S. Navy; well group no. 2;	Bc 5
1956	-	-	120	-	-		E		well no. 14; observation	
1960	-	234	130	-	-				well, May 1988 to present	
1941	-	-	385	-	6.0	D	B, D	P	Owner's well no. 1	Bc 6
1945	174.5	238.5	-	-	-		E			
1960	104	250	365	-	2.5					
-	-	-	-	-	-	-	-	-	Well supplied 19 homes in 1946; location unknown	Bc 7
-	-	-	-	-	-	-	-	A	Well supplied 12 homes in 1946	Bc 8
-	-	-	-	-	-	-	-	A		Bc 9
1946	30	-	-	-	-	-	-	A	Observation well from Nov. 1946 through Dec. 1952	Bc 10
1947	10.5	-	-	-	-	-	-	A		Bc 11
1949	125	160	12	3	.3	D	A	-		Bc 12
1951	120	140	10	3	5.0	D	-	-		BC 13
1952	120.5	-	-	-	-					
1952	190	250	12	-	.2	D	-	-		Bc 14
1952	120.12	-	-	-	-	D	D	A	U.S Navy; well no. 22;	Bc 15
1961	128.05	-	-	-	-				abandoned test well	
-	-	-	-	-	-	-	-	A	U.S. Navy; well no. 23; replaced by well no. 21; well sealed	Bc 16
1961	158.54	-	-	-	-	D, G	-	A	U.S. Navy; well no. 21;	Bc 17
1981	138.01	-	-	-	-				replaced CH Bc 16; water-level data from 1960 through 1985	
-	125	200	18	18	.2	-	-	D		Bc 18

EXPLANATION OF CODES

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Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-Bc 19	CH- -	Cliff Pierce	1952	Dug	12	16	36	-	-	-	-
Bc 20	6962	K. Raby	1952	Jetted	125	284	3	0-265	-	-	-
Bc 21	21711	U.S. Navy	1956	Rotary	58	600	-	-	-	-	-
Bc 22	41840	H. Milman	1961	Rotary	145	281	4 2	0-252 252-271	2	271-281	Patapsco
Bc 23	30288	Town of Indian Head	1958	Rotary	65	352	16 10 8 8 8	0- 60 0-228 250-262 270-280 292-305	8 8 8 8	229-250 262-270 280-292 305-311	Patapsco
Bc 24	20874	Potomac Heights Mutual Home Owners Association	1955	Rotary	72 10	446	10 10	0-384 399-415	10 10	384-399 415-435	Patapsco
Bc 25	22540	B. Hancock	1956	Cable	22	255	6	0-251	-	-	-
Bc 26	30031	M. Kirkland	1958	Cable	80	223	6	0-222	-	-	-
Bc 27	15410	F. Moody	1954	Cable	72	388	4	0-388	-	-	-
Bc 28	10744	M. Wheeler	1952	Cable	152	342	5	0-333	5	333-342	Patapsco
Bc 29	13628	J. Warder	1953	Rotary	172	442	4 2 2 2	0-210 215-383 388-423 428-441	2 2 2	210-215 383-388 423-428	Patapsco
Bc 30	8566	R. Lewis	1951	Cable	23	237	6	0-232	-	-	-
Bc 31	12872	J. Ely	1953	Cable	33	293	6	0-283	-	283-293	Patapsco
Bc 32	25315	J. Ely	1956	Rotary	33	321	4 2	0-278 288-307	4 2	278-288 307-312	Patapsco
Bc 33	35668	D. Gelzer	1959	Rotary	80	421	4 2	0-195 195-411	2	411-421	Patapsco
Bc 34	-	D. Gelzer	1954	Dug	75	26	20	0- 26	-	-	-
Bc 3	24943	D. Gelzer	-	Dug	78	25	48	-	-	-	-
Bc 36	24943	A. Teske	1956	Rotary	121	275	4 2	0-250 250-270	2	270-275	Patapsco
Bc 37	12170	M. Johnson	1953	Cable	122	260	6	0-256	6	256-260	Patapsco

Water level			Yield test							USGS local well no.
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	
1952	8.72	-	-	-	-	-	-	D		CH-Bc 19
1952	118	125	5	6	0.7	D	-	D		Bc 20
1956	150	-	25	4	-	D	-	A	U.S. Navy; test hole C	Bc 21
1961	145	220	20	4	.3	D	D	D		Bc 22
1958	141	206	240	24	3.7	D	E	P	Owner's well no. 2; aquifer-test results available	Bc 23
1955	122	135	250	4	19.2	D, G	E	O	Owner's well no. 2; observation well May 1988 to present	Bc 24
1956	55	150	10	7	.1	D	-	-		Bc 25
1958	83	120	15	4	.4	D	-	-		Bc 26
1954	70	80	6	15	.6	D	-	-		Bc 27
1952	132	135	16	12	5.3	D	-	-		Bc 28
1953	97	160	4.5	6	.1	D	-	-		Bc 29
1951	48	100	20	8	.4	D	-	-		Bc 30
1953	110	140	30	10	1.0	D	-	A		Bc 31
1956	90	225	30	4	.2	D	-	A		Bc 32
1959	110	170	12	4	.2	D	-	-		Bc 33
1960	105.39	-	-	-	-					
1960	18.51	-	-	-	-	-	-	A		Bc 34
1960	20.66	-	-	-	-	-	-	A		Bc 35
1956	125	205	13	4	.2	D	-	-		Bc 36
1953	105	160	13	4	.2	D	-	D		Bc 37

EXPLANATION OF CODES

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Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH- Bc 38	CH- 33724	J. Scomoni	1959	Rotary	122	486	4 2 2 2	0-274 269-275 280-476 481-486	2 2	275-280 476-481	Patapsco
Bc 39	33286	R. Jenkins	1959	Rotary	120	491	4 2	0-230 224-486	2	486-491	Patuxent
Bc 40	37153	M. Bowie	1959	Rotary	125	480	4 2	0-252 240-470	2	470-480	Patuxent
Bc 41	31974	Bessenyey	1958	Cable	50	281	6	0-263	6	263-281	Patapsco
Bc 42	13831	Bragunier	1954	Rotary	160	547	4 2 2 2 2	0-210 210-212 217-391 396-514 519-535	2 2 2 2	212-212 391-396 514-519 535-540	Patapsco
Bc 43	-	-	-	Dug	172	35	20	0-35	-	-	-
Bc 44	15286	Green Meadows Water Co.	1954	Rotary	172	612	4 2 2	2-410 410-580 595-612	2	580-595	Patuxent
Bc 45	17128	Green Meadows Water Co.	1954	Rotary	175	590	4 2	0-320 320-580	2	580-590	Patuxent
Bc 46	19008	J. Jenkins	1955	Rotary	182	639	4 2	0-332 325-639	2	-	-
Bc 47	-	C. Branson	-	Dug	38	10	24	0-10	-	-	-
Bc 48	-	J. Morton	1942	-	22	19	-	0-19	-	-	-
Bc 49	28980	Town of Indian Head	1958	Cable	33	404	8 8 8	0-340 350-355 365-384	8 8 8	340-350 355-365 384-404	Patapsco
Bc 50	41917	Gilbert Hyatt, Jr.	1961	Jetted	35	184	2	0-147	1 1	169-184 147-169	Patapsco
Bc 51	44247	St. Mary's Star of the Sea	1961	Rotary	172	637	4 2	0-344 344-618	3	618-637	Patuxent
Bc 52	43258	D. Ford	1961	Cable	157	431	6	0-421	6	421-431	Patapsco
Bc 53	44383	Dr. Frank Susan	1961	Rotary	78	331	4 2	2-296 296-317	2	317-321	Patapsco
Bc 54	44629	E. Jenkins	1961	Rotary	184	635	6 4	0-256 239-620	4	620-635	Patuxent
Bc 55	45048	F. Zihlman	1962	Rotary	145	535	4 2	0-325 295-523	3	523-534	Patapsco

Water level			Yield test							USGS local well no.
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	
1959	120	220	20	4	0.2	D	-	D		CH-Bc 38
1959	127	210	12	4	.1	D	-	D		Bc 39
1959	130	160	18	4	.6	D	-	D		Bc 40
1958	60	170	70	8	.6	D	-	D		Bc 41
1954	93	140	5	4	.1	D	-	-		Bc 42
1960	23	-	-	-	-	-	-	-		Bc 43
1954	160	180	10	4	.5	D	-	-		Bc 44
1954	156	182	10	4	.6	D	-	-		Bc 45
1955	170	245	30	4	.4	D	-	-		Bc 46
1960	6	-	-	-	-	-	-	-		Bc 47
1960	10	-	-	-	-	-	-	-		Bc 48
1958	52	160	190	48	1.8	D	E	P	Owner's well no. 6; Woodland Village well no. 2	Bc 49
1961	50	68	7	10	.4	D	-	-		Bc 50
1961	190	230	30	4	.8	D	-	-		Bc 51
1961	170	250	20	3	.3	D	-	-		Bc 52
1961	84	106	15	4	.7	D	-	-		Bc 53
1961	90	400	35	4	.1	D	-	-		Bc 54
1962	155	250	20	6	.2	D	-	P		Bc 55

EXPLANATION OF CODES

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							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-	CH-										
Bc 56	44738	B. Wright	1961	Rotary	160	388	4 2	0-253 253-378	2	378-388	Patapsco
Bc 57	48471	M. Sansbury	1962	Rotary	12	199	2	2-194	2	194-199	Patapsco
Bc 58	48472	D. Cane	1962	Rotary	13	205	2	0-200	2	200-205	Patapsco
Bc 59	48473	R. Thompson	1962	Rotary	12	188	2	2-183	2	183-188	Patapsco
Bc 60	36323	G. Thompson	1959	Rotary	90	438	4 2	0-196 186-428	2	428-438	Patapsco
Bc 61	56515	Potomac Heights Mutual Home Owners Association	1964	Rotary	70	875	4 2	0-246 246-439	2	439-444	Patapsco
Bc 62	660049	Potomac Heights Mutual Home Owners Association	1966	Rotary	50	540	6 6 6	0-414 424-444 464-494	6 6 6	414-424 444-464 494-514	Patapsco
Bc 63	660049	Potomac Heights Mutual Home Owners Association	1966	Rotary	48	470	6	0-144	6	144-174	Patapsco
Bc 64	660049	Potomac Heights Mutual Home Owners Association	1966	Rotary	48	540	6 6 6	0-414 424-444 464-494	6 6 6	414-424 444-464 494-514	Patuxent
Bc 65	660043	Jenkins Lane Water Company	1966	Rotary	176	622	6 4	0-434 420-589	4	589-619	Patuxent
Bc 66	720028	Pomonkey Water Company	1971	Rotary	155	648	6 4	0-430 420-618	4	618-639	Patuxent
Bc 67	720053	Town of Indian Head	1971	Rotary	30	522	10 5 5	0-410 410-488 498-511	5 5	488-498 511-522	Patuxent
Bc 68	670051	Potomac Heights Mutual Home Owners Association	1967	Rotary	75	540	20 8 8 8	0-381 359-414 424-444 464-494	8 8 8	414-424 444-464 494-514	Patuxent
Bc 69	732078	Town of Indian Head	1978	Rotary	68	619	-	-	-	-	-

Year	Water level: Static (ft bls)	Water level: Pumping (ft bls)	Yield test: Pumping rate (gal/min)	Yield test: Duration (hrs)	Yield test: Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
1961	168	228	15	4	0.3	D	-	D		CH-Bc 56
1962	18.6	60	20	4	.5	D	-	D		Bc 57
1962	23	70	17	5	.5	D	-	D		Bc 58
1962	10	65	20	6	.4	D	-	-		Bc 59
1959	100	-	18	4	-	D	-	-		Bc 60
1964	122	-	6	48	-	D, E G	-	A	Test well; sealed	Bc 61
1966	125	250	200	8	1.6	D	E	-		Bc 62
1966	88	160	55	16	.8	D	-	A	Test well; sealed	Bc 63
1966	125	250	200	8	1.6	D	-	A	Test well for CH Bc 68; sealed	Bc 64
1966	192	220	24	8	.9	D	-	-		Bc 65
1971	190	206	43	12	2.7	D	-	-		Bc 66
1971	102	181	300	24	3.8	D	E	P	Owner's well no. 3; aquifer-test results available	Bc 67
1967	148	288	517	24	3.7	D	E	P	Owner's well no. 3	Bc 68
1978	-	-	-	-	-	E, G	-	A	Test hole	Bc 69

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							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-	CH-										
Bc 70	732329	Town of Indian Head	1979	Rotary	35	483	8 8	0-372 392-412	8 8	372-392 412-442	Patapsco
Bc 71	732415	Town of Indian Head	1979	Rotary	30	440	2	0-400	2	400-410	Patapsco
Bc 72	810922	Town of Indian Head	1984	Rotary	34	500	12 6 6 6 6	0-220 220-224 254-284 304-334 347-360	6 6 6	224-254 284-304 334-347	Patapsco
Bc73	710022	U.S. Navy	1970	Rotary	55	408	-	-	-	-	-
Bc 74	812919	Montrose Height Subd.	1988	Rotary	165	748	4 2 2 2 2	0-435 435-550 566-574 589-637 642-748	2 2 2	550-566 574-589 637-642	Patuxent
Bd 1	-	Pomonkey Elementary School	1945	Cable	180	292	8 6	-	-	-	-
Bd 2	-	J. W. Key	1898	Dug	180	25	36	0- 25	-	-	-
Bd 3	-	W. H. Thompson	-	Dug	187	24	36	-	-	-	-
Bd 4	-	Pearl Mason	-	Dug	180	20	32	-	-	-	-
Bd 5	-	J. W. Clark	1920	Dug	180	18	32	-	-	-	-
Bd 6	-	-	-	Dug	170	9	43	-	-	-	-
Bd 7	-	N. Robie	<1940	Dug	180	30	42	-	-	-	-
Bd 8	-	N. Robie	1929	Dug	183	26	36	-	-	-	-
Bd 9	-	Mitchel	<1935	Dug	200	20	36	-	-	-	-
Bd 10	-	-	-	Dug	200	19	-	-	-	-	-
Bd 11	6963	Pomonkey Elementary School	1950	Cable	180	269	6	0-259	6	259-269	Magothy
Bd 12	-	John H. Mulholland Corp.	-	-	140	-	-	-	-	-	-
Bd 13	7257	P. Pfisterer	1951	-	140	200	6	0-179	-	-	-

Water level			Yield test							USGS local well no.
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	
1979	80	306	96	24	0.4	D, E G	E	P	Owner's well no. 4	CH-Bc 70
1979	82	250	17	5	.1	D, E	-	-	Observation well Sept. 1981 to present	Bc 71
1984	96	156	160	24	2.7	D, E	E	P	Owner's well no. 5; Woodland Village no. 2	Bc 72
-	-	-	-	-	-	D, E	-	A	Matz, Childs & Assoc.; Test well no. 3; sealed	Bc 73
1988	-	256	53	24	2.1	D,G	-	T		Bc 74
-	-	-	-	-	-	-	-	P		Bd 1
1946	20	-	-	-	-	-	-	-		Bd 2
1946 1960	18 15	-	-	-	-	-	-	D		Bd 3
1946 1960	15 15	-	-	-	-	-	-	D		Bd 4
1946	13.4	-	-	-	-	-	-	-	Observation well Nov. 1946 through Oct. 1947	Bd 5
1947	3.2	-	-	-	-	-	-	-	Site of old Benfield Schoold	Bd 6
-	-	-	-	-	-	-	-	-		Bd 7
1947	18	-	-	-	-	-	-	-		Bd 8
1945	18	-	-	-	-	-	-	-		Bd 9
1947	13.6	-	-	-	-	-	-	-		Bd 10
1950	150	210	25	8	.4	D	-	P		Bd 11
1950	-	-	17	-	-	-	-	-	Spring	Bd 12
1951	47	198	3	-	.1	D	-	D		Bd 13

EXPLANATION OF CODES

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Well status or use codes:
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Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-Bd 14	CH-Oil & Gas 8	J. H. Willett	1954	Cable	192	1,177	8	-	-	-	Patuxent
Bd 15	14997	U.S. Army Corps of Engineers	1954	Cable	205	334	6	0-324	6	324-334	Aquia
Bd 16	16856	Indian Head Manor	1954	Rotary	180	506	4 2 2 2	0-338 329-412 422-454 459-506	2 2	412-422 454-459	Patapsco
Bd 17	16857	Indian Head Manor	1954	Rotary	170	460	4 2 2	0-297 288-411 416-455	2 2	411-416 455-460	Patapsco
Bd 18	22911	Indian Head Manor	1956	Rotary	178	673	6 4	0-404 390-662	4	662-673	Patuxent
Bd 19	17938	E. Dutton	1955	Rotary	165	640	4 2	0-300 293-629	2	629-640	Patapsco
Bd 20	32983	A. Branning	1958	Rotary	12	224	2	0-219	2	219-224	Patapsco
Bd 21	-	-	-	Dug	178	13	20	-	-	-	-
Bd 22	21161	S. Hampton Village	1956	Rotary	175	651	6 4	0-352 344-627	4	627-644	Patuxent
Bd 23	26304	Pomonkey High School	1957	Cable	173	270	8	0-252	8	252-270	Patapsco
Bd 24	14669	A. Lund	1954	Rotary	178	301	4 2 2 2	0-238 238-243 248-258 268-299	2 2	243-248 258-268	Patapsco
Bd 25	30448	A. Lund	1958	Rotary	178	301	4 2 2 2	0-229 229-240 245-257 267-301	2 2	240-245 257-267	Patapsco
Bd 26	-	-	-	Dug	175	24	36	-	-	-	-
Bd 27	-	E. Jones	1950	Dug	195	17	20	-	-	-	-
Bd 28	43458	USGS	1961	Augered	185	58	4	-	-	-	-
Bd 29	42481	N. Indian Head Estates	1961	Rotary	170	626	6 4 4	0-445 445-570 620-626	4	570-620	Patuxent
Bd 30	44610	R. Speake	1961	Rotary	175	672	4 2	2-293 293-656	2	656-671	Patuxent

Year	Water level: Static (ft bls)	Water level: Pumping (ft bls)	Yield test: Pumping rate (gal/min)	Yield test: Duration (hrs)	Yield test: Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
1962	190.8	-	-	-	-	D	-	T	Oil and gas test hole	CH-Bd 14
1954	170	300	25	24	0.2	D	B, C D	P		Bd 15
1954	160	205	25	4	.6	D	-	P		Bd 16
1954	160	220	27	4	.5	D	-	P		Bd 17
1956	168	276	63	4	.6	D	-	P		Bd 18
1955	169	293	7	-	.1	D	-	D		Bd 19
1958	13	60	15	4	.3	D	-	D		Bd 20
1960	10	-	-	-	-	-	-	-		Bd 21
1956	179	255	60	4	.8	D	-	P		Bd 22
1957	125	190	45	12	.7	D	-	P		Bd 23
1954	107	131	10	6	.4	D	-	P		Bd 24
1958	146	186	20	4	.5	D	-	P		Bd 25
1960	19	-	-	-	-	-	-	-		Bd 26
1960	12	-	-	-	-	-	-	D		Bd 27
1961	14	-	-	-	-	D	-	T		Bd 28
1961	180	220	126	4	3.2	D	-	P		Bd 29
1961	185	245	30	4	.5	D	-	P		Bd 30

EXPLANATION OF CODES

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Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-	CH-										
Bd 31	45830	L. Ullman	1962	Rotary	177	879	4	0-304	2	863-879	Patapsco
							2	304-863			
Bd 32	670085	J.C.P. High School	1967	Rotary	175	660	6	0-648	6	648-660	Patapsco
Bd 33	660079	Potomac Utilities	1966	Rotary	180	654	18	0-460	10	536-556	Patapsco
							10	415-536	10	561-586	
									10	556-561	
Bd 34	720151	E. Dutton	1972	Rotary	170	920	6	0-375	5	839-859	Patapsco
							4	362-839	2	875-905	
									4	859-869	
									2	864-875	
Bd 35	720050	Potomac Utilities	1973	Rotary	175	666	20	0-550	10	595-645	Patuxent
							10	495-595			
Bd 36	731127	R. Stockman	1976	Rotary	180	363	4	0-353	4	353-363	Patapsco
Bd 37	731819	Green Park LTD	1978	Rotary	195	591	4	0-362	2	488-493	Patapsco
							2	354-488	2	501-506	
							2	493-501	2	514-519	
							2	506-514	2	555-560	
							2	519-555	2	564-569	
							2	560-564			
							2	569-591			
Bd 38	732270	Berry Rd. Joint Venture	1980	Rotary	200	875	6	0-680	4	696-721	Patapsco
							4	610-696			
Bd 39	732377	Cherry Walk Joint Venture	1979	Rotary	200	900	6	0-560	4	738-756	Patapsco
							4	550-738	4	769-774	
							4	756-769	4	825-846	
							4	774-825	4	866-886	
							4	846-866			
							4	886-900			
Bd 40	732417	Berry Rd. Joint Venture	1979	Rotary	185	904	4	0-492	3	736-741	Patapsco
							2	438-736	3	825-846	
							2	741-825			
							2	846-904			
Bd 41	710093	Avon Crest Corp.	1972	Rotary	200	521	6	0-408	-	408-521	Patapsco
Bd 42	732377	Cherry Walk Joint Venture	1979	Rotary	200	900	4	0-470	3	738-754	Patapsco
							2	462-738	3	769-774	
							2	754-769	3	825-846	
							2	774-825	3	867-878	
							2	846-867			
							2	878-900			
Bd 43	732377	Cherry Walk Joint Venture	1979	Rotary	200	907	4	0-491	3	741-757	Patapsco
							2	479-741	3	832-848	
							2	757-832			
							2	848-907			

Year	Water level: Static (ft bls)	Water level: Pumping (ft bls)	Yield test: Pumping rate (gal/min)	Yield test: Duration (hrs)	Yield test: Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
1962	195	260	8	5	.1	D	-	D		CH-Bd 31
1967	190	410	30	3	.1	D	-	P		Bd 32
1966	194	250	400	8	7.0	D, E	-	P	Owner's well no. 1	Bd 33
1972	188	360	12	48	.1	D, G	-	P		Bd 34
1973	205	259	300	8	5.5	D	-	P		Bd 35
1976	198	216	30	8	1.7	D	-	D		Bd 36
1978	188.50	197.88	11	6	1.2	D	-	-	aquifer-test results available	Bd 37
1980	205	-	-	-	-	D, E G	-	T	aquifer-test results available	Bd 38
1979	219	260	88	12	2.1	D, G	-	P	CH Bd 39, 42, 43 were drilled on same permit	Bd 39
1979	212	249	26	12	.7	D, G	-	P		Bd 40
1972	154	351	46	8	.2	D	-	P		Bd 41
1979	216	249	30	6	.9	D	-	O	Former test hole; well no. 4	Bd 42
1979	216	225	17	6	1.9	D	-	-		Bd 43

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Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-	CH										
Bd 44	732500	Berry Rd. Joint Venture	1980	Rotary	180	840	12 6 4	0- 40 40-500 500-799	4	799-822	Patapsco
Bd 45	732743	S. Kwindmceki	1980	Rotary	205	476	4	0-444	4	444-462	Patapsco
Bd 46	811714	Charles Co. Department of Public Works	1986	Rotary	180	859	6 4 4 4	0-695 695-700 730-805 820-830	4 4	700-730 805-820	Patapsco
Bd 47	880124	Cherry Walk Joint Venture	1988	Rotary	200	900	-	-	6	-	-
Cb 1	-	-	<1947	Dug	100	41	-	-	-	-	-
Cb 2	-	L.G. Kragh	<1947	Dug	143	48	-	-	-	-	-
Cb 3	-	-	<1947	Dug	140	46	-	-	-	-	-
Cb 4	-	Thomas H. Speake	<1947	Dug	107	38	-	-	-	-	-
Cb 5	-	W.W. Linton	<1947	Dug	140	33	-	-	-	-	-
Cb 6	7846	Dept. of Forests & Parks	1951	Rotary	22	208	4	0-195	2	195-200	Patapsco
Cb 7	11908	U.S. Navy	1952	Cable	36	400	8 8	0-154 167-400	6	154-167	Patapsco
Cb 8	11932	U.S. Navy	1953	Rotary	38	615	20 12 12 12 10 10	0- 82 0- 85 93-124 133-153 153-221 229-234	12 12 10 10	85 - 93 124-133 221-229 234-242	Patapsco
Cb 9	11931	U.S. Navy	1953	Rotary	24	623	16 10 8 8 8	0-150 0-191 206-230 234-241 245-268	8 8 8 8	191-206 230-234 241-245 268-280	Patapsco
Cb 10	-	U.S. Navy	1945	Cable	20	610	-	-	-	-	-
Cb 11	-	U.S. Navy	1945	Cable	5	454	-	-	-	-	-

Water level			Yield test							USGS local well no.
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	
1980	208	402	91	24	0.5	D	-	T	Owner's well no. 2	CH-Bd 44
1980	188	275	10	8	.1	D, G	-	D		Bd 45
1986	233	288	90	-	1.7	-	E	P	Owner's well no. 3	Bd 46
-	-	-	-	-	-	E, G O	-	P		Bd 47
1947	39.2	-	-	-	-	-	-	A	Abandoned domestic well; filled in	Cb 1
1947	38.2	-	-	-	-	-	-	D		Cb 2
1960	39.5	-	-	-	-					
1947	44.3	-	-	-	-	-	-	D		Cb 3
1947	37.2	-	-	-	-	-	-	D		Cb 4
1960	34.4	-	-	-	-					
1947	31.6	-	-	-	-	-	-	D		Cb 5
1960	29.9	-	-	-	-					
1951	35	41	35	4	5.8	D	-	D		Cb 6
1952	67	140	151	24	2.1	D, G	-	O	U.S. Navy; well no. 19; observation well 1952 to present	Cb 7
1953	52	131	559	24	7.1	D, E	B, D	A	U.S. Navy; well no. 16; drilled to basement complex	Cb 8
1953	52	192	310	24	2.2	D	B, D	P	U.S. Navy; well no. 15; drilled to basement complex	Cb 9
1960	81.6	156	206	-	-					
1978	-	-	185	-	-					
1980	-	-	185	-	-					
1981	-	-	150	-	-					
1953	-	-	52	-	-	D	D	A	U.S. Navy; well no. 13SN; drilled to basement complex	Cb 10
1945	30	157	80	-	.6	D	D	A	U.S. Navy; well no. 43SN; standby well	Cb 11

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Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-	CH-										
Cb 12	-	U.S. Navy	1945	Cable	35	441	-	-	-	-	-
Cb 13	-	U.S. Navy	1944	Cable	15	443	-	-	-	-	-
Cb 14	-	U.S. Navy	-	-	25	200	-	-	-	-	-
Cb 15	14261	U.S. Navy	1953	Rotary	30	452	2	-	8	261-295	Patapsco
Cb 16	13185	U.S. Navy	1961	Rotary	31	605	3	-	8 8	208-220 274-302	Patapsco
Cb 17	14007	U.S. Navy	1953	Rotary	31	454	-	-	-	-	Patapsco
Cb 18	15753	U.S. Navy	1954	Rotary	30	452	16 10	0-185 185-261	8	261-285	Patapsco
Cb 19	13185	U.S. Navy	1954	Rotary	32	605	16 10	0-120 0-208	8 8 8	208-220 274-302 220-274	Patapsco
Cb 20	-	Alexandria Methodist Church	-	Dug	128	19	36	-	-	-	-
Cb 21	-	P. Williams	1958	Dug	40	24	24	-	-	-	-
Cb 22	36684	F. Simmons	1960	Cable	48	167	5	0-162	5	162-167	Patapsco
Cb 23	38172	E. Gallahue	1960	Cable	72	260	6	0-253	6	253-260	Patapsco
Cb 24	30696	U.S. Navy	1958	Rotary	135	580	6	0-496	-	-	-
Cb 25	-	U.S. Navy	1958	Rotary	30	603	4	0-570	4	570-585	Patuxent
Cb 26	-	U.S. Navy	1958	Rotary	5	600	4 4 4 4	0-185 190-203 208-225 230-275	4 4 4 4	185-190 203-208 225-230 275-285	Patapsco
Cb 27	40772	U.S. Navy	1960	Rotary	5	331	-	-	-	-	Patapsco
Cb 28	41102	U.S. Navy	1961	Rotary	5	331	24 10 10 10	0-152 0-190 200-230 240-280	10 10 10	190-200 230-240 280-290	Patapsco
Cb 29	-	U.S. Navy	1956	Rotary	12	350	16 10 10	0-220 0-228 239-269	10 10	228-239 269-286	Patapsco

Year	Water level: Static (ft bls)	Water level: Pumping (ft bls)	Yield test: Pumping rate (gal/min)	Yield test: Duration (hrs)	Yield test: Specific capacity [(gal)/min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
										CH-
1945	71.4	-	40	12	-	D	D, E	A	U.S. Navy; well no. 66SN	Cb 12
1956	85	-	15	36	-					
-	-	-	52	-	-	D	-	A	U.S. Navy; well no. 51SN	Cb 13
1953	33.6	-	-	-	-	-	-	A	U.S. Navy; well no. 11SN	Cb 14
1954	77	-	-	-	-	D	-	A	U.S. Navy; well no. 5; test hole for CH Cb 18	Cb 15
1954	33.4	-	-	-	-	D	D	A	U.S. Navy; well no. 3; test hole for CH Cb 19	Cb 16
-	-	-	-	-	-	D	-	A	U.S Navy; well no. 4; former test hole	Cb 17
1954	77	210	350	12	2.6	D	D, E	I	U.S Navy; well no. 17	Cb 18
1956	-	-	300	-	-					
1960	125	221	232	-	-					
1977	120	218	160	-	-					
1980	-	-	-	-	-					
1954	95	187	363	24	3.9	D	B, D	I	U.S. Navy; well no. 18	Cb 19
1960	100	175	300	2	4.0		E			
1970	125	180	170	-	3.1					
1980	-	-	115	-	-					
1960	11.6	-	-	-	-	-	-	P		Cb 20
1960	29.8	-	-	-	-	-	-	D		Cb 21
1960	48	120	15	6	.2	D	-	P		Cb 22
1960	67	95	7	3	.2	D	-	D		Cb 23
1958	188	202	8	78	.6	D	-	P		Cb 24
1958	110	195	18	24	.2	D	-	A	Sydnor; test well 2	Cb 25
1958	48	60	23	-	1.9	D	D	A	U.S Navy; well no. 1SN	Cb 26
-	-	-	-	-	-	D, E	-	A	U.S. Navy; test hole	Cb 27
1961	65	200	275	40	2.0	D	D, E	P	U.S. Navy; well no. 2012SN	Cb 28
1956	100	-	-	-	-	D	D, E	I	U.S. Navy; well no. 24A or "A" well	Cb 29
1957	-	-	350	17	-					
1979	-	-	160	-	-					
1980	-	-	108	-	-					
1981	-	-	100	-	-					

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							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-	CH-										
Cb 30	-	U.S. Navy	1961	-	35	167	-	-	-	-	-
Cb 31	22350	U.S. Navy	1956	Rotary	12	600	-	-	-	-	-
Cb 32	-	-	-	-	-	-	-	-	-	-	-
Cb 33	-	-	-	-	-	-	-	-	-	-	-
Cb 34	720121	U.S. Navy	1972	Rotary	30	233	20 12	0-200 0-217	12	217-232	Patapsco
Cb 35	810572	U.S. Navy	1984	Rotary	25	503	6 4 4	0-433 461-467 486-488	4 4	433-461 467-486	Patuxent
Cb 36	710024	U.S. Navy	1970	Rotary	65	425	6 6	0-190 212-220	6 6	190-212 220-240	Patapsco
Cb 37	710058	U.S. Navy	1971	Rotary	35	403	6	0-276	6	276-296	Patapsco
Cb 38	-	U.S. Navy	1978	Rotary	4	250	4 2	0-210 210-231	2	231-246	Patapsco
Cb 39	732804	General Smallwood St. Park	1980	Rotary	10	426	6 4 4	0-300 290-300 310-373	4 4	300-310 373-383	Patapsco
Cb 40	730357	General Smallwood St. Park	1974	Rotary	80	301	6 4	0-227 227-287	4	287-301	Patapsco
Cc 1	-	M.. Scott	-	Dug	174	19	-	-	-	-	-
Cc 2	-	Cockerham	-	Dug	120	18	-	-	-	-	-
Cc 3	-	Hudson Garage	-	Dug	60	22	-	-	-	-	-
Cc 4	6766	S. Cockerham	1950	Cable	122	201	6	0-177	-	-	-
Cc 5	6948	M.Scott	1950	Cable	170	274	5	0-215	-	-	-
Cc 6	-	L. Bowie	1940	Dug	125	18	-	-	-	-	-
Cc 7	-	Buckley	1930	Dug	150	31	36	0-31	-	-	-
Cc 8	-	O. Schuegard	-	Dug	130	13	40	-	-	-	-
Cc 9	-	Carter	<1930	Dug	140	19	-	-	-	-	-
Cc 10	-	Bicknell	1933	Cable	120	135	6	-	-	-	-
Cc 11	-	-	-	-	60	-	-	-	-	-	-

Water level			Yield test							USGS local well no.
Year	Static (ft bls)	Pumping (ft bls)	Pumping rate (gal/min)	Duration (hrs)	Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	
1961	61	-	-	-	-	-	-	A		CH-Cb 30
1956	95	-	-	-	-	D	-	A	U.S. Navy; test hole for Cb 29	Cb 31
-	-	-	-	-	-	-	-	-	Changed to Bb 18	Cb 32
-	-	-	-	-	-	-	-	-	Changed to Bb 19	Cb 33
1972	83	200	250	24	2.1	D	E	I	U.S. Navy; well no. 3A	Cb 34
1984	84	255	226	24	1.3	D, E G	E	I	U.S. Navy; well no. 16A	Cb 35
1970	90	135	210	24	4.7	D	E	A	Matz-Childs & Assoc.; test well no. 1	Cb 36
1971	97	205	187	8	1.7	D	-	A	Matz-Childs & Assoc.; test well no. 4A	Cb 37
1978	18	100	20	5	.2	D	E	P	U.S. Navy; well on Rum Point	Cb 38
1980	79	166	32	24	.4	D	-	P	Water-level observation during winter months	Cb 39
1974	107	129	17	10	.8	D	-	P	Water-level observation during winter months	Cb 40
1947	9.3	-	-	-	-	-	-	-		Cc 1
1947	15.1	-	-	-	-	-	-	-		Cc 2
1947	17.0	-	-	-	-	-	-	-		Cc 3
1950	63	160	16	4	.2	D	-	D		Cc 4
1950	68	-	8	4	-	D	A, D	D		Cc 5
1952	6.3	-	-	-	-	-	-	-		Cc 6
1952	13.9	-	-	-	-	-	-	-		Cc 7
1952	9.1	-	-	-	-	-	-	-		Cc 8
1952	14.2	-	-	-	-	-	-			Cc 9
1952	41.3	-	-	-	-	-	-	-		Cc 10
1960	-	-	3	-	-	-	-	-		Cc 11

EXPLANATION OF CODES

Well-log codes:
C, caliper
D, descriptive
E, electric
G, gamma
O, other

Chemical analyses reference codes:
A, Otton (1955)
B, Slaughter and Laughlin (1966)
C, Weigle and Webb (1970)
D, Woll (1978)
E, office files, USGS, Towson, Md.

Well status or use codes:
A, abandoned
D, domestic
I, industrial
O, observation
P, public supply
T, test hole

Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-	CH-										
Cc 12	8531	O. Millard	1955	Cable	40	104	6	0- 99	6	99-104	Patapsco
Cc 13	32144	N. DeSantis	1959	Cable	65	239	6	0-234	6	234-239	Patapsco
Cc 14	16355	M. Blanton	1954	Cable	52	231	6	0-225	6	225-230	Patapsco
Cc 15	27722	C. Twiford	1957	Cable	122	334	5	0-330	5	330-334	Patapsco
Cc 16	20415	J. Mathews	1955	Rotary	128	401	4 2 2	0-294 294-322 332-396	2 2	322-332 396-401	Patapsco
Cc 17	13463	R. Mitchell	1953	Cable	142	330	6	0-325	6	325-330	Patapsco
Cc 18	14668	J. Weston	1954	Rotary	140	371	4 2 2	0-332 337-342 347-360	2 2 2	332-337 342-347 360-370	Patapsco
Cc 19	39279	R. Smith	1960	Jetted	100	216	2 1	0-155 149-205	1	205-216	Patapsco
Cc 20	41715	R. Smith	1961	Cable	130	348	6	0-343	4	343-348	Patapsco
Cc 21	42338	Myrtle Grove Game Refuge	1961	Rotary	103	680	4 2	0-257 257-670	2	670-680	Pataspsco
Cc 22	43460	USGS	1961	Augered	150	43	4	-	-	-	-
Cc 23	690053	Gale Bailey Elementary School	1969	Rotary	145	929	6 4 4	0-279 279-873 893-929	4	873-893	Patuxent
Cc 24	690091	Gale Bailey Elementary School	1969	Rotary	145	312	6 4	0-294 294-299	6	299-310	Patapsco
Cc 25	680044	Du-Mar Estates Water Co.	1968		75	406	6 4	0-292 285-391	4	391-406	Patapsco
Cc 26	710060	Garden Estates	1971	-	135	320	4	0-300	2	300-320	Patapsco
Cc 27	710061	Garden Estates	1971	-	130	320	4	0-300	2	300-320	Patapsco
Cc 28	56912	R. Smith	1964	Rotary	130	353	4	0-343	4	343-353	Patapsco
Cc 29	730963	Charles Co. Sanitary District	1975	Rotary	40	545	6 4	0-170 165-180	5	180-198	Patapsco
Cc 30	690058	Lackey High School	1969	Rotary	95	494	8 8 8	0-273 278-314 329-334	8 8	273-278 314-329	Patapsco

Year	Water level: Static (ft bls)	Water level: Pumping (ft bls)	Yield test: Pumping rate (gal/min)	Yield test: Duration (hrs)	Yield test: Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
1955	12	85	18	4	0.2	D	-	P		CH-Cc 12
1959	38	200	12	8	.1	D	-	D		Cc 13
1954	15	-	10	-	-	D	-	D		Cc 14
1957	60	200	9	8	.1	D	-	D		Cc 15
1955	149	210	11	4	.2	D	-	D		Cc 16
1953	90	195	6	4	.1	D	-	D		Cc 17
1954	97	230	7	4	.1	D	-	D		Cc 18
1960	55	75	4	4	.2	D	-	D		Cc 19
1961	62.3	-	-	-	-					
1961	134	158	22	12	.9	D	-	P		Cc 20
1961	109	159	15	4	.3	D	-	D		Cc 21
1961	17.6	-	-	-	-	D	-	A	Test hole	Cc 22
1969	174	268	6	1	.1	D	-	P	Owner's well no. 1	Cc 23
1969	135	159	14	12	.6	D	-	P	Owner's well no. 2	Cc 24
1968	120	143	20	8	.9	D	E	P		Cc 25
1971	95	145	23	3	.5	D	-	P	Owner's well no. 1	Cc 26
1971	95	145	25	4	.5	D	-	P	Owner's well no. 2	Cc 27
1964	96	104	25	8	3.1	D	-	P		Cc 28
1976	37	148	8	24	.1	D, E	-	-		Cc 29
1969	129	220	76	8	0.8	D	-	P		Cc 30

EXPLANATION OF CODES

Well-log codes:
C, caliper
D, descriptive
E, electric
G, gamma
O, other

Chemical analyses reference codes:
A, Otton (1955)
B, Slaughter and Laughlin (1966)
C, Weigle and Webb (1970)
D, Woll (1978)
E, office files, USGS, Towson, Md.

Well status or use codes:
A, abandoned
D, domestic
I, industrial
O, observation
P, public supply
T, test hole

Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing Diameter (in.)	Casing Interval (ft bls)	Screen Diameter (in.)	Screen Interval (ft bls)	Primary aquifer
CH-Cc 31	CH-731416	Dravo Corp	1977	Rotary	35	563	6 4 4 4	0-200 200-438 453-480 505-544	4 4 4	438-453 480-505 544-554	Patapsco
Cc 32	730898	Red Hill Estates	1976	Rotary	135	375	4 2 2	0-300 291-343 353-375	3	343-353	Patapsco
Cc 33	730448	Charles Co. Commissioners	1974	Rotary	122	589	4 2 2	0-299 294-570 585-589	2	570-585	Patapsco
Cd 1	-	Community of Port Tobacco	-	-	22	139	2	-	-	-	-
Cd 2	-	J. Brown	1930	Dug	196	21	36	-	-	-	-
Cd 3	-	I. Proctor	1947	Dug	180	8	-	-	-	-	-
Cd 4	-	G. Dixon	1940	Dug	190	-	36	-	-	-	-
Cd 5	-	M. Grevemberg	-	-	30	-	-	-	-	-	-
Cd 6	-	Warren	-	Dug	172	29	-	-	-	-	-
Cd 7	2998	Hawthorne Country Club	1948	Cable	160	565	6	0-555	6	555-565	Patapsco
Cd 8	9820	R.D. Evans	1952	Cable	160	411	-	-	-	-	-
Cd 9	9771	Port Tobacco School	1952	Cable	149	423	6	0-416	6	416-423	Patapsco
Cd 10	-	J. Johnson	<1952	Dug	570	20	36	-	-	-	-
Cd 11	-	L. Davis	1952	Dug	170	16	36	-	-	-	-
Cd 12	10168	J. Mitchell	1952	Jetted	64	420	2 1 1	0-170 170-240 260-400	1 1	240-260 400-420	Patapsco
Cd 13	14155	E. Burroughs	1954	Rotary	182	516	4 2 2	0-305 300-490 505-516	2	490-505	Patapsco
Cd 14	27696	H.E. Ryerson	1957	Rotary	152	485	4 2	0-300 292-475	2	475-485	Patapsco

Year	Water level: Static (ft bls)	Water level: Pumping (ft bls)	Yield test: Pumping rate (gal/min)	Yield test: Duration (hrs)	Yield test: Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
1977	75	185	125	24	1.1	D, E	E	P		CH-Cc 31
1976	142	182	10	8	.2	D	-	P		Cc 32
1974	134	142	10	20	1.2	D	-	P		Cc 33
1947	-	-	1.6	-	-	-	-	P		Cd 1
1951	-	-	2.6	-	-					
1947	16.7	-	-	-	-	-	-	-		Cd 2
1947	5.8	-	-	-	-	-	-	-		Cd 3
-	-	-	-	-	-	-	-	D		Cd 4
1947	-	-	0.5	-	-	-	-	-		Cd 5
1947	28.1	-	-	-	-	-	-	-		Cd 6
1948	165	265	35	12	.4	D	D	D		Cd 7
1952	110	140	7	2	.2	D	-	D		Cd 8
1952	130	334	40	18	.2	D	D	P		Cd 9
-	-	-	-	-	-	-	A, D	D		Cd 10
1952	9.4	-	-	-	-	-	-	D		Cd 11
1952	22	42	10	6	.4	D	-	D		Cd 12
1954	160	200	5	4	.1	D	-	D		Cd 13
1957	147	205	30	4	.5	D	-	D		Cd 14

EXPLANATION OF CODES

Well-log codes:
C, caliper
D, descriptive
E, electric
G, gamma
O, other

Chemical analyses reference codes:
A, Otton (1955)
B, Slaughter and Laughlin (1966)
C, Weigle and Webb (1970)
D, Woll (1978)
E, office files, USGS, Towson, Md.

Well status or use codes:
A, abandoned
D, domestic
I, industrial
O, observation
P, public supply
T, test hole

Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing		Screen		Primary aquifer
							Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
CH-	CH-										
Cd 15	17354	B. Demott	1955	Rotary	155	578	4	0- 302	2	384- 389	Patapsco
							2	302- 384	2	404- 409	
							2	389- 404	2	466- 481	
							2	409- 466	2	531- 536	
							2	481- 531	2	545- 555	
							2	536- 545			
							2	555- 578			
Cd 16	-	B. Demott	1955	Rotary	160	480	-	-	-	-	-
Cd 17	32030	I. Jones	1958	Rotary	155	388	4	0- 300	2	300- 310	Patapsco
							2	310- 378	2	378- 388	
Cd 18	32029	G. Hyatt	1958	Rotary	150	410	4	0- 400	2	400- 410	Patapsco
Cd 19	18234	G. Mc Phee	1955	Rotary	165	564	4	0- 301	2	543- 563	Patapsco
							2	290- 543			
							2	563- 564			
Cd 20	40327	J. Scott	1960	Rotary	110	472	4	0- 289	2	460- 470	Patapsco
							2	289- 460			
							2	470- 472			
Cd 21	39974	R. Barbour	1960	Jetted	22	252	2	0- 63	1	232- 252	Magothy
							1	63- 232			
Cd 22	41077	J. Dyson	1960	Jetted	185	460	2	0- 231	1	442- 462	Magothy
							1	231- 442			
Cd 23	46388	R.V. Rollins	1962	Jetted	150	250	2	0- 230	1	239- 250	Aquia
							1	224- 239			
Cd 24	33114	U.S. Army	1955	Rotary	160	1,003	6	0- 813	5	885- 900	Patapsco
							4	700- 885	5	960- 970	
							4	900- 960			
							4	970-1,003			
Cd 25	43455	USGS	1961	Augered	55	23	2	0- 5	2	5- 10	-
Cd 26	43724	Mt. Carmel Church	1961	Cable	166	407	6	0- 397	6	397- 407	Magothy
Cd 27	-	L. Johnson	1961	Augered	142	54	36	-	-	-	-
Cd 28	47072	Port Tobacco Riviera	1962	-	14	162	-	-	2	152- 162	Aquia
Cd 29	46384	R.V. Rollins	1962	Jetted	141	225	2	0- 210	1	215- 225	Aquia
Cd 30	680042	Utilico Corp.	1968	Cable	193	1,346	6	0- 408	4	936- 946	Patapsco
							4	368- 936	4	1,085-1,100	
							4	946-1,085	4	1,108-1,118	
							4	1,100-1,108	4	1,310-1,330	
							4	1,118-1,310			
							4	1,330-1,346			

Year	Water level: Static (ft bls)	Water level: Pumping (ft bls)	Yield test: Pumping rate (gal/min)	Yield test: Duration (hrs)	Yield test: Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
1955	155	195	11	4	0.3	D	-	D		CH-Cd 15
-	-	-	-	-	-	-	-	-		Cd 16
1958	90	158	15	16	.2	D	-	D		Cd 17
1958	105	144	10	4	.3	D	-	D		Cd 18
1955	158	215	11	4	.2	D	-	D		Cd 19
1960	165	195	10	4	.3	D	-	D		Cd 20
1960	-	12	10	3	.8	D	-	D	Well was flowing in 1960	Cd 21
1960	110	150	6	10	.2	D	-	D		Cd 22
1962	147	154	6	3	.9	D	-	D		Cd 23
1955	178	345	65	48	.5	D	D	P		Cd 24
1961	4.5	-	-	-	-	D	-	O	Observation well	Cd 25
1961	105	200	20	8	.2	D	D	P		Cd 26
1961	26.3	-	-	-	-	-	-	D		Cd 27
1962	-	10 e	10	2	-	-	-	-	Well was flowing in 1962	Cd 28
1962	-	-	5	3	-	D	-	D		Cd 29
1968	175	282	68	12	.6	D, E	-	P		Cd 30

EXPLANATION OF CODES

Well-log codes:
C, caliper
D, descriptive
E, electric
G, gamma
O, other

Chemical analyses reference codes:
A, Otton (1955)
B, Slaughter and Laughlin (1966)
C, Weigle and Webb (1970)
D, Woll (1978)
E, office files, USGS, Towson, Md.

Well status or use codes:
A, abandoned
D, domestic
I, industrial
O, observation
P, public supply
T, test hole

Table 3. *Summary of information for selected wells in the Indian Head area, northwestern Charles County, Maryland*--Continued

USGS local well no.	State permit no.	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (feet)	Casing Diameter (in.)	Casing Interval (ft bls)	Screen Diameter (in.)	Screen Interval (ft bls)	Primary aquifer
CH-	CH-										
Cd 31	660072	Keech-Neave Development Co., Inc.	1966	Rotary	130	650	6	0-406	6	406-436	Patapsco
							6	436-472	6	472-482	
							6	482-504	6	504-509	
							6	509-523	6	523-528	
							6	528-557	6	557-562	
							6	562-570			
Cd 32	650090	Charles Co. Junior College	1965	Rotary	155	657	4	0-345	4	345-355	-
							4	355-376	4	376-381	
							4	381-390	4	390-400	
							4	400-427	4	427-437	
							4	437-450	4	450-455	
							4	455-471			
							4	481-502			
Cd 33	690105	Charles Co. Vocational Tech. Center	1969	Rotary	190	917	4	0-355	2	390-395	-
							2	343-390	2	415-420	
							2	395-415	2	449-454	
							2	420-449	2	472-482	
							2	454-472	2	501-511	
							2	482-501			
							2	511-597			
Cd 34	730498	McDonough High School	1974	Rotary	200	532	6	0-400	4	400-415	Patapsco
							4	415-464	4	464-474	
							4	474-486	4	486-506	
							4	506-521	4	521-526	
							4	526-532			
Cd 35	730601	R. Fiest	1974	Rotary	175	1,206	-	-	-	-	-
Cd 36	680004	Charles Co. Community College	1967	Cable	180	643	6	0-631	6	631-643	Patapsco
Cd 37	700077	Charles Co. Vocational Tech. Center	1970	Rotary	180	546	6	0-389	6	389-394	Patapsco
							6	394-415	6	415-418	
							6	418-448	6	448-455	
							6	455-472	6	472-478	
							6	478-501	6	501-509	
Cd 38	731346	Fennel Heating and Plumbing Co.	1977	Rotary	180	578	4	0-546	3	546-566	Patapsco
							3	566-569	3	569-575	
Cd 39	730159	W. Shelton	1973	Rotary	180	670	4	0-285	2	343-363	Patapsco
							2	285-343			
							2	363-670			
Cd 40	-	USGS	1984	Rotary	90	255	-	-	-	-	-

Year	Water level: Static (ft bls)	Water level: Pumping (ft bls)	Yield test: Pumping rate (gal/min)	Yield test: Duration (hrs)	Yield test: Specific capacity [(gal)min)/ft]	Available well logs	Chemical analyses reference	Well status or use	Remarks	USGS local well no.
1966	90	165	105	24	1.4	D, E	-	D		CH-Cd 31
1965	117	195	25	9	.3	D, E	-	P		Cd 32
1969	149	303	5	36	0	D	-	T		Cd 33
1974	185	275	50	24	.6	D	E	P		Cd 34
-	-	-	-	-	-	D	-	A		Cd 35
1967	190	300	34	12	.3	D	-	P		Cd 36
1970	139	187	45	20	.9	D	-	P		Cd 37
1977	210	235	30	12	2.0	D, E G	-	D		Cd 38
1973	168	190	8	5	.4	D	-	P		Cd 39
-	-	-	-	-	-	D, E G	-	-		Cd 40

EXPLANATION OF CODES

Well-log codes:
C, caliper
D, descriptive
E, electric
G, gamma
O, other

Chemical analyses reference codes:
A, Otton (1955)
B, Slaughter and Laughlin (1966)
C, Weigle and Webb (1970)
D, Woll (1978)
E, office files, USGS, Towson, Md.

Well status or use codes:
A, abandoned
D, domestic
I, industrial
O, observation
P, public supply
T, test hole

Table 4. *Summary of information for selected wells and auger holes in Prince William and Fairfax Counties, Virginia*

[USGS, U.S. Geological Survey; ft asl, feet above sea level; ft, feet; in., inches; ft bls, feet below land surface; gal/min, gallons per minute; hrs, hours; (gal/min)/ft, gallons per minute per foot; -, no data available]

Map designation	Owner	Year completed	Method of drilling	Land surface (ft asl)	Total depth drilled (ft)	Casing		Screen		Primary geologic unit
						Diameter (in.)	Interval (ft bls)	Diameter (in.)	Interval (ft bls)	
HP 1	Hallowing Point Development	1949	Cable	35	312	8	0-305	8	305-312	Potomac Group
HP 1A	Hallowing Point Development	1987	Rotary	35	496	6 4	0-267 282-329	4 4	267-282 329-334	Potomac Group
HP 2	Hallowing Point Development	1963	Cable	35	466	8	0-434	8	434-464	Potomac Group
MN 1	Mason Neck State Park	1981	Rotary	21	308	6 6 6	0-170 180-195 200-270	6 6 6	170-180 195-200 270-280	Potomac Group
MN 2	Mason Neck State Park	1981	Rotary	30	359	6 6 6	0-127 132-248 258-288	6 6 6	127-132 248-258 288-293	Potomac Group
BP 1	Fairfax County Water Authority	1961	Cable	60	296	-	-	-	-	Potomac Group
[1]AH 1	USGS	-	Augered	47	30	-	-	-	-	Chopawamsic Formation
[1]AH 2	USGS	-	Augered	30	65	-	-	-	-	Chopawamsic Formation
[1]AH 3	USGS	-	Augered	7	65	-	-	-	-	Chopawamsic Formation
[1]AH 4	USGS	-	Augered	30	20	-	-	-	-	Chopawamsic Formation
[1]AH 5	USGS	-	Augered	27	62	-	-	-	-	Chopawamsic Formation
[2]AH 6	USGS	-	Augered	17	97	-	-	-	-	Chopawamsic Formation
[2]AH 7	USGS	-	Augered	5	151	-	-	-	-	Potomac Group
[2]AH 8	USGS	-	Augered	-	-	-	-	-	-	Chopawamsic Formation
[2]MW 1	USGS	-	Augered	-	-	-	-	-	-	Chopawamsic Formation
[3]Q 1	U.S. Marine Corps at Quantico	before 1930	Cable	8	358	-	-	-	-	Potomac Group
[3]Q 2	U.S. Marine Corps at Quantico	before 1930	Cable	28	360	-	-	-	-	Potomac Group
[3]Q 3	U.S. Marine Corps at Quantico	before 1930	Cable	8	355	-	-	-	-	Potomac Group
[3]Q 4	U.S. Marine Corps at Quantico	before 1930	Cable	8	551	-	-	-	-	Potomac Group
[3]Q 5	U.S. Marine Corps at Quantico	before 1930	Cable	45	391	-	-	-	-	Potomac Group
[3]Q 6	U.S. Marine Corps at Quantico	before 1930	Cable	27	350	-	-	-	-	Potomac Group

Year	Water level: Static (ft bls)	Water level: Pumping (ft bls)	Yield test: Pumping rate (gal/min)	Yield test: Duration (hrs)	Yield test: Specific capacity [(gal/min)/ft]	Available well logs	Well status or use	Remarks	Map designation
1949	60	150	60	10	0.67	D	A	Owner's well no. 1	HP 1
1987	67.5	138	150	24	2.1	D, G	P	Owner's well no. 1A; replaced HP 1	HP 1A
1963	89	-	60	-	-	D	P	Owner's well no. 2	HP 2
1981	33	-	125	-	-	D, G	P	Owner's well no. 1; gravel pack 55-308 ft bls	MN 1
1981	65	-	100	-	-	D, G	P	Owner's well no. 2; gravel pack 52-359 ft bls	MN 2
-	-	-	-	-	-	D	T	Owner's test well no.1	BP 1
-	-	-	-	-	-	D	T	Basement at 17 ft asl	[1] AH 1
-	-	-	-	-	-	D	T	Basement at 35 ft asl	[1] AH 2
-	-	-	-	-	-	D	T	Basement at 52 ft bsl	[1] AH 3
-	-	-	-	-	-	D	T	Basement at 10 ft asl	[1] AH 4
-	-	-	-	-	-	D	T	Basement at 35 ft bsl	[1] AH 5
-	-	-	-	-	-	D	T	Basement at 80 ft bsl	[2] AH 6
-	-	-	-	-	-	D	T	Well did not hit basement	[2] AH 7
-	-	-	-	-	-	D	T	Basement at 83 ft bsl	[2] AH 8
-	-	-	-	-	-	D	T	Basement at 170 ft bsl	[2] MW 1
-	-	-	-	-	-	D	-	Owner's well no. 1; basement at 350 ft bsl	[3] Q 1
-	-	-	-	-	-	D	-	Owner's well no. 2	[3] Q 2
-	-	-	-	-	-	D	-	Owner's well no. 3	[3] Q 3
-	-	-	-	-	-	D	-	Owner's well no. 4; basement at 543 ft bsl	[3] Q4
-	-	-	-	-	-	D	T	Owner's test well no. 1	[3] Q 5
-	-	-	-	-	-	D	T	Owner's test well no. 2	[3] Q 6

EXPLANATION OF CODES

Footnotes
[1] Data compiled from Seiders and Mixon, 1981.
[2] Data compiled from Mixon and others, 1972.
[3] Data compiled from Cady, 1938.

Well log code
D, descriptive
G, geophysical

Well status or use codes
A, abandoned
P, public supply
T, test hole

Table 5. *Lithologic description of continuous core from well CH Bb 22*

[Land surface elevation is 98 feet above sea level]

Depth below land surface, in feet	Description of material	Geologic unit
0 - 29	Clay, red, sandy; hard, gravel and cobble at base	*Park Hall Formation, Tertiary, Upper Pliocene*
29 - 49	Clay, gray, silty; hard, marbled with (red) oxidized stain	*Patapsco Formation, Lower Cretaceous*
49 - 64	Silt, gray, clayey; hard, cobble bed at base	
64 - 72	Sand, blue-gray, silty; cemented	
72 - 90	Clay, red and blue; hard	
90 - 104	Sand, gray and brown, very fine	
104 - 109	Silt, gray and brown, sandy; cemented, oxidized stain	
109 - 119	Sand, blue-gray, silty; very soft, carbonaceous, visible plant remains	
119 - 156	Sand, blue-gray, silty; cemented, marbled with (red) oxidized stain	
156 - 165	Sand, blue-gray, coarse; very soft	
165 - 188	Clay and silt, blue-gray; firm, carbonaceous	
188 - 195	Sand, gray, fine to coarse; soft, carbonaceous, visible plant remains	
195 - 200	Clay, gray and black; carbonaceous, pyrite crystals	
200 - 217	Sand, white, coarse with pebbles; very soft	
217 - 225	Silt, blue and green, sandy; firm	
225 - 245	Sand, blue-gray, silty; cemented	
245 - 260	Sand, green, silty; bedding planes evident, cemented	
260 - 285	Sand, blue-gray, silty; soft	
285 - 310	Sand, blue gray, coarse; very soft	
310 - 326	Sand, blue-gray, coarse with gravel; soft, visible plant remains	
326 - 335	Sand, blue-gray, coarse with pebbles; soft, intact clay balls	
335 - 355	Sand, gray-white, coarse; very soft	
355 - 371	Clay, gray-black, sandy; hard	
371 - 385	Silt, blue-gray, sandy; carbonaceous	
385 - 415	Clay, red and blue, silty; very hard, fractured	*Arundel Formation, Lower Cretaceous*
415 - 438	Sand, green, silty; hard	
438 - 450	Clay, blue and brown, silty; marbled	
450 - 460	Sand, green and brown, silty	*Patuxent Formation, Lower Cretaceous*
460 - 477	Sand, blue-gray, coarse; soft	
477 - 505	Clay, red and blue; hard, fractured	
505 - 520	Sand, blue and brown, silty; hard	
520 - 555	Sand, blue-gray, coarse; soft, intact clay balls	
555 - 565	Clay, gray and black, silty; carbonaceous, visible plant remains, rounded pebbles and gravel	
565 - 570	Clay, blue-green, silty; hard	
570 - 600	Sand, green, silty; very soft	
600 - 615	Sand, white, silty; carbonaceous	
615 - 630	Clay, blue-gray, silty; very hard, fractured	
630 - 643	Clay, red and blue, silty; marbled, very hard, fractured	
643 - 663	Sand, blue-gray, coarse; soft, mica flakes evident, pebbles with angular edges	
663 - 670	Sand, white-gray, coarse; soft, rounded gravel and pebble beds	
670 - 687	Sand, blue-green, fine; soft, rounded gravel and pebbles, mica flakes intact clay balls	
687 - 700	Schist, black and green, micaceous; weathered	*Crystalline "Basement" pre-Cretaceous*

Table 6. *Periodic water-level measurements at observation wells in the Indian Head area, 1981-89*

[Water levels, in feet below land-surface datum]

USGS local well number: **CH Bc 6**
Land-surface datum: 65 feet above sea level
Well depth: 412 feet
Well-screen interval(s): 362 to 412 feet
Highest water level: 138.05 feet below land surface, Mar. 31, 1988
Lowest water level: 148.92 feet below land surface, Apr. 7, 1989

Date	Water level	Date	Water level	Date	Water level
Mar. 31, 1988	138.05	Dec. 29, 1988	146.83	Apr. 7, 1989	148.92
Apr. 30, 1988	138.27	Feb. 15, 1989	147.86		

USGS local well number: **CH Bc 71**
Land-surface datum: 30 feet above sea level
Well depth: 410 feet
Well-screen interval(s): 400 to 410 feet
Highest water level: 81.58 feet below land surface, Sept. 23, 1981
Lowest water level: 129.31 feet below land surface, Dec. 1, 1988

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Sept. 23, 1981	81.58	Apr. 13, 1984	105.36	Jan. 22, 1988	97.04	Dec. 1, 1988	129.31
Apr. 13, 1982	113.90	Sept. 18, 1984	126.74	Mar. 31, 1988	93.74	Dec. 28, 1988	125.93
Sept. 23, 1982	102.90	Apr. 25, 1985	113.85	Aug. 30, 1988	114.16	Apr. 7, 1989	127.44
Apr. 5, 1983	107.52	Apr. 3, 1986	112.01	Nov. 2, 1988	121.14		

USGS local well number: **CH Bc 74**
Land-surface datum: 165 feet above sea level
Well depth: 748 feet
Well-screen interval(s): 550 to 566, 574 to 589, 637 to 642 feet
Highest water level: 228.77 feet below land surface, Feb. 16, 1989
Lowest water level: 229.42 feet below land surface, Apr. 7, 1989

Date	Water level	Date	Water level
Feb. 16, 1989	228.77	Apr. 7, 1989	229.42

USGS local well number: **CH Cb 11**
Land-surface datum: 5 feet above sea level
Well depth: 454 feet
Well-screen interval(s): unknown
Highest water level: 53.90 feet below land surface, Nov. 1, 1988
Lowest water level: 63.90 feet below land surface, Dec. 29, 1988

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Mar. 10, 1988	63.11	May 18, 1988	56.18	Dec. 29, 1988	63.90	Apr. 7, 1989	57.99
Apr. 30, 1988	58.08	Nov. 1, 1988	53.90	Feb. 15, 1989	60.15		

USGS local well number: **CH Cb 28**
Land-surface datum: 5 feet above sea level
Well depth: 290 feet
Well-screen interval(s): 190 to 200, 230 to 240, 280 to 290 feet
Highest water level: 50.38 feet below land surface, Mar. 10, 1988
Lowest water level: 62.35 feet below land surface, Apr. 30, 1988

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Mar. 10, 1988	50.38	Apr. 30, 1988	62.35	Dec. 29, 1988	51.25	Apr. 7, 1989	51.05
Apr. 30, 1988	62.35	May 18, 1988	50.58	Feb. 15, 1989	52.42		

Table 6. *Periodic water-level measurements at observation wells in the Indian Head area, 1981-89*--Continued

USGS local well number: **CH Cb 35**
Land-surface datum: 25 feet above sea level
Well depth: 488 feet
Well-screen interval(s): 433 to 461, 467 to 486 feet
Highest water level: 84.89 feet below land surface
Lowest water level: 135.72 feet below land surface

Date	Water level	Date	Water level	Date	Water level	Date	Water level
Mar. 9, 1988	89.55	Apr. 29, 1988	86.19	July 11, 1988	84.89	Feb. 15, 1989	88.91
Mar. 10, 1988	89.21	May 18, 1988	86.40				
Dec. 29, 1988	135.72	Apr. 7, 1989	86.10				

USGS local well number: **CH Cb 38**
Land-surface datum: 5 feet above sea level
Well depth: 246 feet
Well-screen interval(s): 231 to 246 feet
Highest water level: 75.48 feet below land surface, Apr. 7, 1989
Lowest water level: 76.27 feet below land surface, Feb. 15, 1989

Date	Water level	Date	Water level
Feb. 15, 1989	76.27	Apr. 7, 1989	75.48

USGS local well number: **CH Cb 39**
Land-surface datum: 10 feet above sea level
Well depth: 383 feet
Well-screen interval(s): 300 to 310, 373 to 383 feet
Highest water level: 58.19 feet below land surface, Dec. 29, 1988
Lowest water level: 86.08 feet below land surface, Feb. 15, 1989

Date	Water level	Date	Water level	Date	Water level
Dec. 29, 1988	58.19	Feb. 15, 1989	86.08	Apr 7, 1989	85.28

USGS local well number: **CH Cb 40**
Land-surface datum: 80 feet above sea level
Well depth: 301 feet
Well-screen interval(s): 287 to 301 feet
Highest water level: 114.85 below land surface, Apr. 7, 1989
Lowest water level: 115.35 below land surface, Feb. 15, 1989

Date	Water level	Date	Water level	Date	Water level
Dec. 29, 1988	115.07	Feb. 15, 1989	115.35	Apr. 7, 1989	114.85

Table 7. *Summary of daily mean water-level depths in observation wells equipped with digital recorders*

[Water-level depth, in feet below land surface; climatic year April 1988 through March 1989; ---, data not available]

CH Bb 17 Station number 383524077111802
Latitude 383524, longitude 0771118, U.S. Navy well "B"
Well depth 294 feet, land-surface datum 52 feet above sea level

Day	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1	---	119.28	115.35	115.60	115.79	118.51	119.31	---	117.74	119.43	118.80	---
2	---	119.14	115.43	115.83	115.74	118.15	118.73	---	117.56	119.31	---	---
3	---	119.01	114.78	115.44	115.74	118.04	118.33	118.94	117.50	119.17	---	---
4	---	118.72	114.69	115.03	115.59	117.75	118.18	118.95	118.00	119.82	---	---
5	---	118.45	115.15	115.13	115.80	117.47	---	118.39	118.01	119.85	---	---
6	---	118.57	115.70	115.48	116.00	117.45	118.41	118.15	117.95	119.37	---	---
7	---	118.45	115.72	115.54	116.11	117.49	118.74	118.19	117.91	119.45	---	---
8	---	118.56	115.45	115.79	115.74	117.66	118.97	118.01	118.14	119.31	---	---
9	---	118.17	115.16	115.65	115.76	117.88	118.48	118.20	118.14	119.51	---	---
10	---	118.14	115.36	115.45	115.82	118.08	118.29	117.85	118.40	119.84	---	---
11	---	118.22	115.38	115.44	116.11	118.25	118.71	118.06	118.57	120.05	---	---
12	---	118.80	115.20	115.54	116.14	118.17	119.11	118.32	118.71	120.00	---	---
13	---	118.79	114.93	115.68	116.22	118.00	119.46	117.58	118.42	120.07	---	---
14	---	118.92	114.70	115.40	116.39	118.29	119.29	117.39	118.46	120.36	---	---
15	---	118.43	114.81	115.12	116.65	118.32	119.00	117.49	118.33	120.10	118.23a	---
16	---	117.69	114.98	114.90	117.35	118.33	119.01	117.25	118.90	120.11	---	---
17	---	117.38	114.90	114.61	117.41	118.23	118.48	117.12	118.73	120.09	---	---
18	---	116.92	115.11	114.70	117.17	118.35	118.04	117.67	118.86	120.14	---	---
19	---	116.59	114.83	114.77	117.01	118.42	118.07	117.54	118.66	120.12	---	---
20	---	116.45	114.74	115.34	117.14	118.27	118.12	117.25	118.85	120.04	---	---
21	---	117.12	114.80	115.93	117.47	118.40	117.96	117.60	119.15	120.76	---	---
22	---	117.14	114.82	116.21	117.79	118.69	118.09	117.93	119.48	120.52	---	---
23	---	116.58	114.71	116.22	117.75	118.40	118.24	117.88	119.27	120.42	---	---
24	---	116.75a	115.03	116.12	117.77	118.51	118.14	117.85	119.06	120.24	---	---
25	---	116.72	114.99	115.92	118.05	118.35	118.25	117.77	119.14	120.10	---	---
26	---	116.88	114.97	115.93	118.07	118.53	118.28	117.40	119.50	119.96	---	---
27	---	116.13	115.66	116.28	118.22	119.04	118.41	117.30	119.58	119.63	---	---
28	---	115.85	115.64	116.40	118.22	119.56	118.33	117.19	119.28	119.61	---	---
29	118.63a	115.73	115.39	116.21	118.00	119.66	118.62	117.79	119.82	119.12	---	---
30	119.21	115.51	115.56	116.49	118.23	119.45	118.63	117.84	119.67	119.22	---	---
31	---	115.24	---	116.16	118.54	---	118.58	---	119.40	119.24	---	---

CH Bc 5 Station number 383524077094401
Latitude 383524, longitude 0770944, U.S. Navy well no. 14,
Well depth 430 feet, land-surface datum 39.2 feet above sea level

Day	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1	---	---	---	---	---	---	---	---	---	126.12	---	---
2	---	---	---	---	---	---	---	---	122.13a	126.18	---	---
3	---	---	---	---	---	---	---	120.41a	122.19	126.25	---	---
4	---	---	---	---	123.72a	---	---	---	122.39	126.41	---	---
5	---	---	---	---	---	---	123.62a	---	122.52	---	---	---
6	---	---	---	---	---	---	---	---	122.58	---	---	---
7	---	---	---	---	---	---	---	---	122.60	---	---	---
8	---	---	---	---	---	---	---	---	122.75	---	---	---
9	---	---	---	---	---	---	---	---	122.81	---	---	---
10	---	---	---	---	---	---	---	---	122.90	---	---	---
11	---	122.90a	---	124.27a	---	---	---	---	123.06	---	---	---
12	---	123.23	---	---	---	---	---	---	123.27	---	---	---
13	---	123.34	---	---	---	---	---	---	---	---	---	---
14	---	123.43	---	---	---	---	---	---	---	---	---	---
15	---	123.39	---	---	---	---	---	---	123.48	---	---	---

a, instantaneous water-level measurement

Table 7. *Summary of daily mean water-level depths in observation wells equipped with digital recorders*--Continued

CH Bc 5 Station number 383524077094401--Continued
Latitude 383524, longitude 0770944, U.S. Navy well no. 14,
Well depth 430 feet, land-surface datum 39.2 feet above sea level

Day	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
16	---	---	---	---	---	---	---	---	123.82	---	---	---
17	---	---	---	---	124.01a	---	---	---	123.88	---	---	---
18	---	---	---	---	---	---	---	---	124.01	---	---	---
19	---	122.84a	---	---	---	---	---	---	---	---	---	---
20	---	---	---	---	---	---	---	---	124.44	---	---	---
21	---	---	---	---	---	---	---	---	124.64	---	---	---
22	---	---	---	---	---	---	---	---	124.93	---	---	---
23	---	---	---	---	---	---	---	---	125.01	---	---	---
24	---	122.60a	---	---	---	---	---	---	---	---	---	---
25	---	123.03a	---	---	---	---	---	---	---	---	---	---
26	---	---	---	---	---	---	---	---	125.46	---	---	---
27	---	---	---	---	---	---	---	---	125.62	---	---	---
28	123.77a	---	---	---	---	---	---	---	125.23a	---	---	---
29	123.94a	---	---	---	---	---	---	---	125.86	---	124.64a	---
30	---	---	---	---	---	---	---	---	---	---	---	---
31	---	---	---	---	---	---	---	---	---	---	---	---

CH Bc 24 Station number 383633077083001
Latitude 383633 longitude 0770830 Potomac Heights well no. 2
Well depth 435 feet, land-surface datum 72 feet above sea level

Day	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1	---	142.71	146.47	150.06	151.03	152.91	150.25	150.04	150.87	150.71	151.79	---
2	---	143.12	146.59	150.24	151.05	152.52	150.21	---	150.95	150.58	---	---
3	---	143.39	146.34	150.42	151.10	152.14	150.37	150.89	150.75	150.49	---	---
4	---	143.61	146.51	150.62	151.18	151.64	150.58	150.64	150.98	151.00	---	---
5	---	143.91	146.80	150.97	---	151.51	150.65	150.03	150.88	150.90	---	---
6	---	143.80	147.05	151.30	151.44	151.64	150.97	149.84	150.77	150.62	---	---
7	---	143.84	147.11	151.54	151.55	151.51	151.02	150.12	150.67	150.70	---	---
8	---	143.57	147.05	151.77	151.56	151.34	150.96	150.24	150.83	150.56	---	---
9	---	143.64	147.08	151.99	151.63	151.29	150.47	150.34	150.78	150.76	---	---
10	---	143.61	147.29	152.07	151.66	151.18	150.31	150.10	150.73	151.01	---	---
11	---	143.80	147.38	---	151.93	151.15	150.62	150.17	150.78	151.12	---	---
12	---	143.83	147.47	152.17	152.05	151.03	150.86	150.36	150.94	151.01	---	---
13	---	143.80	147.59	152.17	152.06	150.82	151.05	150.10	150.72	151.06	---	---
14	---	143.81	147.79	151.98	152.15	150.94	150.81	150.20	150.71	151.28	---	---
15	---	143.85	148.01	152.00	152.36	150.89	150.60	150.25	150.71	151.11	152.02a	---
16	---	143.89	148.19	152.13	152.59	150.85	150.66	150.25	151.03	151.23	---	---
17	---	143.91	148.34	152.21	152.39	150.67	150.48	150.12	150.83	151.38	---	---
18	---	143.84	148.59	152.41	152.23	150.61	150.41	150.46	150.93	151.54	---	---
19	---	143.97	148.69	152.35	152.12	150.62	150.54	150.42	150.84	151.56	---	---
20	---	144.23	148.79	152.29	151.97	150.56	150.55	150.18	150.98	151.61	---	---
21	---	144.13	149.10	152.04	151.94	150.64	150.28	150.62	151.09	152.24	---	---
22	---	144.13	149.33	151.88	151.99	150.81	150.22	150.92	151.20	152.01	---	---
23	---	144.11	149.50	151.59	151.79	150.55	150.26	150.79	150.93	152.00	---	---
24	---	144.22	149.67	151.32	151.60	150.62	150.17	150.70	150.72	151.91	---	---
25	---	144.40	149.41	151.24	151.70	150.45	150.35	150.69	150.81	151.86	---	---
26	---	---	149.39	151.09	151.67	150.43	150.36	150.65	151.04	151.76	---	---
27	---	146.29	149.69	151.00	151.78	150.42	150.39	150.53	151.03	151.77	---	---
28	---	146.14	149.57	150.95	151.83	150.38	150.24	150.57	150.72	152.00	---	---
29	---	146.13	149.62	150.95	151.74	150.40	150.35	150.99	151.11	151.93	---	---
30	142.58a	146.21	149.85	150.94	153.67	150.23	150.28	150.82	150.92	151.99	---	---
31	---	146.37	---	150.94	153.61	---	150.22	---	150.69	151.99	---	---

a, instantaneous water-level measurement

Table 7. *Summary of daily mean water-level depths in observation wells equipped with digital recorders*--Continued

CH Cb 7 Station number 383422077114601
Latitude 383422, longitude 0771146, U.S. Navy well no. 19
Well depth 400 feet, land-surface datum 36 feet above sea level

Day	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
1	---	87.91	83.99	---	---	87.29	86.81	86.49	85.37	86.52	85.76	---
2	---	87.91	84.01	---	---	87.15	86.54	86.46	85.16	86.43	---	---
3	---	87.88	83.72	---	---	86.96	86.19	86.71	85.04	86.29	---	---
4	---	87.72	83.53	---	84.36a	86.78	85.97	86.82	85.38	86.53	---	---
5	---	87.68	83.67	83.89	84.54	86.57	85.92	86.64	85.41	86.72	---	---
6	---	87.57	83.92	---	84.74	86.43	86.07	86.52	85.41	86.43	---	---
7	---	87.61	83.96	---	84.96	86.32	86.28	86.61	85.50	86.43	---	---
8	---	87.51	83.89	---	84.86	86.36	86.46	86.56	85.65	86.34	---	---
9	---	87.43	83.73	---	84.86	86.42	86.31	86.68	85.62	86.40	---	---
10	---	87.36	83.81	---	84.95	86.51	86.14	86.66	85.65	86.60	---	---
11	---	---	83.92	84.05	85.19	86.64	86.31	86.60	85.86	86.75	---	---
12	---	87.61	83.87	84.09	85.31	86.68	86.64	86.75	85.84	86.75	---	---
13	---	87.63	83.72	84.19	85.34	86.55	86.93	86.40	85.80	86.77	---	---
14	---	87.72	83.55	84.11	85.45	86.66	86.99	86.13	85.76	86.96	---	---
15	---	87.57	83.53	83.91	85.63	86.72	86.89	86.11	85.93	86.84	86.48a	---
16	---	87.11	83.68	83.73	85.90	86.73	86.92	85.93	86.02	86.83	---	---
17	---	86.82	83.67	83.49	86.03	86.67	86.69	85.67	86.07	86.84	---	---
18	---	86.50	83.81	83.41	86.03	86.69	86.34	85.90	86.05	86.84	---	---
19	---	86.19	83.73	83.44	86.02	86.71	86.24	85.89	86.07	86.85	---	---
20	---	85.86	83.60	83.52	86.07	86.66	86.27	85.61	86.21	86.79	---	---
21	---	85.86	83.63	83.73	86.23	86.64	86.14	85.69	86.43	87.16	---	---
22	---	85.93	83.62	---	86.46	86.78	86.12	85.87	86.44	87.19	---	---
23	---	85.66	83.58	---	86.54	86.71	86.25	85.86	86.28	87.12	---	---
24	---	85.56	83.74	---	86.53	86.71	86.23	85.82	86.26	87.05	---	---
25	---	85.51	83.83	---	86.68	86.66	86.31	85.78	86.45	86.97	---	---
26	---	85.54	83.84	---	86.77	86.65	86.37	85.51	86.56	86.88	---	---
27	---	85.16	---	---	86.89	86.67	86.47	85.33	---	86.67	---	---
28	---	84.87	---	---	86.99	86.70	86.43	85.11	---	86.47	---	---
29	87.79a	84.60	---	---	86.99	86.79	86.59	85.35	86.63	86.02	---	---
30	87.90	84.41	---	---	87.10	86.80	86.65	85.38	86.68	85.94	---	---
31	---	84.19	---	---	87.24	---	86.67	---	86.54	86.00	---	---

a, instantaneous water-level measurement

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*

[Chemical concentration, in milligrams per liter (mg/L) unless otherwise noted; all analyses by USGS laboratory unless indicated by *; µS/cm, microsiemens per centimeter at 25 degrees Celsius; <, less than; --, no data available]

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH--														
Bb 1	07/19/38	7.6	65	210	--	--	42	1.0	0.6	2.1	150	12	1.0	--
	05/26/52	6.2	60	195	261	7.7	34	1.1	.2	2.1	150	10	.7	--
	07/13/56	11	69	229	299	8.0	30	.7	.1	2.9	160	9.6	.8	4.3
Bb 2	05/28/52	20	78	222	342	8.3	19	.3	.2	2.5	170	10	.6	--
	10/11/73*	19	--	--	300	8.0	34.5	.1	2.4	--	--	8	--	--
Bb 4	05/28/52	10	68	215	291	8.2	25	.4	.1	2.7	150	16	.8	.8
Bb 5	05/28/52	6.1	65	198	274	8.0	27	.6	.1	2.6	152	14	.8	--
	07/13/56	6.1	67	202	270	8.0	34	.3	<.1	2.4	150	11	.9	5
	10/14/57	9.0	66	219	304	7.9	32	.9	.5	3.2	157	8.6	.8	3.7
	06/17/59	9.8	66	208	279	7.9	39	.9	.2	2.5	149	12	1.2	4.0
	04/27/61	8.5	62	199	280	7.6	34	.3	.2	2.5	142	10	1.0	4.6
Bb 6	07/15/38	2.0	--	--	--	--	--	--	--	--	--	--	--	-
	05/28/52	7.1	64	196	282	8.0	25	.5	--	2.4	151	12	.7	.5
	07/13/56	7.0	65	207	280	8.0	32	.9	.1	2.4	155	11	1.0	3.3
	10/14/57	9.0	70	216	309	8.0	34	.7	.3	3.2	166	10	.9	2.2
	06/17/59	7.2	65	205	286	7.8	38	.7	.2	2.4	151	12	1.1	4.0
	04/27/61	8.0	62	195	285	7.5	33	.5	.2	2.5	145	11	1.0	4.4
	03/15/62	7.5	--	199	--	--	--	--	--	--	--	--	--	--
Bb 7	07/15/38	9.0	--	--	--	--	--	--	--	--	--	--	--	--
	05/28/52	10	71	220	310	7.9	25	.3	.1	2.5	163	12	1.2	.4
	07/13/56	11	71	229	308	7.9	34	.3	.2	2.4	164	11	1.1	6.7
	10/14/57	9.0	73	220	316	7.9	35	.4	.5	3.2	171	10	.9	3.8
	06/17/59	10	72	226	312	7.8	39	.9	.4	2.6	163	12	1.3	4.2
	04/27/61	9.5	67	211	303	7.5	35	.4	.2	2.5	153	11	1.1	5.9
	03/15/62	10	--	219	--	--	--	--	--	--	--	--	--	--

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*--Continued

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH–														
Bb 8	07/19/38	4.3	60	192	--	--	36	1.1	0.6	2.0	144	13	1.0	--
	01/25/51	7.0	56	196	284	7.7	34	1.4	.3	4.7	145	14	1.1	--
	05/15/52	6.6	64	198	276	7.9	34	.3	.2	2.6	150	14	.7	--
	07/13/56	6.2	65	210	281	8.0	35	.4	.1	2.4	155	11	.9	5.8
	10/14/57	8.5	69	227	314	7.9	36	.4	.5	3.2	168	10	.9	3.6
	06/17/59	6.2	69	216	289	7.8	45	.4	.2	2.8	160	13	1.0	4.4
	04/27/61	7.0	62	199	279	7.4	35	.4	<.5	2.5	140	12	.9	5.1
	05/27/75*	9.3	67	--	--	--	--	.1	--	--	--	--	--	--
Bb 9	05/28/52	2.7	61	198	255	7.9	37	1.5	.2	2.7	153	16	.8	--
	07/13/56	3.0	63	198	262	7.9	35	.5	.1	2.7	146	11	.8	4.7
	10/14/57	3.0	58	202	275	7.8	37	.9	.6	3.2	154	11	.8	3.4
	04/27/61	2.5	58	186	259	7.4	36	.7	.1	2.8	138	12	.9	4.8
	03/15/62*	3.0	--	191	--	--	--	--	--	--	--	--	--	--
	05/27/75*	3.0	59	168	--	--	--	.1	--	--	--	--	--	--
	12/17/85*	6.0	59	--	--	7.7	--	--	--	--	--	--	.7	--
Bb 12	12/15/53*	6.2	--	232	--	--	--	--	--	--	--	--	--	--
	11/15/56*	7.0	--	184	--	--	--	--	--	--	--	--	--	--
	07/15/58*	6.5	--	274	--	--	--	--	--	--	--	--	--	--
	06/18/71*	28	110	386	--	--	--	--	--	--	--	--	--	--
	06/22/73*	34	113	398	--	--	--	--	--	--	--	--	--	--
	09/24/74*	36	120	474	--	--	--	--	--	--	--	--	--	--
	03/05/75*	32	140	416	--	7.9	35	4.8	3.5	--	278	4.2	.4	--
	08/25/82*	--	--	412	--	--	--	--	--	--	--	--	--	--
	05/09/85*	22	102	328	--	--	--	--	--	5.6	--	2.4	.4	--
	06/05/85*	28	99	366	--	--	--	--	--	6.8	--	1.1	3.7	--
Bb 13	07/13/56*	7.0	65	207	280	8.0	32	.9	.1	2.4	155	11	1.0	3.3

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*--Continued

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH--														
Bb 14	10/14/57	11	66	218	314	7.8	34	0.4	0.5	3.2	157	9.4	0.8	3.2
	06/15/59	14	73	217	315	7.8	37	.9	.3	2.8	159	11	1.0	3.5
	04/27/61	19	72	221	333	7.7	30	.5	.1	2.7	152	11	1.0	3.8
Bb 15	12/29/55	--	--	--	315	--	--	--	--	--	--	--	--	--
	01/05/56	15	60	238	352	8.2	37	6.8	4.4	5.2	194	1.6	.3	1.6
Bb 16	03/01/56	13	--	--	325	8.3	--	--	--	--	164	--	--	4.8
Bb 17	12/12/59	18	93	271	377	7.6	39	1.7	.5	3.7	210	7.2	.6	2.6
	04/27/61	28	100	295	459	7.4	36	1.3	.5	4.4	240	2.0	.6	2.2
	03/00/62*	26	--	277	--	--	--	--	--	--	--	--	--	--
	05/27/75*	37	103	286	--	--	--	.1	--	--	--	--	--	--
Bb 18	11/02/70*	11	--	227	--	--	34	--	.45	--	--	3	.5	--
Bb 19	10/11/73	--	--	--	300	--	34.5	.1	2.40	--	--	8	--	--
Bb 20	01/18/71*	95	--	399	--	--	40	--	8	--	--	.5	--	--
Bb 21	12/17/70*	67	--	389	--	--	45	--	3.7	--	--	5	--	--
Bc 2	05/15/52	2.6	58	187	253	7.9	34	.3	.20	2.6	140	14	.6	--
	07/13/56	2.2	59	190	255	8.0	34	--	--	--	--	--	--	--
	10/14/57	2.5	59	193	255	7.8	37	.4	.10	3.2	140	10	.8	3.2
Bc 3	07/27/38	11	72	211	--	--	26	1.5	.40	2.2	170	11	1.1	--
	05/28/52	14	76	220	323	7.9	29	.5	.10	2.9	170	14	.7	--
	07/13/56	7.3	66	210	280	8.0	31	.3	.20	2.3	160	9.4	.9	4.5
	10/14/57	5.0	64	198	276	7.8	35	.7	.50	2.4	150	9.6	.8	3.0
	6/17/59	3.6	61	194	267	7.8	37	.7	.60	2.5	150	12	1.0	2.9
	4/27/61	4.0	60	194	268	7.4	35	.5	.05	2.8	150	10	.8	4.2
	7/15/62*	4.5	--	202	--	--	--	--	--	--	--	--	--	--

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*--Continued

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH--														
Bc 5	05/26/52	19	77	227	337	7.8	27	0.5	0.10	2.8	170	11	0.8	--
	07/13/56	23	84	242	362	8.0	26	.4	.10	2.8	170	9.0	.9	3.6
	10/14/57	23	78	240	373	7.7	28	.4	.40	1.8	170	9.4	.0	3.5
	06/17/59	25	83	238	371	7.9	36	.8	.40	3.0	170	10	1.1	2.8
	04/27/61	25	80	235	373	7.5	28	.7	.40	3.3	170	11	.9	3.2
	03/15/62*	26	--	241	--	--	--	--	--	--	--	--	--	--
Bc 6	03/15/56	3.6	--	188	258	--	--	--	--	--	--	--	--	--
	11/15/58	3.3	--	206	--	--	--	--	--	--	--	--	--	--
	03/09/61	2.5	56	185	258	7.7	45	.8	.05	2.1	130	14	1.0	6.6
	04/15/61*	4.5	--	170	--	--	--	--	--	--	--	--	--	--
	08/15/61*	5.0	--	230	--	--	--	--	--	--	--	--	--	--
	05/15/62*	4.5	--	206	--	--	--	--	--	--	--	--	--	--
	03/15/63*	6.0	--	170	--	--	--	--	--	--	--	--	--	--
	03/15/64*	5.3	--	194	--	--	--	--	--	--	--	--	--	--
	09/15/65*	3.5	--	194	--	--	--	--	--	--	--	--	--	--
	12/15/66*	4.0	--	186	--	--	--	--	--	--	--	--	--	--
	06/15/69*	4.5	--	210	--	--	--	--	--	--	--	--	--	--
	06/15/70*	1.2	--	196	--	--	--	--	--	--	--	--	--	--
	06/15/71*	4.0	--	194	--	--	--	--	--	--	--	--	--	--
	06/15/73*	5.1	--	200	--	--	--	--	--	--	--	--	--	--
	03/15/75*	4.7	--	188	--	--	--	--	--	--	--	--	--	--
	06/15/81*	2.0	--	220	--	--	--	--	--	--	--	--	--	--
Bc 12	03/28/50	1.2	70	224	357	7.8	16	5.9	2.4	8.6	210	13	.5	--
Bc 15	04/14/55	6.0	68	215	299	7.8	36	.6	1.0	3.6	160	7.3	1.1	5.8
Bc 22	01/31/56	10	--	--	348	8.2	--	--	--	--	190	--	--	3.8
	02/07/56	2.8	--	--	260	8.2	--	--	--	--	150	--	--	3.8

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*--Continued

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH--														
Bc 23	10/15/60*	11	--	248	--	--	--	--	--	--	--	--	--	--
	08/15/61*	--	--	270	--	--	--	--	--	--	--	--	--	--
	05/15/62*	12	--	264	--	--	--	--	--	--	--	--	--	--
	03/15/63*	16	--	282	--	--	--	--	--	--	--	--	--	--
	04/15/64*	18	--	294	--	--	--	--	--	--	--	--	--	--
	12/15/64*	20	--	318	--	--	--	--	--	--	--	--	--	--
	12/15/66*	17	--	320	--	--	--	--	--	--	--	--	--	--
	06/15/68*	62	--	292	--	--	--	--	--	--	--	--	--	--
	06/15/69*	22	--	344	--	--	--	--	--	--	--	--	--	--
	06/15/71*	28	--	386	--	--	--	--	--	--	--	--	--	--
	06/18/71*	17	95	280	--	--	--	--	--	--	--	--	--	--
	07/28/71*	--	--	320	--	--	--	--	--	--	--	--	--	--
	01/14/74	--	130	374	--	--	--	--	--	--	--	--	--	--
	03/27/75	29	120	348	--	7.0	33	2.2	1.9	--	23	5.0	0.4	--
	06/15/75*	28	--	322	--	--	--	--	--	--	--	--	--	--
	12/07/82*	44	120	426	--	--	--	--	--	--	--	--	--	--
	06/05/85*	32	103	374	--	--	--	--	--	6.3	--	<1	.3	--
	12/22/86*	41.9	--	--	--	--	--	--	--	--	--	--	--	--
Bc 24	09/14/55*	--	--	--	--	7.6	--	--	--	--	--	--	--	--
	11/27/62*	--	--	201	--	--	--	--	--	--	--	--	.7	--
Bc 49	06/15/69*	4.5	--	216	--	--	--	--	--	--	--	--	--	--
	06/15/70*	1.2	--	206	--	--	--	--	--	--	--	--	--	--
	06/15/71*	2.0	--	200	--	--	--	--	--	--	--	--	--	--
	07/15/73*	3.2	--	210	--	--	--	--	--	--	--	--	--	--
	08/15/75*	3.4	--	182	--	--	--	--	--	--	--	--	--	--
	02/15/79*	4.0	--	188	--	--	--	--	--	--	--	--	--	--
Bc 63	11/20/62	--	--	201	--	7.7	30.4	--	--	--	--	--	.7	--

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*--Continued

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH--														
Bc 67	07/14/70*	66	--	380	--	7.4	--	0.1	--	--	--	10.7	1.3	--
	06/22/73*	78	97	346	--	--	--	--	--	--	--	--	--	--
	03/06/75	81	126	366	--	7.5	35	<1	<1	--	157	7.7	1.6	--
	08/25/82*	--	--	387	--	--	--	--	--	--	--	--	--	--
	08/25/82*	--	--	380	--	--	--	--	--	--	--	--	--	--
	06/05/85*	110	121	394	--	--	--	--	--	--	--	--	--	--
	11/26/86*	112	--	--	--	--	--	--	--	--	--	--	--	--
Bc 70	03/08/82	2	72	--	--	--	--	--	--	--	--	--	--	--
	05/09/85	3	49	174	--	7.7	--	--	--	1.8	--	10	.90	--
	06/05/85	2	62	192	--	7.4	--	--	--	2.5	--	10	.90	--
	11/26/86	3.7	--	--	--	--	--	--	--	--	--	--	--	--
Bd 15	05/12/60	6.5	--	170	273	8.0	11	16	4.4	--	140	17	.20	--
Bd 46	06/26/86*	2.9	95	297	410	7.4	33	.6	.30	3.7	250	13	1.4	--
Cb 7	02/29/52*	2.8	61	204	277	7.8	34	3.3	.10	2.6	156	15	1.0	.2
Cb 8	08/26/53	101	47	339	536	6.9	32	23	19	2.7	140	.8	<.05	.2
	01/15/71*	61	29	244	385	6.9	34	30	7.8	--	--	1.8	<.05	--
	05/15/75*	137	--	410	--	6.9	35	62	56	--	--	--	--	--
Cb 9	07/13/56	6.5	68	213	291	7.8	33	.9	.50	3.2	160	11	1.2	4.7
	10/14/57	6.0	64	209	293	7.6	35	.4	.50	1.8	160	10	.50	13.0
	06/17/59*	8.4	72	224	318	7.6	36	1.0	.60	3.3	170	13	1.5	5.5
	04/27/61*	10	70	219	322	7.3	35	.8	.60	3.5	160	12	1.3	6.1
	03/15/62*	11	--	234	--	--	--	--	--	--	--	--	--	--
	05/27/75*	--	--	238	--	--	--	.1	--	--	--	--	--	--
Cb 10	10/18/55	28	100	308	464	7.5	33	1.4	1.0	1.1	228	6.6	.70	4.8

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*--Continued

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH--														
Cb 11	07/13/56	51	140	407	638	8.0	36	1.4	0.5	5.7	312	7.0	1.3	1.7
	10/14/57	49	150	420	650	7.6	38	.7	.5	8.8	316	7.0	1.1	3.7
Cb 12	11/01/55	49	150	406	646	7.7	34	.8	.1	5.7	316	7.4	1.0	2.3
	07/16/56	53	150	411	650	7.9	35	1.4	.2	5.6	309	7.0	1.3	1.6
	10/14/57	--	146	417	650	7.7	37	.9	.5	8.8	316	7.0	1.2	3.8
Cb 16	04/27/61	11	76	232	340	7.6	35	.3	.1	3.5	174	12	1.3	6.2
Cb 18	09/11/54	8.0	78	230	315	7.4	27	.6	.2	2.6	176	6.9	1.5	9.1
	04/14/55	8.2	75	230	323	7.8	34	.4	.8	3.6	177	6.1	1.0	5.3
	07/13/56	9.8	75	230	326	8.0	33	.5	.3	3.2	176	11	1.2	4.4
	10/14/57	8.5	71	229	301	7.7	35	.4	.2	2.4	174	11	.5	13.0
	06/15/59	9.8	78	235	336	7.9	40	.9	.2	3.3	179	13	1.7	4.5
	04/27/61*	11	76	232	340	--	35	.1	3.5	--	174	12	1.3	6.2
	03/15/62*	12	--	238	--	--	--	--	--	--	--	--	--	--
	05/27/75*	24.5	88	260	--	--	--	--	--	--	--	--	--	--
	03/23/78*	45.3	91	--	--	--	15	.8	3.4	--	--	1.0	--	--
Cb 19	07/13/56	7.5	68	210	296	7.7	34	.9	.3	3.1	160	9.4	.9	2.7
	10/14/57	8.0	70	217	309	7.7	35	.4	.2	2.4	170	9.8	.2	--
	06/15/59*	1.9	60	192	261	7.7	37	1.4	.4	2.8	150	11	1.0	3.8
	04/27/61*	2.5	58	188	262	7.3	36	1.0	.2	2.9	140	12	.9	5.3
	03/15/62*	5.5	--	202	--	--	--	--	--	--	--	--	--	--
	05/27/75*	11.0	72	226	--	--	--	--	--	--	--	--	--	--
	03/15/78*	21.4	--	--	--	--	--	--	--	--	--	--	--	--
	12/16/85*	21.0	74	--	--	8.0	--	--	--	--	--	--	.8	--
Cb 26	11/12/58	13	73	220	334	7.5	35	1.4	.8	4.3	171	11	1.1	6.0

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*--Continued

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH--														
Cb 28	01/12/61	9.0	69	211	310	7.3	33	0.7	0.50	13	160	1.1	<0.05	6.70
	03/15/62	8.0	--	209	--	--	--	--	--	--	--	--	--	--
	12/17/85*	10	62	381	--	7.4	--	--	--	--	--	--	1.02	<.2
	06/09/87*	--	57	--	--	--	--	--	--	--	--	--	--	--
Cb 29	10/14/57	2.0	59	198	270	7.8	36	.1	2.8	10	151	.70	.09	2.60
	04/27/61	7.5	66	207	298	7.5	36	.5	2.9	12	154	.90	.09	4.90
	03/15/62*	7.5	--	216	--	--	--	--	--	--	--	--	--	--
	05/15/75*	5.5	--	188	--	--	--	--	--	--	--	--	--	--
	05/27/75*	5.5	158	188	--	--	--	--	--	--	--	--	--	--
	03/15/78*	7.0	--	--	--	--	--	--	--	--	--	--	--	--
Cb 34	01/15/71	95	--	399	--	7.3	40	8	--	.5	--	--	.5	--
	01/15/73	143	--	--	950	7.1	30	44	--	--	--	--	--	--
	11/15/81	140	--	--	950	6.7	33	12	--	10	110	--	--	--
Cb 35	06/19/84*	58	10.4	335	--	--	34	<.01	8.5	10	--	.6	.26	--
	07/03/86*	42	29.6	415	37	7.4	30	8	--	12	312	.90	.7	1.50
Cb 36	10/30/70*	233	--	--	--	--	33	.4	--	7	--	.6	.4	--
Cb 37	03/02/71*	176	--	508	--	--	36	.1	--	13	--	2.0	--	--
Cc 5	04/02/52	.5	88	265	411	7.9	36	3.5	7.6	7.5	270	.90	.80	.30
Cc 25	05/15/69*	3.5	--	330	--	--	--	--	--	--	--	--	--	--
	07/15/71*	2.1	--	290	--	--	--	--	--	--	--	--	--	--
	07/15/72*	2.1	--	304	--	--	--	--	--	--	--	--	--	--
	06/15/73*	2.6	--	268	--	--	--	--	--	--	--	--	--	--
	05/15/75*	3.0	--	250	--	--	--	--	--	--	--	--	--	--
	02/15/79*	2.0	--	254	--	--	--	--	--	--	--	--	--	--
	05/15/81*	2.0	--	242	--	--	--	--	--	--	--	--	--	--
Cc 31	05/02/77*	1.0	70	280	--	--	48	.09	--	13.2	173	.98	--	--

Table 8. *Summary of selected chemical-quality analyses of ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1937-87*--Continued

Local well no.	Date	Chloride, dissolved (mg/L as Cl)	Sodium, dissolved (mg/L as Na)	Total dissolved solids (mg/L)	Specific conductance (µS/cm)	pH (standard units)	Silica, dissolved (mg/L as SiO_2)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Potassium, dissolved (mg/L as K)	Bicarbonate, dissolved (mg/L as HCO_3)	Sulfate, dissolved (mg/L as SO_4)	Fluoride, dissolved (mg/L as F)	Phosphate, dissolved (mg/L as PO_4)
CH--														
Cd 7	04/03/52	7.0	--	306	465	7.9	24	0.2	4.9	4.0	300	1.3	0.80	1.00
Cd 9	03/09/61	.5	--	275	423	7.9	36	.1	5.7	5.2	270	.90	<.50	1.70
Cd 10	04/17/52	3.8	4.4	110	173	6.8	15	1.3	5.7	5.8	96	<.05	.62	<.05
Cd 24	05/12/60	7.5	--	200	279	6.8	40	1.2	5.7	13	150	1.2	.31	<.05
Cd 26	12/15/61	20	57	262	424	7.6	13	5.6	6.8	20	220	.50	.31	.11
Cd 34	09/25/74*	4.0	94	305	--	--	30	5.44	--	--	--	.70	.66	--

Table 9. *Summary of selected chemical-quality analyses of water samples collected from the Potomac River near Indian Head area, northwestern Charles County, Maryland, 1988*

[µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; --, no data avalilable]

Local identifier	Station no.	Date	Specific conductance, (µS/cm)	pH (standard units)	Water temperature, (C)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Sulfate, dissolved (mg/L as SO4)	Chloride, dissolved (mg/L as Cl)	Bromide, dissolved (mg/L as Br)
Potomac River at Indian Head	01655480	08-30-88	403	8.0	15.5	23	11	35	51	56	0.081
		11-01-88	--	--	--	34	19	92	85	170	.38
Potomac River at Buoy 45/46	383330077141000	08-30-88	944	7.5	14.5	20	21	120	69	210	.61
		11-01-88	--	--	--	40	56	390	150	710	2.2
Potomac River at Buoy 64/66	384040077073000	08-30-88	396	8.0	15.0	29	10	31	53	43	.044

Local identifier	Silica, dissolved (mg/L as SiO_2)	Solids, residue at 180 °C dissolved (mg/L)	Solids, sum of constituents dissolved (mg/L)	Iron (mg/L as Fe)	Manganese (mg/L as Mn)
Potomac River at Indian Head	0.31	216	203	<3	3
	2.5	480	442	7	4
Potomac River at Buoy 45/46	.88	530	461	14	69
	2.4	1,450	1,380	<3	11
Potomac River at Buoy 64/66	.61	222	201	12	4

Table 10. *Summary of selected chemical-quality analyses from ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1988*

[USGS, U.S. Geological Survey; TIH, Town of Indian Head; PH, Potomac Heights; SN, Stump Neck; min, minutes; gal/min, gallons per minute; µS/cm, microsiemens per centimeter at 25 degrees Celsius; °C, degrees Celsius; mg/L milligrams per liter; µg/L, micrograms per liter; <, less than; >, greater than; -, no data available]

USGS identifier	Local identifier	Station no.	Date	Primary geologic units	Water level, depth below and surface (feet)	Depth of well (feet)	Depth, to top of sample interval (feet)	Depth, to bottom of sample interval (feet)
CH Bb 6	USN 6	383505077101006	05-17-88	Patapsco	--	398	251	397
			08-29-88		--	398	251	397
			11-01-88		--	398	251	397
			12-01-88		--	398	251	397
CH Bb 7	USN 7	383505077101007	05-17-88	Patapsco	--	399	255	399
			08-29-88		--	399	255	399
			11-01-88		--	399	255	399
			12-01-88		--	399	255	399
CH Bb 9	USN 9	383505077101009	05-17-88	Patapsco	--	390	185	376
			08-29-88		--	390	185	376
			11-01-88		--	390	185	376
			12-01-88		--	390	185	376
CH Bb 12	TIH 1	383552077100401	05-19-88	Patapsco	--	515	238	298
			05-26-88		--	515	238	298
			08-30-88		--	515	238	298
			11-02-88		--	515	238	298
			12-02-88		--	515	238	298
CH Bb 17	USN B	383524077111802	05-24-88	Patapsco	116.75	294	240	294
CH Bb 19	USN 2	383533077104002	05-18-88	Patapsco	--	380	270	380
			08-29-88		--	380	270	380
			11-01-88		--	380	270	380
			12-01-88		--	380	270	380
CH Bc 3	USN 12	383507077094903	05-17-88	Patuxent	--	390	--	--
			08-29-88		--	390	--	--
			11-01-88		--	390	--	--
			12-01-88		--	390	--	--
CH Bc 5	USN 14	383524077094401	05-25-88	Cretaceous	123.03	430	--	--
CH Bc 6	PH 1	383631077083501	05-19-88	Patuxent	--	412	362	412
			05-26-88		--	412	362	412
			08-30-88		--	412	362	412
			11-02-88		--	412	362	412
CH Bc 23	TIH 2	383545077095501	05-19-88	Patapsco	--	352	229	311
			05-26-88		--	352	229	311
			08-30-88		--	352	229	311
			11-02-88		--	352	229	311
			12-02-88		--	352	229	311
CH Bc 24	PH 2	383633077083001	05-26-88	Patuxent	147.66	435	383	435
CH Bc 49	TIH 6	383540077090701	05-19-88	Patuxent	--	404	340	404
			08-30-88		--	404	340	404
			11-02-88		--	404	340	404
			12-01-88		--	404	340	404
CH Bc 67	TIH 3	383606077092101	05-19-88	Patuxent	--	522	488	522
			05-26-88		--	522	488	522
			08-30-88		--	522	488	522
			11-02-88		--	522	488	522
			12-02-88		--	522	488	522
CH Bc 68	PH 3	383610077081001	05-19-88	Patuxent	--	514	414	514
			08-30-88		--	514	414	514
			11-02-88		--	514	414	514
			12-01-88		--	514	414	514

Elevation of land-surface data above sea level (feet)	Pump or flow period prior to sampling (min)	Estimated flow rate instantaneous (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Water temperature (°C)	Color (platinum-cobalt units)	Calcium, dissolved (mg/L as Ca)	USGS identifier
38.7	1,000	150	286	7.9	17.0	3	0.27	CH Bb 6
	1,000	150	386	7.6	20.0	--	.30	
	1,000	150	280	8.0	16.0	--	.32	
	1,000	150	255	7.9	15.5	--	.33	
38.9	50	150	315	7.9	18.0	1	.31	CH Bb 7
	60	150	310	7.9	19.0	--	.28	
	60	150	300	8.0	16.0	--	.25	
	1,000	150	302	7.9	16.0	--	.26	
32.1	1,000	150	262	7.8	17.0	1	.36	CH Bb 9
	1,000	150	265	7.4	19.0	--	.35	
	1,000	150	274	--	15.5	--	.40	
	1,000	150	256	7.8	17.0	--	.41	
95	20	200	750	7.2	18.5	14	5.8	CH Bb 12
	360	200	337	7.2	12.0	--	--	
	70	200	651	7.3	17.0	--	4.5	
	15	200	835	7.3	15.0	--	8.2	
	20	200	622	7.2	16.0	--	4.6	
52	240	7.2	497	7.7	19.0	3	4.4	CH Bb 17
90	15	150	473	7.6	17.5	2	.75	CH Bb 19
	30	150	493	7.8	17.0	--	.81	
	15	150	497	7.7	15.5	--	.89	
	15	150	501	7.6	16.5	--	.94	
18.7	1,000	150	281	8.0	18.0	2	.19	CH Bc 3
	1,000	150	280	7.7	18.0	--	.19	
	1,000	150	281	8.0	15.5	--	.29	
	1,000	150	279	8.0	15.5	--	.22	
39.2	240	8.0	420	8.0	16.0	2	.65	CH Bc 5
70	30	150	252	8.0	17.0	<1	.05	CH Bc 6
	30	150	246	8.1	17.5	--	--	
	120	150	251	8.0	17.5	--	.07	
	60	150	256	8.1	15.5	--	.14	
65	240	150	720	7.5	18.5	13	4.1	CH Bc 23
	360	150	467	7.3	18.0	--	--	
	120	150	485	7.5	16.5	--	1.9	
	240	150	511	7.6	14.5	--	2.1	
	120	150	719	7.5	15.0	--	5.2	
72	240	8.0	659	7.2	17.5	2	34	CH Bc 24
33	45	150	294	7.6	17.0	1	.58	CH Bc 49
	45	150	272	7.9	16.5	--	.35	
	60	150	261	8.0	15.0	--	.33	
	20	150	243	8.0	15.5	--	.30	
30	20	200	675	7.7	18.5	<1	.29	CH Bc 67
	360	200	647	7.7	10.0	--	--	
	120	200	678	7.9	18.5	--	.32	
	30	200	660	7.9	16.5	--	.32	
	120	200	653	8.0	17.0	--	.36	
75	20	150	244	7.8	16.5	<1	.12	CH Bc 68
	30	150	245	8.0	18.0	--	.11	
	30	150	249	8.0	15.0	--	.12	
	60	150	244	7.9	16.5	--	.12	

Table 10. *Summary of selected chemical-quality analyses from ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1988*--Continued

USGS identifier	Local identifier	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)	Alkalinity, total field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Bromide, dissolved (mg/L as Br)
CH Bb 6	USN 6	0.25	67	2.3	130	9.0	7.5	0.90	0.040
		.29	67	--	--	8.9	7.9	--	.036
		.25	64	--	--	8.5	7.3	--	.040
		.25	66	--	--	8.4	7.0	--	.035
CH Bb 7	USN 7	.27	70	2.3	138	10	11	1.0	.040
		.32	71	--	--	11	10	--	.047
		.21	66	--	--	10	9.7	--	.050
		.24	71	--	--	9.8	9.3	--	.045
CH Bb 9	USN 9	.34	62	1.8	121	11	2.9	.80	<.010
		.33	61	--	--	11	3.2	--	.019
		.34	63	--	--	12	4.1	--	.018
		.24	64	--	--	12	3.3	--	.021
CH Bb 12	TIH 1	3.9	170	7.7	341	4.8	49	.30	.49
		--	--	--	163	--	12	--	.078
		3.1	140	--	--	3.3	39	--	.25
		5.8	180	--	--	5.5	59	--	.39
		2.9	140	--	--	4.0	37	--	.17
CH Bb 17	USN B	.86	110	3.6	227	2.1	47	.80	.22
CH Bb 19	USN 2	.73	110	3.6	219	3.6	21	.60	.18
		.84	110	--	--	2.5	23	--	.18
		.83	120	--	--	2.3	24	--	.18
		.81	120	--	--	1.9	26	--	.041
CH Bc 3	USN 12	.14	67	2.0	130	8.3	6.2	.80	.035
		.29	65	--	--	8.1	6.6	--	.030
		.32	68	--	--	7.7	6.5	--	.033
		.19	68	--	--	8.2	6.2	--	.035
CH Bc 5	USN 14	.51	100	3.5	202	9.1	42	.80	.15
CH Bc 6	PH 1	.03	57	1.0	114	14	2.9	.90	.011
		--	--	--	110	--	3.1	--	.013
		.06	58	--	--	14	3.0	--	.014
		.06	57	--	--	14	3.2	--	.021
CH Bc 23	TIH 2	3.1	140	7.2	394	3.9	41	.40	.20
		--	--	--	291	--	24	--	.14
		1.5	110	--	--	3.0	21	--	.13
		1.7	110	--	--	2.9	24	--	.16
		3.9	170	--	--	4.9	43	--	.16
CH Bc 24	PH 2	14	80	9.9	220	42	60	.50	.19
CH Bc 49	TIH 6	.27	68	2.8	215	10	8.8	.70	.034
		.22	63	--	--	12	6.0	--	.010
		.15	61	--	--	12	4.1	--	.027
		.14	59	--	--	12	--	--	.017
CH Bc 67	TIH 3	.24	150	4.0	152	7.3	120	1.5	.38
		--	--	--	155	--	110	--	.38
		.30	140	--	--	7.0	120	--	.37
		.28	140	--	--	7.2	120	--	.37
		.37	140	--	--	7.1	120	--	.38
CH Bc 68	PH 3	.12	58	1.2	149	18	1.6	.70	.012
		.18	57	--	--	12	1.3	--	.010
		.16	56	--	--	12	1.2	--	.011
		.22	58	--	--	12	1.2	--	<.010

Silica, dissolved (mg/L as SiO_2)	Solids, residue at 180 °C dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, NO_2+NO_3 (total as N)	Phosphorus, total, (mg/L as P)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Carbon, organic total (mg/L as C)	USGS identifier
33	196	198	<0.100	1.70	45	14	0.3	CH Bb 6
32	199	194	--	--	52	11	--	
32	191	189	--	--	48	11	--	
34	188	193	--	--	47	12	--	
33	202	211	<.100	.02	78	7	.1	CH Bb 7
33	216	207	--	--	56	7	--	
32	201	197	--	--	34	9	--	
34	200	204	--	--	23	9	--	
34	187	186	<.100	1.60	34	10	.2	CH Bb 9
34	185	182	--	--	35	8	--	
34	202	190	--	--	65	12	--	
34	189	191	--	--	57	12	--	
35	477	483	<.100	.63	1,000	89	3.5	CH Bb 12
--	239	--	--	--	--	--	--	
34	414	397	--	--	660	68	3.5	
33	529	516	--	--	1,200	120	--	
35	394	388	--	--	670	75	--	
30	307	336	<.100	1.70	410	7	1.2	CH Bb 17
35	319	307	<.100	.77	170	27	1.3	CH Bb 19
33	320	307	--	--	250	31	--	
34	337	323	--	--	260	28	--	
35	320	325	--	--	240	18	--	
33	193	196	<.100	1.40	59	6	.3	CH Bc 3
33	200	192	--	--	69	8	--	
33	210	194	--	--	70	9	--	
35	199	196	--	--	39	9	--	
25	272	303	<.100	.77	260	18	.3	CH Bc 5
37	186	181	<.100	.09	69	1	.5	CH Bc 6
--	181	--	--	--	--	--	--	
35	186	177	--	--	30	<1	--	
36	169	178	--	--	53	3	--	
34	462	471	<.100	.53	760	88	3.5	CH Bc 23
--	330	--	--	--	--	--	--	
34	316	307	--	--	290	43	--	
34	341	317	--	--	310	43	--	
33	478	468	--	--	980	110	--	
33	410	407	<.100	.15	1,400	43	2.0	CH Bc 24
33	206	253	<.100	1.10	130	8	.6	CH Bc 49
33	185	188	--	--	120	7	--	
32	187	180	--	--	110	7	--	
32	171	--	--	--	130	9	--	
35	402	410	<.100	.95	110	14	<.1	CH Bc 67
--	392	--	--	--	--	--	--	
34	396	394	--	--	85	9	--	
34	403	395	--	--	130	9	--	
35	407	396	--	--	130	10	--	
36	182	205	<.100	.06	57	2	.2	CH Bc 68
35	177	174	--	--	62	3	--	
35	189	173	--	--	52	5	--	
36	170	176	--	--	55	5	--	

Table 10. *Summary of selected chemical-quality analyses from ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1988--Continued*

USGS identifier	Local identifier	Station no.	Date	Primary geologic units	Water level, depth below and surface (feet)	Depth of well (feet)	Depth, to top of sample interval (feet)	Depth, to bottom of sample interval (feet)
CH Bc 70	TIH 4	383554077085702	05-19-88	Patapsco	--	442	372	442
			08-29-88		--	442	372	442
			11-02-88		--	442	372	442
			12-01-88		--	442	372	442
CH Bc 72	TIH 5	383548077091101	05-19-88	Patapsco	--	360	224	347
			08-30-88		--	360	224	347
			11-02-88		--	360	224	347
			12-01-88		--	360	224	347
CH Cb 7	USN 19	383422077114601	05-11-88	Patapsco	87.68	400	154	167
CH Cb 9	USN 15	383354077121501	05-17-88	Patapsco	--	280	191	280
			08-29-88		--	280	191	280
			11-01-88		--	280	191	280
			11-28-88		--	280	191	280
CH Cb 11	USN 43SN	383313077125401	05-18-88	Patuxent	53.09	454	--	--
			05-26-88		--	454	--	--
			08-29-88		--	454	--	--
			11-01-88		--	454	--	--
			12-01-88		--	454	--	--
CH Cb 18	USN 17	383412077112802	05-17-88	Patapsco	--	295	261	295
			08-29-88		--	295	261	295
			11-01-88		--	295	261	295
			11-28-88		--	295	261	295
CH Cb 19	USN 18	383448077105202	05-18-88	Patapsco	--	302	208	302
			08-29-88		--	302	208	302
			11-01-88		--	302	208	302
			12-01-88		--	302	208	302
CH Cb 28	USN 2012	383315077131401	05-18-88	Patapsco	50.58	290	190	290
			05-26-88		--	290	190	290
			08-29-88		--	290	190	290
			11-01-88		--	290	190	290
			12-02-88		--	290	190	290
CH Cb 29	USN A	383451077102601	05-17-88	Patapsco	--	286	228	286
			08-29-88		--	286	228	286
			11-01-88		--	286	228	286
			12-01-88		--	286	228	286
CH Cb 34	USN 3A	383427077121001	05-17-88	Patapsco	--	232	217	232
			05-25-88		--	232	217	232
			08-29-88		--	232	217	232
			11-01-88		--	232	217	232
			12-02-88		--	232	217	232
CH Cb 35	USN 16A	383407077120501	05-18-88	Patuxent	86.40	486	433	486
			05-25-88		--	486	433	486
			08-30-88		--	486	433	486
			12-01-88		--	486	433	486
			12-02-88		--	488	433	486
CH Cb 38	USN RUM PT	393328077114201	05-18-88	Patapsco	--	235	220	235
			08-30-88		--	235	220	235
			11-01-88		--	235	220	235
			12-01-88		--	235	220	235

Elevation of land-surface data above sea level (feet)	Pump or flow period prior to sampling (min)	Estimated flow rate instantaneous (gal/min)	Specific conductance (µS/cm)	pH (standard units)	Water temperature (°C)	Color (platinum-cobalt units)	Calcium, dissolved (mg/L as Ca)	USGS identifier
35	20	200	242	7.7	18.5	2	0.09	CH Bc 70
	30	200	242	8.0	17.5	--	.09	
	240	200	245	8.2	15.5	--	.11	
	15	200	241	8.0	16.0	--	.09	
34	15	200	264	7.8	17.0	<1	.33	CH Bc 72
	120	200	275	7.9	16.5	--	.27	
	15	200	286	8.0	14.5	--	.27	
	15	200	286	7.8	15.5	--	.30	
36	105	6.00	290	6.8	14.0	--	2.8	CH Cb 7
24	>1,000	150	370	7.8	16.5	2	.83	CH Cb 9
	>1,000	150	312	7.9	18.0	--	.73	
	>1,000	150	365	8.2	15.0	--	.75	
	>1,000	150	385	7.8	16.5	--	1.7	
5	20	100	590	7.5	17.0	2	1.5	CH Cb 11
	30	100	594	7.9	14.0	--	--	
	60	100	314	7.6	20.0	--	2.0	
	30	100	324	7.6	16.5	--	1.5	
	20	100	325	7.7	16.0	--	1.6	
30.5	>1,000	150	481	7.6	16.5	2	.42	CH Cb 18
	>1,000	150	421	7.8	18.0	--	.41	
	>1,000	150	481	--	15.0	--	6.7	
	>1,000	150	488	7.9	17.5	--	.46	
32	20	150	374	8.0	18.5	1	.52	CH Cb 19
	120	150	376	8.0	18.0	--	.50	
	120	150	370	8.1	15.5	--	.50	
	15	150	288	8.1	15.0	--	.70	
5	20	150	297	7.5	16.5	3	1.7	CH Cb 28
	20	150	277	7.4	17.0	--	--	
	60	150	292	7.4	19.0	--	1.6	
	40	150	291	7.8	14.0	--	1.6	
	60	150	290	7.7	15.5	--	1.7	
12.4	150	150	302	8.0	17.0	2	.25	CH Cb 29
	120	150	301	8.1	18.0	--	.23	
	120	150	330	8.2	15.5	--	.30	
	>1,000	150	287	7.9	15.5	--	.24	
30	*>1,000	120	1,310	7.0	14.5	45	8.1	CH Cb 34
	20	120	1,230	7.1	16.0	--	--	
	60	120	1,300	7.2	17.0	--	8.1	
	60	120	1,290	7.7	15.5	--	7.7	
	15	120	1,220	7.6	16.0	--	7.9	
25	20	200	575	7.8	19.0	2	.39	CH Cb 35
	30	200	551	7.8	17.0	--	--	
	20	200	578	8.0	18.5	--	.41	
	60	200	509	7.7	16.5	--	.41	
	>1,000	200	522	7.9	17.0	--	.56	
5	20	15	290	7.7	17.0	3	1.1	CH Cb 38
	20	15	--	--	--	--	1.1	
	20	15	288	7.9	14.5	--	1.0	
	15	15	277	7.9	15.5	--	1.1	

Table 10. *Summary of selected chemical-quality analyses from ground-water samples collected in the Indian Head area, northwestern Charles County, Maryland, 1988*--Continued

USGS identifier	Local identifier	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)	Alkalinity, total field (mg/L as $CaCO_3$)	Sulfate, dissolved (mg/L as SO_4)	Chloride, dissolved (mg/L as Cl)	Fluoride, dissolved (mg/L as F)	Bromide, dissolved (mg/L as Br)
CH Bc 70	TIH 4	0.14	60	1.8	158	13	1.3	0.90	<0.010
		.11	57	--	--	13	1.3	--	<.010
		.05	55	--	--	13	1.3	--	.019
		<.01	57	--	--	15	1.3	--	<.010
CH Bc 72	TIH 5	.19	64	2.3	121	10	3.7	.80	.026
		.33	62	--	--	10	4.7	--	.030
		.24	65	--	--	10	5.4	--	.037
		.30	72	--	--	8.9	7.0	--	.041
CH Cb 7	USN 19	1.7	63	2.7	136	9.9	7.1	.90	--
CH Cb 9	USN 15	.74	76	2.8	146	11	22	1.1	.075
		.72	82	--	--	11	21	--	.079
		.73	82	--	--	17	21	--	.071
		1.2	83	--	--	11	21	--	.078
CH Cb 11	USN 43SN	.74	140	4.6	270	8.3	45	1.2	.16
		--	--	--	246	--	48	--	.17
		.70	68	--	--	11	10	--	.024
		.57	68	--	--	11	12	--	.032
		.63	75	--	--	10	12	--	.035
CH Cb 18	USN 17	.51	110	2.8	181	7.6	40	1.1	.17
		.44	92	--	--	11	31	--	.11
		.51	110	--	--	7.2	41	--	.17
		.51	110	--	--	7.1	41	--	.18
CH Cb 19	USN 18	.48	86	2.7	155	8.1	18	.80	.093
		.36	85	--	--	7.9	18	--	.091
		.47	80	--	--	7.7	19	--	.092
		.48	69	--	--	9.0	8.3	--	.029
CH Cb 28	USN 2012SN	1.3	66	3.9	134	12	7.2	1.1	.038
		--	--	--	118	--	6.6	--	.034
		1.2	63	--	--	12	6.6	--	.024
		1.3	64	--	--	11	6.8	--	.037
		1.1	68	--	--	11	11	--	.018
CH Cb 29	USN A	.21	70	2.0	139	10	7.0	.80	.044
		.28	70	--	--	10	7.1	--	.024
		.29	70	--	--	9.8	6.9	--	.041
		.22	73	--	--	10	6.9	--	.038
CH Cb 34	USN 3A	8.7	270	7.5	364	12	210	.50	1.1
		--	--	--	370	--	210	--	1.3
		8.4	250	--	--	14	200	--	1.2
		8.3	260	--	--	3.1	200	--	1.1
		8.1	260	--	--	4.6	210	--	.88
CH Cb 35	USN 16A	.39	130	3.4	305	7.7	44	1.2	.16
		--	--	--	265	--	43	--	.16
		.36	130	--	--	7.8	43	--	.15
		.48	130	--	--	7.8	41	--	.15
		.55	140	--	--	7.7	42	--	.15
CH Cb 38	USN RUM PT	1.0	62	3.0	135	15	3.1	1.0	.010
		1.0	65	--	--	13	2.9	--	.015
		.95	63	--	--	15	2.9	--	.015
		.98	65	--	--	12	2.9	--	.015

Silica, dissolved (mg/L as SiO_2)	Solids, residue at 180 °C dissolved (mg/L)	Solids, sum of constituents, dissolved (mg/L)	Nitrogen, NO_2+NO_3 (total as N)	Phosphorus, total, (mg/L as P)	Iron, dissolved (µg/L as Fe)	Manganese, dissolved (µg/L as Mn)	Carbon, organic total (mg/L as C)	USGS identifier
35	181	207	<0.100	1.60	80	6	0.1	CH Bc 70
35	183	173	--	--	89	5	--	
35	187	171	--	--	92	5	--	
37	155	--	--	--	67	5	--	
36	197	190	<.100	1.40	97	11	.5	CH Bc 72
34	197	188	--	--	120	7	--	
34	206	193	--	--	120	8	--	
35	200	206	--	--	160	9	--	
33	--	203	<.100	1.70	370	55	--	CH Cb 7
33	242	235	<.100	1.90	110	19	.6	CH Cb 9
32	247	232	--	--	91	19	.1	
31	238	240	--	--	96	20	--	
32	239	238	--	--	110	22	--	
34	374	398	<.100	.92	480	21	<.1	CH Cb 11
--	389	--	--	--	--	--	--	
34	214	206	--	--	110	14	.7	
33	224	210	--	--	97	11	--	
33	217	216	--	--	240	14	--	
33	304	304	<.100	1.60	170	19	.8	CH Cb 18
33	272	262	--	--	210	20	1.0	
32	311	306	--	--	190	20	--	
33	293	301	--	--	220	19	--	
35	242	245	<.100	1.40	100	16	.7	CH Cb 19
34	246	240	--	--	110	14	1.1	
34	250	236	--	--	110	15	--	
34	205	200	--	--	74	15	--	
32	201	206	<.100	2	640	30	.2	CH Cb 28
--	195	--	--	--	--	--	--	
32	193	194	--	--	620	29	.6	
31	194	193	--	--	590	36	--	
31	206	201	--	--	140	18	--	
34	207	208	<.100	1.60	110	10	.1	CH Cb 29
33	196	203	--	--	100	12	--	
32	217	202	--	--	99	9	--	
31	210	273	--	--	260	33	--	
39	768	778	<.100	0.30	2,400	370	5.2	CH Cb 34
--	775	--	--	--	--	--	--	
38	759	740	--	--	3,100	350	7.2	
37	754	737	--	--	410	310	--	
38	772	750	--	--	810	340	--	
34	366	404	<.100	0.75	110	120	<.1	CH Cb 35
--	363	--	--	--	--	--	--	
33	366	351	--	--	120	14	.2	
34	350	349	--	--	68	12	--	
35	371	361	--	--	81	20	--	
33	201	201	<.100	1.90	460	22	.2	CH Cb 38
33	196	197	--	--	420	23	--	
33	197	197	--	--	360	23	--	
33	194	196	--	--	490	22	--	

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RCRA FACILITY INVESTIGATION/ VERIFICATION INVESTIGATION REPORT FOR STUMP NECK ANNEX INDIAN HEAD DIVISION NAVAL SURFACE WARFARE CENTER INDIAN HEAD, MARYLAND

COMPREHENSIVE LONG-TERM ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

VOLUME I OF IV - TEXT

Submitted to:
Engineering Field Activity Chesapeake
Environmental Branch Code 18
Naval Facilities Engineering Command
Washington Navy Yard, Building 212
Washington, D.C. 20374-2121

Submitted by:
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King of Prussia, Pennsylvania 19406-1433

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JANUARY 1998

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TABLE OF CONTENTS

SECTION		PAGE
ACRONYMS AND DEFINITIONS		xv
EXECUTIVE SUMMARY		ES-1
1.0	INTRODUCTION	1-1
1.1	PURPOSE OF THE REPORT	1-1
1.2	GENERAL BACKGROUND INFORMATION	1-2
1.2.1	Base Location and Description	1-2
1.2.2	Base History	1-2
1.2.3	Summary of Previous Investigations	1-2
1.3	OVERVIEW/REGULATORY STATUS OF SITES UNDER INVESTIGATION	1-3
1.4	ORGANIZATION OF THE RFI/VI REPORT	1-3
2.0	INVESTIGATION ACTIVITIES	2-1
2.1	FIELD INVESTIGATION ACTIVITIES	2-1
2.1.1	Mobilization/Demobilization	2-2
2.1.2	Soil-Gas Survey	2-2
2.1.3	Magnetometer Survey	2-3
2.1.4	Field Test Kits	2-4
2.1.5	Surface Soil Sampling	2-4
2.1.6	Subsurface Soil Sampling	2-5
2.1.7	Monitoring Well Construction	2-5
2.1.8	Groundwater Sampling	2-6
2.1.9	Water-Level Measurements	2-7
2.1.10	Aquifer Testing	2-7
2.1.11	Surface Water and Sediment Sampling	2-7
2.1.12	Surveying	2-8
2.1.13	Waste Handling	2-8
2.1.14	Equipment Decontamination	2-9
2.1.15	Sample Custody and Handling	2-9
2.1.16	Quality Control Sampling	2-9
2.2	OVERVIEW OF BACKGROUND INVESTIGATION	2-9
2.2.1	Groundwater	2-10
2.2.2.	Surface and Subsurface Soils	2-10
2.2.3	Freshwater Sediment	2-12
2.2.4	Tidal Fresh and Oligohaline Sediments	2-12
2.2.5	Summary of Background Investigation	2-12
2.3	DATA EVALUATION AND VALIDATION	2-13
2.3.1	Introduction	2-13
2.3.2	General Data Validation Procedures	2-14
2.3.3	Data Validation Qualifiers	2-14
2.3.4	Summary Of Data Validation Results	2-16
2.3.5	Soil Gas Data Quality	2-18
2.3.6	Field Test-Kit Data Application and Limitation	2-20
2.4	CHEMICAL FATE AND TRANSPORT ANALYSIS	2-22
2.4.1	Chemical and Physical Properties	2-22
2.4.2	Chemical Persistence	2-25
2.4.3	Chemical Migration	2-31

TABLE OF CONTENTS (Continued)

SECTION		PAGE
2.5	HUMAN HEALTH RISK ASSESSMENT	2-33
2.5.1	Data Evaluation	2-35
2.5.2	Toxicity Assessment	2-38
2.5.3	Exposure Assessment	2-44
2.5.4	Risk Characterization	2-57
2.5.5	Uncertainty Analysis	2-59
2.6	ECOLOGICAL ISSUES	2-61
2.6.1	Ecological Risk Assessment Methodology	2-62
2.6.2	Risk Management	2-78
3.0	**CHARACTERISTICS OF STUDY AREA**	**3-1**
3.1	PHYSIOGRAPHY AND TOPOGRAPHY	3-1
3.2	METEOROLOGY	3-1
3.3	SOILS	3-1
3.4	REGIONAL GEOLOGY	3-2
3.5	LOCAL GEOLOGY	3-2
3.6	REGIONAL HYDROGEOLOGY	3-3
3.7	LOCAL HYDROGEOLOGY	3-4
3.8	HYDROLOGY	3-4
3.9	POPULATION AND LAND USE	3-4
3.10	ECOLOGY	3-5
3.10.1	Flora	3-5
3.10.2	Wildlife	3-5
3.10.3	Aquatic Life	3-5
3.10.4	Threatened and Endangered Species	3-6
4.0	**SWMU 5 - RANGE 6**	**4-1**
4.1	SITE DESCRIPTION AND HISTORY	4-1
4.1.1	Site Description	4-1
4.1.2	Site Operations And History	4-1
4.1.3	VI Field Investigation Conducted For CTO 222	4-3
4.2	RFI FIELD INVESTIGATION	4-4
4.2.1	Field Screening	4-5
4.2.2	Soil Investigation	4-5
4.2.3	Groundwater Investigation	4-6
4.2.4	Surface Water and Sediment Investigation	4-6
4.2.5	Summary of Environmental Investigation	4-7
4.3	SITE CHARACTERISTICS	4-7
4.3.1	Geology	4-7
4.3.2	Hydrogeology	4-8
4.4	NATURE AND EXTENT OF CONTAMINATION	4-9
4.4.1	Surface and Subsurface Soil	4-10
4.4.2	Groundwater	4-19
4.4.3	Surface Water	4-22
4.4.4	Sediments	4-22
4.5	CONTAMINANT FATE AND TRANSPORT	4-24

TABLE OF CONTENTS (Continued)

SECTION		PAGE
4.6	BASELINE HUMAN HEALTH RISK ASSESSMENT	4-25
4.6.1	Data Evaluation/Selection of Chemicals of Potential Concern	4-25
4.6.2	Exposure Assessment	4-29
4.6.3	Risk Characterization	4-30
4.6.4	Uncertainty Analysis	4-32
4.6.5	Summary of Risk Assessment	4-32
4.7	ECOLOGICAL ISSUES	4-33
4.7.1	Ecological Risk Assessment	4-33
4.7.2	Risk Management	4-38
4.7.3	ERA and Risk Management Summary and Conclusions	4-43
4.7.4	Site-Specific Uncertainties	4-44
4.8	SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	4-45
5.0	**SWMU 2/3 - RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A**	**5-1**
5.1	SITE DESCRIPTION AND HISTORY	5-1
5.1.1	Site Description	5-1
5.1.2	Site History	5-1
5.2	RFI FIELD INVESTIGATION	5-2
5.2.1	Field Screening	5-2
5.2.2	Soil Investigation	5-3
5.2.3	Groundwater Investigation	5-4
5.2.4	Surface Water and Sediment Investigation	5-4
5.2.5	Summary of Environmental Investigation	5-4
5.3	SITE CHARACTERISTICS	5-4
5.3.1	Geology	5-5
5.3.2	Hydrogeology	5-6
5.4	NATURE AND EXTENT OF CONTAMINATION	5-7
5.4.1	Surface and Subsurface Soil	5-7
5.4.2	Groundwater	5-13
5.4.3	Surface Water	5-15
5.4.4	Sediment	5-15
5.5	CONTAMINANT FATE AND TRANSPORT	5-17
5.6	BASELINE HUMAN HEALTH RISK ASSESSMENT	5-18
5.6.1	Data Evaluation/Selection of Chemicals of Potential Concern	5-18
5.6.2	Exposure Assessment	5-22
5.6.3	Risk Characterization	5-23
5.6.4	Uncertainty Analysis	5-24
5.6.5	Summary of Risk Assessment	5-24
5.7	ECOLOGICAL ISSUES	5-25
5.7.1	Ecological Risk Assessment	5-25
5.7.2	Risk Management	5-30
5.7.3	ERA and Risk Management Summary and Conclusions	5-36
5.7.4	Site-specific Uncertainties	5-37
5.8	SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	5-38

TABLE OF CONTENTS (Continued)

SECTION		PAGE
6.0	**SWMU 1 - RUM POINT LANDFILL**	**6-1**
6.1	SITE DESCRIPTION AND HISTORY	6-1
6.1.1	Site Description	6-1
6.1.2	Site History	6-1
6.2	VI FIELD INVESTIGATION	6-1
6.2.1	Field Screening	6-2
6.2.2	Soil Investigation	6-2
6.2.3	Groundwater Investigation	6-3
6.2.4	Surface Water and Sediment Investigation	6-3
6.2.5	Summary of Environmental Investigation	6-3
6.3	SITE CHARACTERISTICS	6-3
6.3.1	Geology	6-3
6.3.2	Hydrogeology	6-5
6.4	NATURE AND EXTENT OF CONTAMINATION	6-6
6.4.1	Surface and Subsurface Soil	6-7
6.4.2	Groundwater	6-11
6.4.3	Surface Water	6-13
6.4.4	Sediment	6-13
6.5	CONTAMINANT FATE AND TRANSPORT	6-14
6.6	BASELINE HUMAN HEALTH RISK ASSESSMENT	6-15
6.6.1	Data Evaluation/Selection of Chemicals of Potential Concern	6-15
6.6.2	Exposure Assessment	6-18
6.6.3	Risk Characterization	6-20
6.6.3	Uncertainty Analysis	6-22
6.6.4	Summary of Risk Assessment	6-22
6.7	ECOLOGICAL ISSUES	6-22
6.7.1	Ecological Risk Assessment	6-22
6.7.2	Risk Management	6-27
6.7.3	ERA and Risk Management Summary and Conclusions	6-30
6.7.4	Site-specific Uncertainties	6-31
6.8	SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	6-31
7.0	**SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B**	**7-1**
7.1	SITE DESCRIPTION AND HISTORY	7-1
7.1.1	Site Description	7-1
7.1.2	Site History	7-1
7.2	VI FIELD INVESTIGATION	7-1
7.2.1	Field Screening	7-2
7.2.2	Soil Investigation	7-2
7.2.3	Groundwater Investigation	7-3
7.2.4	Surface water and Sediment Investigation	7-3
7.2.5	Summary of Environmental Investigation	7-3
7.3	SITE CHARACTERISTICS	7-3
7.3.1	Geology	7-3
7.3.2	Hydrogeology	7-5
7.4	NATURE AND EXTENT OF CONTAMINATION	7-6
7.4.1	Surface and Subsurface Soil	7-6
7.4.2	Groundwater	7-9

TABLE OF CONTENTS (Continued)

SECTION		PAGE
7.5	CONTAMINANT FATE AND TRANSPORT	7-11
7.6	BASELINE HUMAN HEALTH RISK ASSESSMENT	7-12
7.6.1	Data Evaluation/Selection of Chemicals of Potential Concern	7-12
7.6.2	Exposure Assessment	7-14
7.6.3	Risk Characterization	7-16
7.6.3	Uncertainty Analysis	7-18
7.6.4	Summary of Risk Assessment	7-18
7.7	ECOLOGICAL ISSUES	7-18
7.7.1	Ecological Risk Assessment	7-18
7.7.2	Risk Management	7-24
7.7.3	ERA and Risk Management Summary and Conclusions	7-26
7.7.4	Site-specific Uncertainties	7-27
7.8	SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	7-28
8.0	**SWMU 6 - AIR BLAST POND**	**8-1**
8.1	SITE DESCRIPTION AND HISTORY	8-1
8.1.1	Site Description	8-1
8.1.2	Site History	8-1
8.2	VI FIELD INVESTIGATION	8-2
8.2.1	Field Screening	8-2
8.2.2	Soil Investigation	8-2
8.2.3	Groundwater Investigation	8-3
8.2.4	Surface water and Sediment Investigation	8-3
8.2.5	Summary of Environmental Investigation	8-3
8.3	SITE CHARACTERISTICS	8-3
8.3.1	Geology	8-3
8.3.2	Hydrogeology	8-4
8.4	NATURE AND EXTENT OF CONTAMINATION	8-5
8.4.1	Surface and Subsurface Soil	8-5
8.4.2	Sediment	8-8
8.5	CONTAMINANT FATE AND TRANSPORT	8-10
8.6	BASELINE HUMAN HEALTH RISK ASSESSMENT	8-10
8.6.1	Data Evaluation/Selection of Chemicals of Potential Concern	8-11
8.6.2	Exposure Assessment	8-13
8.6.3	Risk Characterization	8-15
8.6.3	Uncertainty Analysis	8-15
8.6.4	Summary of Risk Assessment	8-15
8.7	ECOLOGICAL ISSUES	8-16
8.7.1	Ecological Risk Assessment	8-16
8.7.2	Risk Management	8-20
8.7.3	ERA and Risk Management Summary and Conclusions	8-24
8.7.4	Site-specific Uncertainties	8-25
8.8	SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	8-26
REFERENCES		**R-1**

TABLE OF CONTENTS (Continued)

APPENDICES

A Soil Gas Survey Results
B Field Test Kits Literature
C Field Test Kits Results
D Surface Soil Sample Log Sheets
E Subsurface Soil Sample Log Sheets
F Groundwater Sample Log Sheets
G Surface Water/Sediment Sample Log Sheets
H Boring Log Sheets
I Monitoring Well Construction/Development Sheets/Groundwater Level Data
J Standard Operating Procedures
K Land Survey Data
L Chains-of-Custody
M Analytical Database
N Data Validation Memoranda
O Statistical Analysis of Environmental Data
P Supporting Information for Human Health Risk Assessment

EXECUTIVE SUMMARY

The results of the RCRA Facility Investigation (RFI)/Verification Investigation (VI) conducted at six Solid Waste Management Units (SWMUs) at the Naval Surface Warfare Center (NSWC), Stump Neck Annex, Indian Head, Maryland are presented in this report. The six SWMUs that are the focus of this report are:

- Range 6 (SWMU 5) (RFI)
- Range 3 Burn Point (SWMU 2) (RFI)
- Chicamuxen Creek's Edge Dump Site A (SWMU 3) (RFI)
- Rum Point Landfill (SWMU 1) (VI)
- Chicamuxen Creek's Edge Dump Site B (SWMU 4) (VI)
- Air Blast Pond (SWMU 6) (VI)

As indicated above, three SWMUs are included in the RFI and three SWMUs are included in the VI. They are presented in this particular order, because this is the order in which they are addressed in the report.

Field sampling activities were conducted in the summers of 1995 and 1997. Sample analysis, data validation and evaluation, and report preparation tasks were completed in the fall and winter of 1997. The following narratives give a brief summary of each SWMU investigated; the results of field investigations, sampling, and analysis; and a summary of the baseline human health risk assessment and ecological risk assessment conducted at each SWMU.

E.1 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR SWMU 5 - RANGE 6

This section summarizes the environmental investigations conducted to date, the nature and extent of the chemicals detected in the environmental media, and the results of the human health and the ecological risk assessments. Range 6 is an inactive explosive ordanance disposal (EOD) training area. Conclusions and recommendations are provided.

The following items summarize the investigative work conducted to date:

1. The field investigation for CTO 222 included the field screening of 22 shallow soil samples for 2,4,6-trinitrotoluene (TNT) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX). The majority of the samples were collected from locations within the large-scale detonation training area.

2. The field investigation also included the collection of soil-gas survey samples at 38 locations within the detonation training areas and adjoining areas. Fourteen aromatic hydrocarbons (e.g., benzene) and chlorinated hydrocarbons (e.g., tetrachloroethene) were the target analytes of concern.

3. Surface and subsurface soil samples were collected from 20 locations and submitted to a fixed-base laboratory General Physics (GP) for analysis.

4. Five monitoring wells (one upgradient; four downgradient) were installed. One round of synoptic water- level measurements was recorded. Rising-head and falling-head slug tests were performed at monitoring well location 5GW01 (B&R Environmental, 1995).

5. Surface water and sediment samples were collected at four locations in the surface water bodies surrounding Range 6. Samples were collected from two locations within Chicamuxen Creek and two locations within the Potomac River.

6. Environmental samples collected for analysis by the fixed-base laboratory were analyzed for a comprehensive suite of analytes, including volatile organic and semivolatile organic compounds, metals, and explosives.

The following items summarize the environmental conditions at Range 6:

1. In the low-lying areas to the south of Archer Avenue, the soils materials generally consist of fine-grained sediments, silt, clay and peat. In the uplands, the soils materials generally consist of sand and gravel interlayered by silt and clay. In the detonation areas the reworked material generally consists of yellow-brown clay, silt, sand, and gravel mixtures approximately 6 feet thick.

2. The groundwater beneath the site occurs primarily under locally semiconfining and unconfined (water table) conditions. The water-table aquifer consists primarily of yellow-brown sand and gravel. The shallow groundwater is presumed to be flowing radially toward and discharging into both the Chicamuxen Creek and the Potomac River. However, both water bodies are tidal, and during high tide, losing-stream conditions may occur.

3. The groundwater resource is probably recharged by downward migration of precipitation through the unsaturated zone to the water table. In addition, groundwater along the edge of the stream is also recharged as a result of the losing-stream conditions during high tide.

4. A groundwater divide occurs north-south down the center of the Range 6 study area. A slight mounding of the groundwater potentiometric surface in the detonation area probably results from a combination of surface topography and the shallow subsurface material.

5. Explosives and components of explosives (TNT, RDX, Cyclotetramethylene tetranitramine (HMX), 2,4-dinitrotoluene, and 2,6-dinitrotoluene), and degradation by-products of explosives (2-amino-4,6-dinitrotoluene) were the predominant site-related organic contaminants detected in the Range 6 soil and groundwater samples. One or more of these chemicals were detected in more than 50 percent of the surface soil samples. The chemical concentrations noted in soil samples from the large-scale training area exceed those noted in samples from most other sampling locations by an order of magnitude. However, these chemicals were not noted in surface water and sediment samples collected from the surrounding surface water bodies (Chixamuxen Creek and the Potomac River).

6. Volatile and semivolatile organic compounds (other than the explosives) were detected less frequently than the explosive compounds and at maximum concentrations often orders of magnitude less than those reported for the explosive compounds. The organics detected include phthalate compounds (e.g., bis(2-ethylhexyl)phthalate), polycyclic aromatic hydrocarbons (PAH) (e.g., benzo(a)pyrene), fuel related compounds (e.g., toluene), and volatile organic solvents (e.g., acetone). Site-related as well as non-site-related activities may have contributed to the presence of these compounds in the environmental media. The detection of several of these compounds in areas outside the immediate detonation training areas may be evidence of the fact that preparatory or ancillary activities for/to the detonation exercises occurred in areas adjoining the large-scale and small-scale detonation training areas.

7. The environmental investigations conducted to date have not confirmed the location of the alleged arsenic disposal pit at Range 6. Arsenic results for soil and groundwater samples collected at the location identified by a former Navy employee reflect background conditions.

8. Several metals (e.g., cadmium, copper, mercury, selenium, and zinc) were detected at sampling locations, particularly within the large-scale training area, at concentrations exceeding basewide background concentrations. Although the maximum detected concentrations clearly exceed background concentrations, the exceedances noted at many of the locations are best described as marginal (i.e., similar to or within two times background). Several metals were noted in Range 6 groundwater samples at concentrations exceeding those noted in background monitoring wells. However, the turbidity levels reported for many of the samples indicate that the metals concentrations noted in some of the samples may be attributable, in part, to the suspended

particulates in the groundwater samples. Metals concentrations detected in surface waters and sediments suggest that historic activities at Range 6 have had minimal impact on surface water and sediment quality in the vicinity of Range 6.

The following items summarize the baseline human health risk assessment conducted for Range 6:

1. The human risk assessment for Range 6 considered exposures to maintenance workers, full-time employees, and construction workers. Potential exposure pathways for direct contact with soil for all receptors included incidental ingestion and dermal contact with soil. Inhalation of fugitive dust and volatiles from soil were not considered since concentrations of all chemicals of potential concern (COPCs) in soil were less than the soil screening levels (SSLs) developed by the EPA for the migration of contaminants from soil to air. In addition, dermal contact with groundwater was evaluated for construction workers.

2. The following chemicals were selected as COPCs for soils: TNT, RDX, 2-amino-4,6-ninitrotoluene, and arsenic. Three explosives (TNT, 2-amino-4,6-dinitrotoluene, and RDX) and six inorganics (antimony, arsenic, barium, total chromium, lead, and vanadium) were selected as COPCs for groundwater. No chemicals were selected as COPCs in surface water or sediment.

3. Incremental lifetime cancer risk estimates for all receptors hypothetically exposed to COPCs in soil and groundwater were within the EPA's target risk range of 10^{-4} to 10^{-6} (USEPA, 1989).

4. Noncarcinogenic risk estimates (HIs) calculated for the maintenance workers were less than unity. Thus, adverse noncarcinogenic health effects are not anticipated under the conditions established in the exposure assessment.

5. Noncarcinogenic risk estimates for full-time employees hypothetically exposed to soil exceeded unity. The hazard index (HI) calculated for the reasonable maximum exposure (RME) was 4. There is a potential for adverse noncarcinogenic health effects when the HI exceeds unity. TNT and 2-amino-4,6-dinitrotoluene (dermal contact route of exposure) were the main contributors to risk.

6. Noncarcinogenic risk estimates for construction workers hypothetically exposed to soil exceed unity. The HI calculated for the RME was 4.8. TNT and 2-amino-4,6-dinitrotoluene (incidental ingestion and dermal contact routes of exposure) were the main contributors to risk.

The following items summarize the baseline ecological risk assessment conducted for Range 6:

1. No final potential chemicals of concern were identified based on the evaluation of analytical results for surface water and sediment samples collected at Range 6. It does not appear that the site-related contamination detected in the soil and groundwater samples has impacted the adjacent aquatic habitats.

2. Copper, mercury, and zinc were retained as final potential chemicals of concern for soil. However, the sporadic elevated concentrations of these metals limit the potential for widespread risks to terrestrial receptors.

3. Five explosive compounds (TNT, HMX, RDX, 2-amino-4,6-dinitrotoluene, and 2,4-dintrotoluene) and di-n-butyl phthalate, a semivolatile compound, were retained as final potential chemicals of concern for soil. The majority of the contamination was noted in the large-scale detonation training area. Minimal data exist regarding the ecotoxicity of these compounds. It should be noted that the detonation area is sparsely vegetated and currently provides limited terrestrial habitat.

It is recommended that risk managers for NSWC Indian Head consider a feasibility study or land use restrictions for Range 6 if site conditions and use are anticipated to change in the future. Baseline human health risk assessment results indicate a potential (albeit low) for adverse noncarcinogenic health effects for full time employees or construction workers hypothetically exposed to surface soils at Range 6. It should be noted that these risk estimates are for site workers in the future; full time employees or construction workers do not currently work at the site. The results of the baseline ecological risk assessment also suggest a potential for adverse effects to terrestrial receptors. However, the site currently provides limited terrestrial habitat. Consequently, few ecological receptors are currently exposed.

E.2 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR SWMU 2/3 - RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A

This section summarizes the environmental investigations conducted to date, the nature and extent of the chemicals detected in the environmental media, and the results of the baseline risk assessment. Range 3 is an active EOD training area the completely overlays Dump Site A. The units were combined in the investigation for this reason. Conclusions and recommendations are provided.

The following items summarize the investigative work conducted to date:

1. The field investigation included the field screening of 50 shallow soil samples for TNT, RDX, and benzene, toluene, ethylbenzene, and xylenes (BTEX).

2. The field investigation included the collection of soil gas survey samples at 48 locations. Fourteen aromatic hydrocarbons (e.g., benzene) and chlorinated hydrocarbons (e.g., tetrachloroethene) were the target analytes of concern.

3. Surface and subsurface soil samples were collected from 14 locations and submitted to a fixed base laboratory (GP) for analysis. Fourteen surface and 22 subsurface samples were analyzed.

4. Four monitoring wells (one upgradient; 3 downgradient) were installed. One round of synoptic water level measurements were recorded.

5. Surface water and sediment samples were collected at two locations in Chicamuxen Creek. Additionally, sediment samples were collected from drainage ditches west and east of the site.

6. Environmental samples collected for analysis by the fixed-base laboratory were analyzed for a comprehensive suite of analytes including volatile organic and semivolatile organic compounds, metals, and explosives.

The following items summarized the environmental conditions at SWMUs 2 and 3:

1. The subsurface materials vary significantly across the study area vertically and horizontally. Reworked natural material was encountered throughout the detonation area at the ground surface to a depth of approximately 4 feet, consisting of red clay, sand, and gravel. The sediments underlying the reworked natural materials generally consist of fine-grained sand, silt, clay, and peat.

2. The groundwater beneath the site occurs primarily under locally semiconfining and unconfined (water table) conditions. The water table aquifer consists primarily of fine-grained sand, silt, clay, and peat. The shallow groundwater is flowing to the south toward and discharging into Chicamuxen Creek. However, the creek is tidal, and during high tide, losing stream conditions may occur. These conditions may cause the water table to be slightly elevated near the stream (bank storage) and may change the groundwater flow pattern, to one showing groundwater flowing north away from the stream.

3. The groundwater resource is probably recharged by downward migration of precipitation through the unsaturated zone to the water table. In addition, groundwater along the edge of the stream is also recharged as a result of the losing stream conditions during high tide.

4. Explosives and components of explosives (TNT, RDX, HMX, 1,3,5-trinitrobenzene), and degradation by-products of explosives (2-amino-4,6-dinitrotoluene) were the predominant site-

related organic contaminants detected in SWMUs 2 and 3 soil samples. However, the detection frequency for the explosive compounds in surface and subsurface soils did not exceed 25 percent and maximum concentrations of most explosives were noted at a location outside the main detonation area and in proximity to a storage bunker. One explosive compound (RDX [1.2 µg/L]) was noted in the upgradient monitoring well; none was noted in groundwater samples from actual downgradient monitoring wells or in the surface water samples. TNT was detected in a sediment sample from a drainage ditch to the west of SWMUs 2 and 3.

5. Volatile and semi-volatile organic compounds (other than the explosives) were detected in soils. The organics detected include phthalate compounds (e.g., bis(2-ethylhexyl) phthalate), polyaromatic hydrocarbons (e.g., benzo(a)pyrene) which are by-products of the combustion process, and volatile organic solvents (e.g., acetone). Site-related as well as non-site-related activities may have contributed to the presence of these compounds in the environmental media.

6. Several metals (e.g., lead, cadmium, copper, mercury, selenium, and zinc) were detected in soils at maximum concentrations exceeding basewide background concentrations. However, all positive detections were within the concentration range reported in the literature for soils of the Eastern United States. Few positive detections of selenium, lead, and mercury exceeded background soils concentrations reported for the State of Maryland. Although the maximum detected concentrations exceed basewide background concentrations, the exceedances were noted at few locations and were often marginal (i.e., similar to or within two times background). Metals concentrations in groundwater were less than or within two times the 95 percent upper tolerance limit ($UTL_{95\%}$)developed for the background groundwater dataset. Maximum concentrations of several metals were noted in the groundwater sample from the upgradient monitoring well.

7. Metals concentrations detected in surface waters suggest that historic activities at SWMUs 2 and 3 have had minimal impact on surface water quality. The source of the elevated metals concentrations noted in two sediment samples is unclear because the metals concentrations noted in the sediments exceed those noted in soil samples collected at SWMUs 2 and 3. Consequently, the metals concentrations in the sediments may not be site-related.

The following items summarize the baseline human health risk assessment conducted for SWMUs 2 and 3:

1. The human health risk assessment for SWMUs 2 and 3 considered exposures to maintenance workers, full-time employees, and construction workers. Potential exposure pathways for direct contact with soil for all receptors included incidental ingestion and dermal contact with soil.

Inhalation of fugitive dust and volatiles from soil were not considered since concentrations of all COPCs in soil were less than the SSLs developed by the EPA for the migration of contaminants form soil to air.

2. Arsenic was the only target analyte selected as a COPC for the evaluation of exposures to soils. No COPCs were selected for groundwater, surface water, or sediments.

3. Incremental lifetime cancer risk estimates developed for the maintenance worker and construction worker hypothetically exposed to arsenic in soil were less than the EPA's target risk range of 10^{-4} to 10^{-6}. Cancer risk estimates developed for the full-time employee were $3.6x10^{-6}$ and $1x10^{-6}$ for the RME and CTE cases, respectively. It should be noted that arsenic is not a significant site-related contaminant; the detected concentrations marginally exceeded facility background concentrations (i.e., they are within 2 times the basewide background concentrations).

4. Noncarcinogenic risk estimates (HIs) calculated for all human receptors evaluated were less than unity, indicating that adverse noncarcinogenic health effects are not anticipated under the conditions established in the exposure assessment.

The following items summarize the baseline ecological risk assessment conducted for SWMUs 2 and 3:

1. Metals were not selected as final potential chemicals of concern soils. No target analytes were selected as final potential chemicals of concern for surface water.

2. Copper, lead, and mercury were retained as final potential chemicals of concern for sediments. However, the metals concentrations noted in the sediment samples from a drainage ditch to the west of SWMUs 2 and 3 were greater than those noted in the surface soil samples. The potential contribution of metals in groundwater discharging to the groundwater may also be minimal. Consequently, SWMUs 2 and 3 may not be a current source of these metals to the sediments.

3. TNT was retained as final potential chemical of concern for soil. However, only one detection exceeded the benchmark used to selected the chemical as a final potential chemical of concern. This suggests that widespread terrestrial risk may not be present. It should be noted that the majority of SWMUs 2 and 3 is sparsely vegetated and currently provides limited terrestrial habitat.

It is recommended that the risk managers for NSWC Indian Head consider a "No further action" decision for the soils, groundwater, and surface water at SWMUs 2 and 3. The human health risk assessment indicates that the cancer risk estimates for human receptors evaluated are within the EPA's target risk range of 10^{-4} to 10^{-6}. Arsenic in surface soils was the only COPC contributing to the estimated cancer risk. However, the maximum concentration detected in the surface soils (6.7 mg/kg) is similar to the 95 percent

upper tolerance limit value established for the basewide background surface soils (4.25 mg/kg) and background soils concentrations reported for the State of Maryland ([Cmax = 7.1 mg/kg)], and less than the maximum concentration reported for the basewide background subsurface soils (10.4 mg/kg). Adverse noncarcinogenic health effects are not anticipated for the human receptors evaluated. The ecological risk assessment indicates a potential for risks to ecological receptors exposed to metals in sediments in a drainage ditch adjoining the site. However, the sediments and surface waters of the adjacent Chicamuxen Creek are probably the more important ecological resource and SWMUs 2 and 3 may not be a current source of the metals detected in the drainage ditch sediments. Consequently, any further investigation of the sediments at SWMUs 2 and 3 may be ancillary to the actual environmental investigation of SWMUs 2 and 3.

E.3 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR SWMU 1 - RUM POINT LANDFILL

This section summarizes the environmental investigations conducted to date, the nature and extent of the chemicals detected in the environmental media, and the results of the baseline risk assessment. The Rum Point Landfill has been inactive since 1989. Conclusions and recommendations are provided..

The following items summarize the investigative work conducted to date:

1. The field investigation included the collection of soil gas survey samples at 12 locations. Fourteen aromatic hydrocarbons (e.g., benzene) and chlorinated hydrocarbons (e.g., tetrachloroethene) were the target analytes of concern.

2. Surface and subsurface soil samples were collected from four boring/monitoring well locations. Four additional surface soil samples were collected by compositing the soils from four locations within four subareas of the landfill (i.e., the landfill was divided into four subareas or quadrants for sampling purposes). Eight surface and 12 subsurface samples were submitted to a fixed-base laboratory (GP) for analysis.

3. Four monitoring wells (one upgradient; 3 downgradient) were installed. One round of synoptic water level measurements were recorded.

4. Surface water and sediment samples were collected from three locations (one upstream; two downstream) in two intermittent streams at Rum Point Landfill.

5. Environmental samples collected for analysis by the fixed-base laboratory were analyzed for a comprehensive suite of analytes including volatile organic and semivolatile organic compounds and metals.

The following items summarize the environmental conditions at the Rum Point Landfill:

1. The subsurface materials are relatively consistent across the study area vertically and horizontally. The surficial deposits generally consist of yellow brown clay, silt, and sand mixtures and range in thickness from 12 to 20 feet. These surficial materials are underlain by a distinct dark gray silt and fine sand with shell fragments ranging in thickness from 20 feet at the western edge of the landfill to 43 feet at the southeast corner of the site. The shell fragment layer is underlain by a distinct green sand, which overlies a very stiff clay. A softer clay layer overlies the green sand in the western portion of the site.

2. The groundwater beneath the site occurs primarily under semiconfining conditions. The water-bearing zone (aquifer) is composed of a green sand. The semiconfining unit is a dark gray silt and fine sand. Generally, the groundwater flows to the north by northwest and discharges into local streams. There is also a downward flow component to the groundwater flow pattern, which indicates that the green sand aquifer is being recharged from the overlying, leaky, semiconfining unit. The deeper groundwater flows north, possibly discharging into the Mattawoman Creek. There is also a minor perched zone supported by the semiconfining unit.

3. Volatile (e.g., acetone) and semi-volatile (e.g., bis(2-ethylhexyl)phthalate) organic compounds were detected in soils, groundwater, surface waters, and sediments. The organic contamination detected is limited to the low-level (generally less than 100 µg/kg; less than 10 µg/L) presence of several volatile organic compounds, and the detection of phthalate and PAH compounds. The phthalate compounds are common plasticizers. The PAHs are by-products of the combustion process. Site-related as well as non-site-related activities may have contributed to the presence of the phthalates and PAHs in the environmental media. For some organics, concentrations detected in samples from upgradient or background locations exceed those noted in samples collected at the site. Benzo(a)pyrene (in soils) was the only organic detected at a concentration exceeding EPA Region III risk-based concentrations (RBCs) for industrial exposures.

4. Several metals (e.g., arsenic, cadmium, chromium, copper, mercury, nickel and tin) were detected in surface or subsurface soils at maximum concentrations exceeding basewide background concentrations. However, all positive detections are within the concentration range reported in the literature for soils of the Eastern United States. A few metals (e.g., arsenic, chromium, and mercury) were detected at maximum concentrations exceeding background soils concentrations reported in the literature for the State of Maryland. Although the maximum detected concentrations exceeded facility background concentrations, the exceedances noted were often within two times the background concentration. Arsenic was the only metal detected at

concentrations exceeding background and the EPA Region III RBCs developed for an industrial land use scenario. Arsenic, chromium and thallium were detected at maximum concentrations exceeding the EPA SSLs for migration of compounds from soil to groundwater.

5. Metals concentrations in groundwater were within the range of basewide background concentrations with the exceptions of arsenic and chromium. However, arsenic was the only metal detected at a concentration exceeding EPA Region III RBCs for tap water. The concentration reported was less than the current federal Safe Drinking Water Act (SDWA) maximum concentration level (MCL).

6. Metals concentrations detected in surface waters suggest that historic activities at Rum Point Landfill have had minimal impact on surface water quality. Concentrations in upstream samples are comparable to those noted in downstream samples. Metals concentrations in sediments appear to reflect background conditions.

The following items summarize the baseline human health risk assessment conducted for Rum Point Landfill:

1. The human health risk assessment for Rum Point Landfill considered exposures to maintenance workers, full-time employees, construction workers, and current/future adolescent trespassers. Potential exposure pathways for direct contact with soil for all receptors included incidental ingestion of and dermal contact with soil. Other potential exposure routes included incidental dermal contact with groundwater by construction workers. Inhalation of fugitive dust and volatiles from soil were not considered since concentrations of all COPCs in soil were less than the SSLs developed by the EPA for the migration of contaminants from soil to air.

2. Arsenic and benzo(a)pyrene were the only target analytes selected as COPCs for the evaluation of exposures to soils. Arsenic and chromium were the only COPCs selected for the evaluation of exposures to groundwater. No COPCs were selected for surface water or sediments.

3. Incremental lifetime cancer risk estimates developed for all receptors were within the EPA's target risk range of 10^{-4} to 10^{-6}.

4. Noncarcinogenic risk estimates (HIs) calculated for all human receptors evaluated were less than unity indicating that adverse noncarcinogenic health effects are not anticipated under the conditions established in the exposure assessment.

The following items summarize the baseline ecological risk assessment conducted for Rum Point Landfill:

1. The concentrations of two organic compounds in surface water exceeded BTAG screening levels but these organics were not detected in sediments or surface soils at Rum Point Landfill.

2. Six inorganic compounds detected in sediments had maximum concentrations in excess of BTAG screening levels, but these concentrations were less than or comparable to average basewide background concentrations.

3. Chromium, lead, and mercury had maximum concentrations in surface soils that were slightly elevated relative to basewide background. However, none of these metals was identified as a PCOC in surface water or sediments, suggesting the absence of off-site migration. Despite some elevated detections of these metals in soil, their concentrations do not appear to be high enough to warrant additional ecological study or remediation based on ecological concerns. Also, qualitatively, the terrestrial flora does not appear to be stressed.

It is recommended that the risk managers for NSWC Indian Head consider a "No further action" decision for the Rum Point Landfill - SWMU 1. The human health risk assessment indicates that the cancer risk estimates for human receptors of concern are within the EPA's target risk range of 10^{-4} to 10^{-6}. COPCs contributing to the risk estimates exceeding 10^{-6} were detected infrequently at concentrations exceeding background. Adverse noncarcinogenic health effects are not anticipated for the human receptors of concern. The ecological risk assessment indicates that risks to ecological receptors appear to be relatively low. Although some metals were detected in soils at concentrations exceeding EPA SSLs for migration of compounds from soil to groundwater, the available groundwater data do not indicate that significant contaminant migration has occurred.

E.4 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B

This section summarizes the environmental investigations conducted to date, the nature and extent of the chemicals detected in the environmental media, and the results of the baseline risk assessment. Dump Site B is located near a former EOD training area, and little is known of its history. Conclusions and recommendations are provided.

The following items summarize the investigative work conducted to date:

1. The field investigation included the field screening of 18 shallow soil samples for TNT and RDX and a magnetometer survey covering a 137,500 square foot area to identify potential contaminant "hot spots".

2. Surface and subsurface soil samples were collected from 10 locations and submitted to a fixed-base laboratory (GP) for analysis. In total, 10 surface and 12 subsurface soil samples were collected.

3. Four monitoring wells were installed. One round of synoptic water level measurements were recorded.

4. Environmental samples collected for analysis by the fixed-base laboratory were analyzed for a comprehensive suite of analytes including volatile organic and semivolatile organic compounds, metals, and explosives.

The following items summarize the environmental conditions at Dump Site B:

1. The subsurface soil materials were relatively consistent across the study area both vertically and horizontally. The surficial deposits generally consist of yellow and brown silt, sand, and clay mixtures and range in thickness from 6 to 12 feet. These surface materials were underlain by a coarsening downward sequence of medium to coarse sand and gravel to the bottom of the well borings. No waste materials were encountered in the subsurface. There were areas of scattered surface debris observed however, probably as a result of wash from Chicamuxen Creek and residual fill from the graded area around well DSBMW01.

2. The groundwater beneath the site occurs primarily under locally semiconfining and unconfined (water table) conditions. The water table aquifer consists primarily of yellow-brown sand. Based on topography, shallow groundwater is presumed to be flowing to the south toward and discharging into Chicamuxen Creek. However, the creek is tidal and during high tide, losing stream conditions occur which cause the water table to be slightly elevated near the stream (bank storage). As a result, the groundwater appears to be flowing to the north away from Chicamuxen Creek. The groundwater flow pattern at the site is not static. During low-tide conditions, Chicamuxen Creek becomes a gaining stream which causes a decrease in the elevation of the water table near the stream and would result in a groundwater flow pattern to the south.

3. The groundwater resource is probably recharged by downward migration of precipitation through the unsaturated zone to the water table. In addition, groundwater along the edge of the stream is also recharged as a result of the losing stream conditions during high tide.

4. The results of the analysis of surface and subsurface soil samples from Dump Site B suggest that historic activities have not resulted in significant contamination of the soils. No explosives were detected. Acetone, the only volatile organic chemical noted, was reported at a maximum

concentration similar to or less than those reported for the background soil dataset. Three phthalate compounds were the only semi-volatile organics detected in soils. Site-related as well as non-site-related activities may have contributed to the presence of these compounds in the environmental media. Concentrations reported in site samples are similar to those reported in the background dataset. With a few exceptions, metals concentrations reported in the surface and subsurface soils samples appear to reflect background conditions.

5. Two volatile organics (chloroform and 1,1,1-trichloroethane), three phthalate compounds (e.g., bis[2-ethylhexyl]phthalate), and phenanthrene were sporadically detected in groundwater samples collected at Dump Site B. The maximum concentrations detected (less than 10 ug/L) suggest that a significant subsurface groundwater contaminant source is not present at Dump Site B.

6. With few exceptions, metals concentrations in groundwater appear to reflect background conditions. Maximum concentrations reported do not exceed EPA Region III RBCs or SDWA MCLs.

The following items summarize the baseline human health risk assessment conducted for Dump Site B:

1. The human health risk assessment for Dump Site B considered exposures to maintenance workers, full-time employees, and construction workers. Potential exposure pathways for direct contact with soil for all receptors included incidental ingestion and dermal contact with soil. Inhalation of fugitive dust and volatiles from soil were not considered since concentrations of all COPCs in soil were less than the SSLs developed by the EPA for the migration of contaminants from soil to air. In addition, dermal contact with groundwater was evaluated for construction workers.

2. Arsenic was the only COPC selected for the evaluation of exposures to soil. Chloroform and RDX were the only COPCs selected for the evaluation of exposures to groundwater.

3. Incremental lifetime cancer risk estimates for all receptors hypothetically exposed to COPCs in soil and groundwater were within or less than the EPA's target risk range of 10^{-4} to 10^{-6}.

4. Noncarcinogenic risk estimates (HIs) calculated for all receptors were less than unity indicating that adverse noncarcinogenic health effects are not anticipated under the conditions established in the exposure assessment.

The following items summarize the baseline ecological risk assessment conducted for Dump Site B:

1. The maximum concentrations of most metals in surface soils that were retained as PCOCs after the foodchain modeling were comparable to basewide and regional background concentrations.

2. Copper and zinc were present in surface soils at maximum concentrations which may be elevated relative to basewide and regional background concentrations.

3. No stressed vegetation is present on the site. The site supports a diverse and abundant flora typical of similar habitats on the base and in the region.

4. The bald eagle's nest located near the site has successfully produced offspring for several years, suggesting that site- and base-related contaminants were not resulting in obvious reproductive effects to this contaminant-sensitive, federally-threatened species. The eagle's foraging range, up to 1,830 hectares (EPA, 1993), is much larger than all of the sites investigated in this ERA combined.

5. Despite elevated copper and zinc in site surface soils, remediation does not appear to be desirable due to the presence of an apparently healthy flora with several large, mature trees, and the presence of the bald eagle's nest. The area is part of the Porter Woods Protection Area and disturbance of this area and its rare flora and fauna should be avoided.

6. Since no surface water and sediment data in Chicamuxen Creek were available near the site, contaminant impacts from Dump Site B to the Creek cannot be quantitatively assessed. However, the surface soil data, subsurface soil data, and topography indicate that significant overland migration of surface soil contaminants is not likely.

Recommendations are not presented because field investigations are on-going for this site.

E.5 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS FOR SWMU 6 - AIR BLAST POND

This section summarizes the environmental investigations conducted to date, the nature and extent of the chemicals detected in the environmental media, and the results of the human health risk assessment. The Air Blast Pond is a former explosives testing area that has been inactive for many years. Conclusions and recommendations are provided.

The following items summarize the investigative work conducted to date:

1. The field investigation activities included field screening of soils for TNT and RDX using field test kits (seven sampling locations and nine samples). Locations within and outside the actual air blast pond were tested.

2. Four soil borings were advanced at locations on the top of the berm at the Air Blast Pond; a surface and subsurface soil sample were collected from each boring. Surface soil samples were also collected at three additional locations within the pond.

3. Four sediment samples were collected from intermittent streams/ditches located in the immediate vicinity of the Air Blast Pond.

4. No surface water or groundwater samples were collected.

5. Environmental samples collected for analysis by the fixed-base laboratory were analyzed for a comprehensive suite of analytes including volatile organic and semivolatile organic compounds, metals, and explosives.

The following items summarize the environmental conditions at the Air Blast Pond:

1. The subsurface soil materials were relatively consistent across the study area both vertically and horizontally. The material encountered in and beneath the berm of the Air Blast Pond generally consists of a 9- to 12 foot thickness of natural, reworked material classified as silty sand and was generally underlain by sand and gravel. In the northern portion of the site; however, it was underlain by silty clay.

2. There are no groundwater monitoring wells located at the Air Blast Pond. The groundwater is presumed to flow toward and discharge into Chicamuxen Creek to the south.

3. The results of the analysis of surface and subsurface soil samples from the Air Blast Pond suggest that historic activities have not resulted in significant contamination of the soils. No explosive compounds were detected. Acetone (C_{max} = 2,000 µg/kg), styrene (C_{max} = 92 µg/kg), and methylene chloride (C_{max} = 7 µg/kg) were the only volatile organic chemicals noted. Acetone was reported at a maximum concentration less than that reported for the background soil dataset. Bis(2-ethylhexyl)phthalate (C_{max} = 2,600 ug/kg), chrysene (C_{max} = 67 ug/kg), and phenanthene(C_{max} = 63 ug/kg) were the only semi-volatile organics detected in soils. Site-related as well as non-site-related activities may have contributed to the presence of these compounds in the environmental media. With few exceptions, metals concentrations reported in the surface and subsurface soils samples appear to reflect background conditions.

4. Two volatile organics (carbon disulfide [C_{max} = 3 ug/kg] and 1,1,1-trichloroethane [C_{max} = 2 ug/kg]), one phthalate compounds (bis[2-ethylhexyl]phthalate [C_{max} = 150 ug/kg]), and several PAH compounds (e.g., benzo(a)pyrene [C_{max} = 510 ug/kg]) were detected in the sediment samples collected at the Air Blast Pond. As noted with the soil characterization, site-related as

well as non-site-related activities may have contributed to the presence of the phthalate and PAH compounds in the sediments.

5. With the exception of copper, lead, tin, and zinc, metals concentrations in the sediment samples were similar to or less than those noted in the soil samples or the maximum concentrations reported for the background freshwater sediment dataset. Maximum metals concentrations were reported for the sample collected from the effluent ditch west of the Air Blast Pond.

The following items summarize the baseline human health risk assessment conducted for the Air Blast Pond:

1. The human health risk assessment for the Air Blast Pond considered exposures to maintenance workers, full-time employees, and construction workers. Potential exposure pathways for direct contact with soil for all receptors included incidental ingestion and dermal contact with soil. Inhalation of fugitive dust and volatiles from soil were not considered since concentrations of all COPCs in soil were less than the SSLs developed by the EPA for the migration of contaminants from soil to air.

2. Arsenic was the only chemical selected as a COPC for soil. No chemicals were selected as COPCs for sediments.

3. Incremental lifetime cancer risk estimates for all receptors hypothetically exposed to arsenic in soil were within the EPA's target risk range of 10^{-4} to 10^{-6}.

4. Noncarcinogenic risk estimates (HIs) calculated for all human receptors hypothetically exposed to arsenic in soils were less than unity indicating that adverse noncarcinogenic health effects are not anticipated under the conditions established in the exposure assessment.

The following items summarize the baseline ecological risk assessment conducted for the Air Blast Pond:

- Copper, lead, and zinc were retained as PCOCs in sediments because their maximum concentrations exceeded basewide background concentrations. The maximum concentrations of these three metals were detected in sediment sample SD03, and metals concentrations were not elevated in sediment samples collected downgradient of that sample.

- The effluent ditch where the sediment samples were collected is essentially comprised of moist soils, precluding the existence of an aquatic community. Therefore, potential risks from copper, lead, and zinc would most likely be confined to terrestrial and semi-aquatic receptors. Since the ditch, and in

particular the area near sample SD03 represent a limited surface area (i.e., limited areal extent), the exposure area for these receptors would be small.

- The maximum concentrations of copper, lead, and zinc in surface soil were higher than the average basewide background concentrations and the range of regional background concentrations, but were below the alternate guidelines presented. The elevated detections of copper, lead, and zinc in surface soil were in two samples located in the Air Blast Pond itself (SS01 and SS02).

It is recommended that the risk managers for NSWC Indian Head consider a "No further action" decision for the Air Blast Pond - SWMU 6. The human health risk assessment indicates that the cancer risk estimates for human receptors evaluated are within the EPA's target risk range of 10^{-4} to 10^{-6}. Arsenic in surface soils was the only COPC contributing to the estimated cancer risk. However, the maximum concentration detected in the surface soils (9.6 mg/kg) is similar to the 95 percent upper tolerance limit value established for the basewide background surface soils (4.25 mg/kg) and background soils concentrations reported for the State of Maryland (C_{max} = 7.1 mg/kg). It is also less than the maximum concentration reported for the basewide background subsurface soils (10.4 mg/kg). Adverse noncarcinogenic health effects are not anticipated for the human receptors evaluated. The ecological risk assessment indicates that risks to ecological receptors appear to be relatively low. COPCs were not detected in soils at concentrations exceeding benchmarks established to evaluate the migration of chemicals from soils to groundwater.

1.0 INTRODUCTION

This Resource Conservation and Recovery Act (RCRA) Facility Investigation/Verification Investigation (RFI/VI) Report presents the results of environmental investigations conducted at six solid waste management units (SWMUs) within the Naval Explosive Ordnance Disposal Technology Division (NAVEODTECHDIV), Stump Neck Annex, Indian Head, Maryland. NAVEODTECHDIV is a tenant activity at the Indian Head Division, Naval Surface Warfare Center (IHDIVNAVSURFWARCEN). The following six SWMUs within NAVEODTECHDIV are the focus of this RFI/VI Report:

- Range 6 (SWMU 5) (RFI)
- Range 3 Burn Point (SWMU 2) (RFI)
- Chicamuxen Creek's Edge Dump Site A (SWMU 3) (RFI)
- Rum Point Landfill (SWMU 1) (VI)
- Chicamuxen Creek's Edge Dump Site B (SWMU 4) (VI)
- Air Blast Pond (SWMU 6) (VI)

As indicated above, three SWMUs are included in the RFI and three SWMUs are included in the VI. The SWMUs are presented in this particular order, because this is the order in which they will be addressed in this report.

Authorization for Brown & Root Environmental (B&R Environmental) to perform the RFI/VI work tasks was provided by the Northern Division of the Naval Facilities Engineering Command via, Contract Task Order (CTO) 287, under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract Number N62472-90-D-1298.

1.1 PURPOSE OF THE REPORT

The primary goal of the RFI/VI is to identify known or suspected releases of hazardous waste and/or hazardous constituents from each SWMU into soil, groundwater, surface water, and sediments and to determine whether corrective measures are needed to protect human health or the environment. Another goal is to screen from further investigations those SWMUs which do not pose a threat to human health or the environment.

1.2 GENERAL BACKGROUND INFORMATION

1.2.1 Base Location and Description

The IHDIVNAVSURFWARCEN is located near Indian Head, Maryland, in the west-central portion of Charles County, approximately 30 miles south-southwest of Washington, D.C., as illustrated in Figure 1-1. This facility occupies two peninsulas of land along the eastern shore of the Potomac River. The NAVEODTECHDIV is located on 1,100 acres situated on the southwest portion of the peninsula known as Stump Neck Annex (Stump Neck). The other peninsula is known as Indian Head. Stump Neck is separated from the Indian Head peninsula (IHDIVNAVSURFWARCEN) by Mattawoman Creek. All sites investigated for this RFI/VI are located on Stump Neck and are controlled by the NAVEODTECHDIV. The sites are located as noted in Figure 1-2.

1.2.2 Base History

The Naval Surface Warfare Center (NSWC) Indian Head was founded in 1890. The mission and activities have changed over the years to meet the needs of the Navy. Early activities centered on research, development and testing various guns and munitions. Propellant for these munitions was also manufactured at NSWC Indian Head. More detailed information concerning base history is found in the Master Plans for Remedial Investigations (B&R Environmental, April 1997). On Stump Neck Annex, the principal mission of NAVEODTECHDIV has been to provide Explosive Ordnance Disposal (EOD) technology and logistics management for the joint U.S. military services and to develop war essential elements of intelligence, equipment, and procedures to counter munitions, both domestic and foreign, as required to support the United States Department of Defense and the peacetime security needs of other agencies. A major tenant organization of IHDIVNAVSURFWARCEN, the Naval School Explosive Ordnance Disposal (NAVSCOLEOD) conducted exercises at Range 6 (SWMU 5) where active military personnel were trained to perform EOD operations. Similar training was also conducted in the vicinity of the current Chicamuxen Creek's Edge Dump Site B (SWMU 4) area.

1.2.3 Summary of Previous Investigations

Several environmental investigations have been conducted at NSWC Indian Head; however, the most recent and most relevant was the VI conducted by B&R Environmental during the implementation of CTO 222. The VI Report (B&R Environmental, June 1996) prepared for CTO 222 by B&R Environmental, presented the results of environmental investigations conducted at four SWMUs within the Naval Explosive Ordnance Disposal Technology Division (NAVEODTECHDIV), Stump Neck Annex, Indian Head, Maryland. The following four SWMUs were the focus of the Verification Investigation:

- Range 6 (SWMU 5)
- The Improvised Explosive Devices (IED) Site (SWMU 26)
- The Inert Ordnance Disposal (IOD) Site (SWMU 27)
- Area 8, the Underwater Ordnance Training Area (SWMU 25).

Additionally, a Background Investigation (BI) was conducted by B&R Environmental under CTO 287 concurrent with this RFI/VI. This BI yielded a basewide background database suitable for comparison to site environmental data for the purposes of human health risk assessment, ecological risk assessment, and general site characterization.

1.3 OVERVIEW/REGULATORY STATUS OF SITES UNDER INVESTIGATION

Environmental investigations are being conducted at Range 6, Range 3 Burn Point, Chicamuxen Creek's Edge Dump Site A, Rum Point Landfill, Chicamuxen Creek's Edge Dump Site B, and Air Blast Pond, because these sites are included in a RCRA Corrective Action Permit (CAP) for the Stump Neck Annex. The permit (CAP Number MD 417 009 0001) was issued in January 1991, by Region III of the United States Environmental Protection Agency (EPA). In response to the CAP, the Navy developed and submitted a draft RFI/VI Work Plan (Ensafe, Allen, and Hoshall, 1991). The RFI/VI Work Plan received initial comments from EPA in 1995 which were addressed with a draft final RFI/VI Work Plan (EnSafe, Allen, and Hoshall, 1995). Final EPA comments on the RFI/VI Work Plan were received in March 1997 and incorporated into Work Plan Addenda prepared by B&R Environmental in May 1997. The Work Plan Addenda also reflect current professional practices as well as decisions made by Navy and B&R Environmental during the March 1997 site visit. The RFI/VI Work Plan and associated Work Plan Addenda were implemented by B&R Environmental under CTO 287 in 1997. At the time this report was written, the process to transition all SWMUs on Stump Neck Annex (including the six which are the focus of this report) from regulation under RCRA to regulation under the Comprehensive Environmental Response Compensation and Liability Act (CERCLA) was underway.

1.4 ORGANIZATION OF THE RFI/VI REPORT

This RFI/VI Report is divided into seven major sections. This introduction is Section 1.0. A description of the field investigation activities and the risk assessment strategy used to evaluate the results of the field investigation results is presented in Section 2.0. Section 3.0 provides a general discussion of the characteristics of the study area. Sections 4.0, 5.0, 6.0, 7.0, and 8.0 provide the following information for Range 6 (SWMU 5), Range 3 Burn Point/Chicamuxen Creek's Edge Dump Site A (SWMU 2/3), Rum Point

Landfill (SWMU 1), Chicamuxen Creek's Edge Dump Site B (SWMU 4), and Air Blast Pond (SWMU 6), respectively:

- Site background and physical setting
- Site operations and history
- A discussion of the site-specific RFI/VI field investigation
- A discussion of site-specific geology and hydrogeology
- The results of the sampling and analysis of environmental media
- The results of qualitative and quantitative assessment of target analyte concentrations detected in the environmental media
- Conclusion

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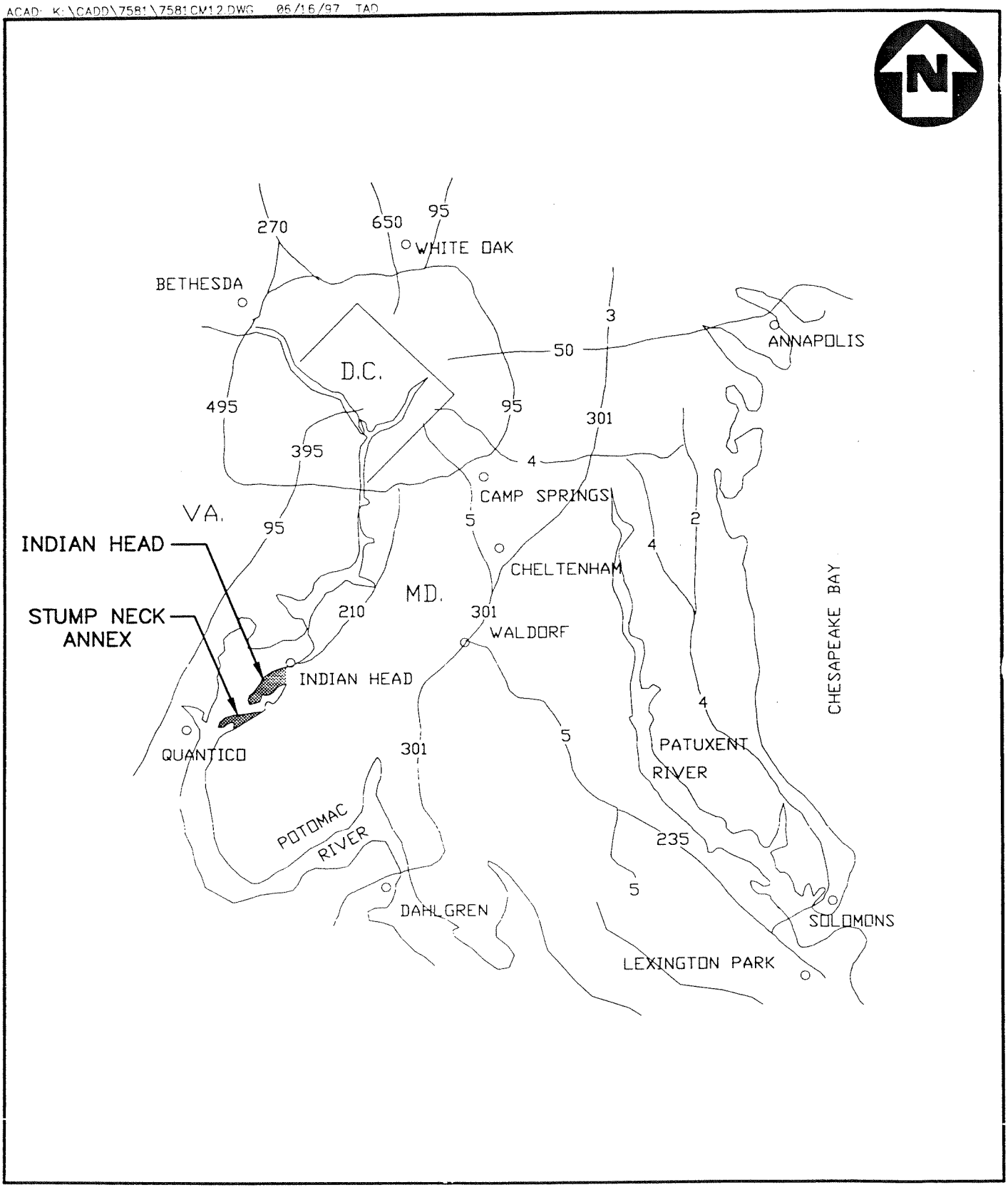


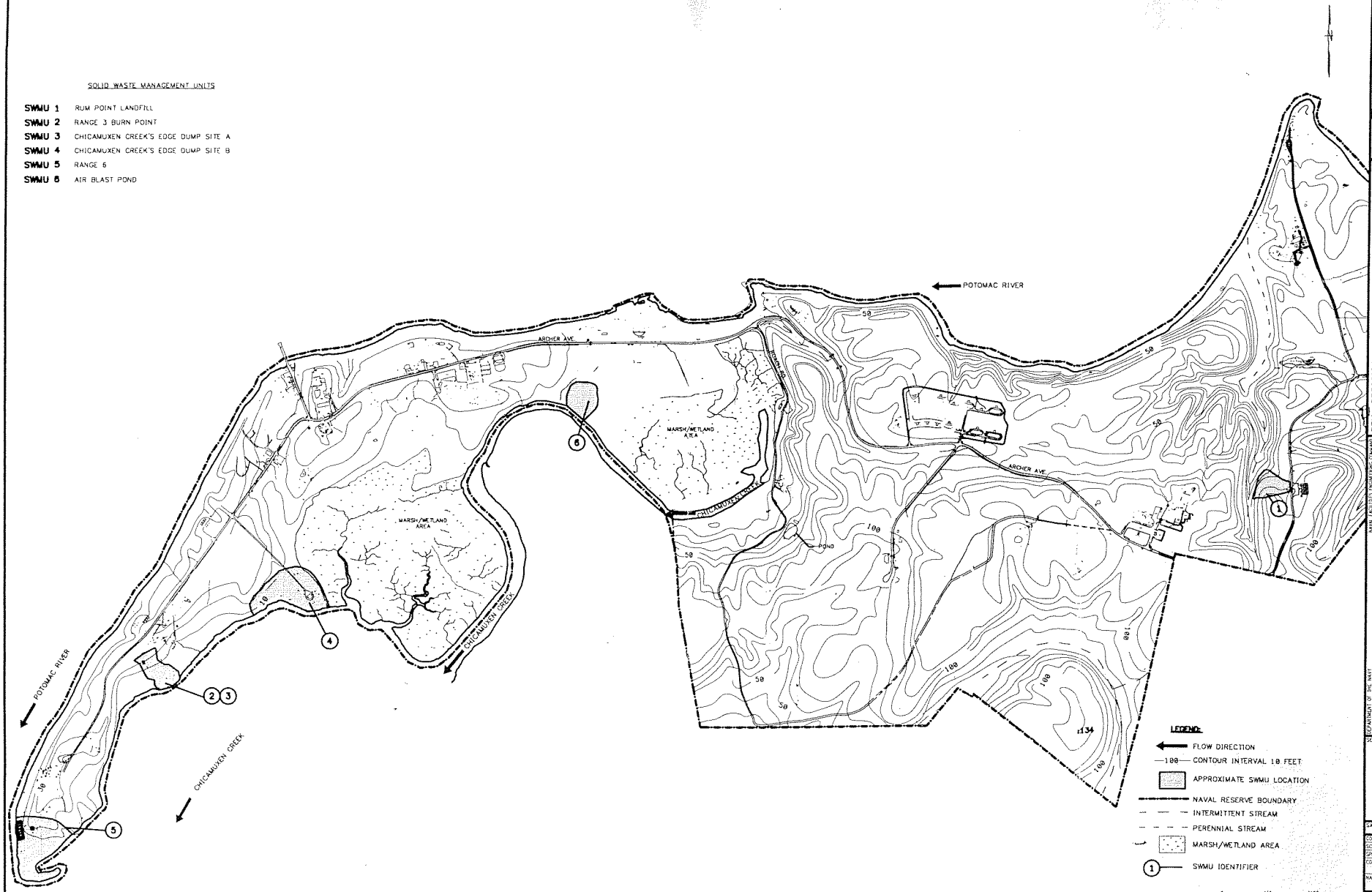
VICINITY MAP
INDIAN HEAD AND STUMP NECK ANNEX
INDIAN HEAD, MD

FIGURE 1-1

Brown & Root Environmental

SOLID WASTE MANAGEMENT UNITS

SWMU 1 RUM POINT LANDFILL
SWMU 2 RANGE 3 BURN POINT
SWMU 3 CHICAMUXEN CREEK'S EDGE DUMP SITE A
SWMU 4 CHICAMUXEN CREEK'S EDGE DUMP SITE B
SWMU 5 RANGE 6
SWMU 6 AIR BLAST POND



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DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, DC
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MD
ENGINEERING FIELD ACTIVITY CHESAPEAKE

SOLID WASTE MANAGEMENT UNIT (SWMU) LOCATIONS
RFI/VI REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SEAL AREA

DAT TO DATE
CODE I.D. NO. 68091
SCALE AS SHOWN
SPEC. NO. 84 - NA
CONSTRN. CONTR. NO NA
NAVFAC DRAWING NO NA
SHEET 1 OF 1
SIZE: D
DRS SH. NO
FIGURE 1-2

DRAFT

RCRA Facility Investigation/ Verification Investigation Report

for

Stump Neck Annex
Indian Head Division
Naval Surface Warfare Center

Indian Head, Maryland

Volume I of IV - Text

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command

Northern Division Contract Number N62472-90-D-1298

Contract Task Order 0287

January 1998

Brown & Root Environmental

A Division of Halliburton NUS Corporation

3.0 CHARACTERISTICS OF STUDY AREA

Section 3 outlines the general characteristics of the NSWC Indian Head Stump Neck peninsula and surrounding area.

3.1 PHYSIOGRAPHY AND TOPOGRAPHY

The NSWC Indian Head Stump Neck peninsula lies within the Atlantic Coastal Plain physiographic province, approximately 8-10 miles east of the Fall Line that marks the western extent of the physiographic province. Stump Neck has gently rolling to undulating topography with elevations ranging from sea level to 134 feet above mean sea level (msl). The higher elevations exist in the eastern portion of the Annex. Generally, the land surface slopes to the east and southeast with slopes of 5 percent or less. The western side of Stump Neck along the Potomac River is characterized by 40- to 50-foot bluffs, whereas the eastern side along Chicamuxen Creek is more gently sloping (Hart, 1983).

3.2 METEOROLOGY

Stump Neck experiences a modified, moist, humid, continental climate with warm and wet summers and cool winters. The Appalachian and Blue Ridge mountain ranges to the west obstruct cold, continental air in the winter, whereas the Potomac River and Atlantic Ocean contribute to more moderate temperatures and higher humidity.

The mean temperature (1958-1987) at Indian Head is 58°F (NOAA, 1987). The warmest month is typically July with an average temperature of 79°F, whereas January is the coldest month with an average temperature of 35°F.

The area receives an average of approximately 39 inches of precipitation per year, with approximately 17 inches of snow. Precipitation is uniformly distributed throughout the year (NOAA, 1987).

3.3 SOILS

The following is a brief description of the soil types in the Stump Neck Annex area as classified by the United States Department of Agriculture (USDA), Soil Survey of Charles County, Maryland (USDA, 1974). The dominant soil series in this area are the Evesboro-Keyport-Elkton association and the Bibb-Tidal Marsh-Swamp association. The Evesboro-Keyport-Elkton association consists of level to moderately sloping, excessively drained, sandy soils and moderately well drained and poorly drained, level to gently

area to about 230 feet thick in the eastern portion of Charles County. At the contact with the underlying Aquia Formation, the interface is indistinct.

The Upland Gravel 4 (upper Pliocene) consists of non-marine, fluvial deposits of poorly sorted, fine- to medium-grained sand with lenses of muddy sand and clay, grading downward to a gravely mud or medium- to coarse-grained sand. The fines are generally pink to gray, and the coarser particles are yellow to orange. The thickness of this formation in the area ranges from 0 to approximately 30 feet.

The Park Hall Formation (upper Pliocene) consists of non-marine, fluvial and estuarine deposits of sand and clay interbedded with sand with gravel. It is overlain unconformably by Quaternary deposits. The thickness of this formation in the area ranges from 0 to approximately 60 feet.

The Tertiary geologic formations are missing in many locations in the Stump Neck area. Where this occurs, the overlying Quaternary deposits come in contact with the underlying Cretaceous formations. The Quaternary fluvial and estuarine deposits at Stump Neck and Indian Head consist of Pleistocene paleochannel deposits and Holocene alluvial deposits (Hiortdahl, 1990). These deposits consist of gravel, sand, silt, clay, and peat mixtures with irregular bedding. The aggregate thickness may range from 0 to 40 feet.

3.6 REGIONAL HYDROGEOLOGY

The Patapsco and Patuxent Formations of the Potomac Group are the main groundwater aquifers used for domestic purposes in the western portion of Charles County and are separated by the Arundel Formation confining unit. Stump Neck is located in the western portion of Charles County. Figure 3-1 presents a generalized cross-sectional view of the Stump Neck Annex regional area.

The three principal water-bearing zones within the Patapsco Formation are the Lower, Middle, and Upper Sands. They are under confined conditions. The Lower Sand outcrops in Virginia; the Middle Sand outcrops below the Potomac River and in Virginia; and the Upper Sand outcrops beneath the Potomac River.

The water-bearing zones of the Patuxent Formation consist of laterally discontinuous sand lenses. The Patuxent Formation outcrops in Virginia, where it is recharged by surface water.

significant portion of the local commerce, as Indian Head is located near some of the best fishing locations on Mattawoman Creek.

3.10 ECOLOGY

The information in this section was taken from the Initial Assessment Study Report (Hart, 1983), except where noted.

3.10.1 Flora

Approximately 35 percent of NSWC Indian Head is wooded. The forests consist hardwoods, including oak and hickory, and Loblolly and Virginia pines. The upland areas are characterized by older growth of pine and oaks, whereas the lower elevations are composed of sycamore, ash, elm, and sweet gum.

About 53 percent of NSWC Indian Head is open field and shrub vegetation. Loblolly pine, sweet gum, red cedar, and black locust are typical of these communities.

Along the shoreline and beaches of the Potomac River black persimmon, false indigo, poison ivy, sea myrtle, grape and Virginia creeper are present along with phlox, gama grass, panic grass, Bermuda grass, or finger grass. Marsh areas predominate Mattawoman Creek. They are characterized by jewelweed, alger, marsh cattail, weedgrass, sedge, three square bulrush, wild rice, saltmarsh cordgrass, smartweek, and marsh mallow.

3.10.2 Wildlife

The ecosystem at NSWC Indian Head supports a variety of animal life, and white-tailed deer are abundant. Other common mammals include possum, bats, squirrels, mice, raccoon, woodchuck, rabbits, and other burrowing rodents, such as voles and shrews. The birds found within Charles County include grebes, herons, ducks, geese, hawks, kestrels, osprey, eagles, gulls, owls, gulls, and perching birds, such as robins, warblers, and jays. Common reptiles and amphibians of Charles County include lizards, skunks, snakes, turtles, salamanders, frogs, and toads.

3.10.3 Aquatic Life

The area of the Potomac River adjacent to the Station is part of the spawning and nursery area for striped bass, white perch, herrings, and shad. Bay anchovies and three species of silversides also spawn and nurse within this area. The area is the upstream limit of the nursery area for estuarine-dependent species,

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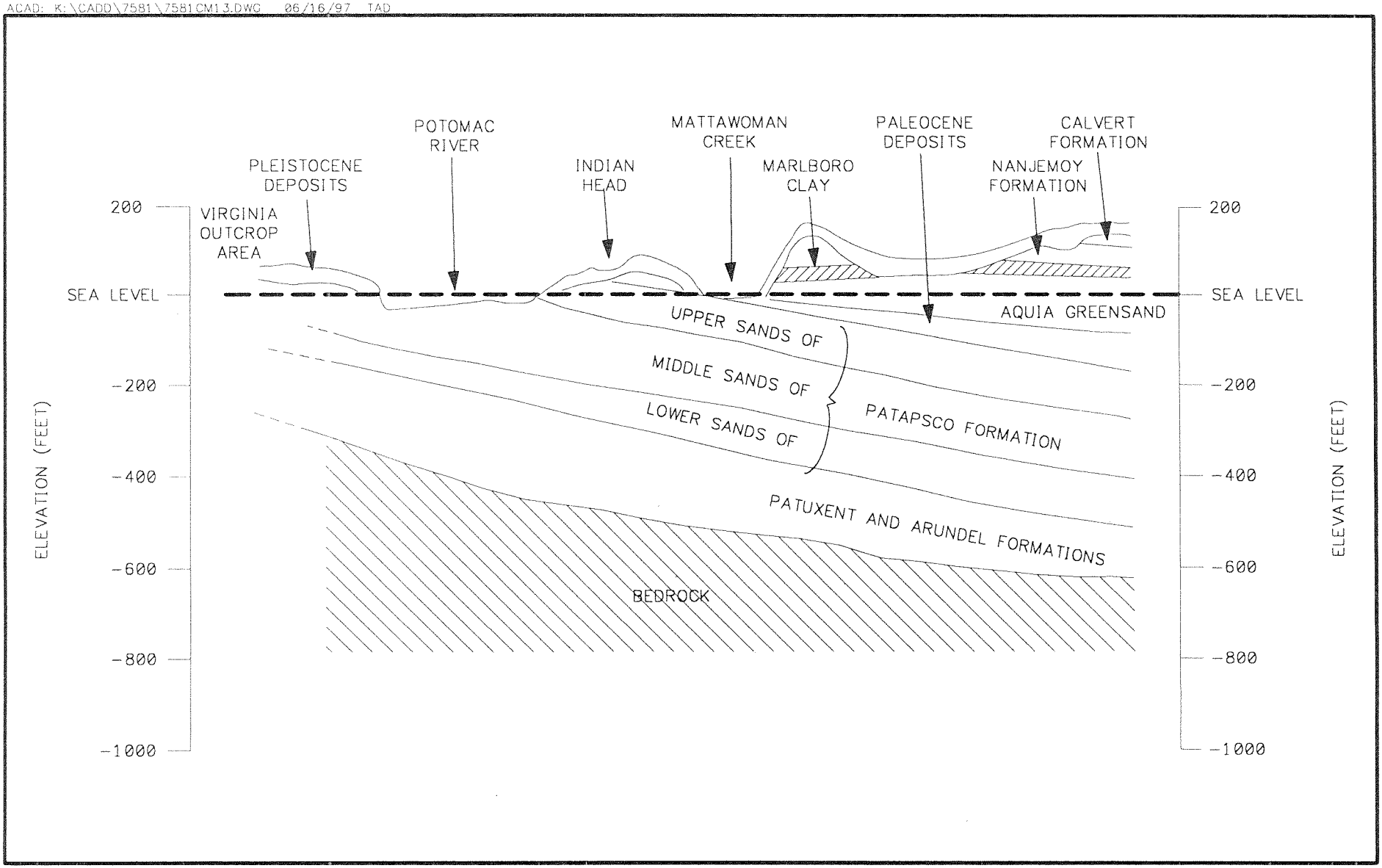


GENERAILIZED CROSS-SECTION OF STUMP NECK ANNEX
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

0 5,000 10,000
SCALE IN FEET

FIGURE 3-1

Brown & Root Environmental

4.0 SWMU 5 - RANGE 6

'98 RFI/VI

Section 4 provides a brief description and history of Range 6 (SWMU 5), an inactive explosives training area at the Stump Neck Annex, and summarizes the scope and results of the environmental investigations and baseline risk assessments conducted for the RFI/VI. The Range 6 training ranges were used for open detonation training from the early 1950s until early in 1988. Environmental data were by B&R Environmental for the RFI/VI under CTOs 222 and 287 in 1995 and 1997, respectively. The field investigation efforts conducted under CTO 222 and CTO 287 are described in Sections 4.1.3 and 4.2, respectively.

4.1 SITE DESCRIPTION AND HISTORY

4.1.1 Site Description

Range 6 is an inactive training area located at the end of Archer Avenue, on a point of land extending into the Potomac River and Chicamuxen Creek. Water surrounds the site on three sides, the Potomac River to the north and west and Chicamuxen Creek to the east. Archer Avenue, an asphalt road, bisects the site. Access to Range 6 is controlled by fencing and a gate located on Archer Avenue. The site lies completely within the 100-year flood plain and is approximately 11 acres in size. Range 6 is sparsely vegetated and surrounded by wetlands. The terrain is generally flat to gently sloping toward the surrounding water bodies. The location and general features of Range 6 are displayed in Figure 4-1.

4.1.2 Site Operations And History

Range 6 consists of five ranges historically used for open detonation training by the Navy. Range 6 was identified in the Notice of Decision for RCRA CAP EPA I.D. Number MD 417 009 0001 (January 24, 1991, through January 23, 2001) as SWMU 5.

The Range 6 training ranges operated from the early 1950s until early in 1988. The frequency of training exercises at this site depended on the number of recruits (students) requiring training at any one given time. It is estimated that the training ranges were used weekly. The following chemicals and materials are among those used at Range 6:

- Trinitrotoluene (TNT)
- RDX
- Composition C-4
- Composition C-3
- HMX
- Pentaerythritol tetranitrate (PETN)
- Ammonium picrate (COMPD)
- Thermite (TH3)

- Nitric acid
- Sulfuric acid
- Nitrocellulose (NC)
- Nitroguanidine (NQ)
- Blasting caps
- H6 shot
- Single base, double base, multibase propellants

Small amounts (less than 2 to 3 pounds) of explosives were used during the training exercises conducted at Range 6. Based on this estimate, approximately 100 pounds of explosives were used each year. Most of the actual detonation work during the training exercises occurred within the sparsely vegetated, lowland area to the south of Archer Avenue. However, other related training activities, such as acid trepanning, occurred to the north of Archer Avenue. Acid trepanning involved the application of strong acids (nitric or sulfuric acid) to the protective hull of ordnance to access and subsequently extract (via steaming) the explosive charge. The ordnance was then safely detonated. Based on personnel interviews, a burn pit and heavily used demolition area may have existed at Range 6. Waste materials at Range 6 are also likely to include small quantities of shrapnel and casings from the aforementioned detonation of explosives.

The Range 6 training ranges are currently inactive, and there is minimal visual evidence of their actual location and size. (Five small white wooden placards [numbered 1 through 5] were noted at Range 6 during a site visit [June 20 - 21, 1995] and during the field sampling events. These placards may indicate the approximate locations of the five test ranges.) It is unlikely that Range 6 will ever be used for training purposes again. The unit has been phased out of operation since this portion of the Explosive Ordnance Disposal School (EODS) relocated to Florida in 1988.

Background documents available for the Stump Neck Annex indicate that in 1956/1957, approximately 1500 to 2000 pounds of arsenic powder, contained in plastic bags, were buried in a pit measuring 40 feet deep and 6 feet in diameter located within Range 6. (It should be noted that this information is suspect, because a 40-foot deep hole would be at least 25 feet below the water table.) However, the Indian Head Base drawing (Dwg. No. 15455-A) indicates that Range 6 is only 300 feet by 300 feet in size and does not indicate the location of the arsenic pit. A location identified by a former Navy employee was investigated during the CTO 287 field event. In addition, a white phosphorus burial site is reported to be located at Range 6. The information regarding the existence and location of an arsenic pit and white phosphorus burial site at Range 6 is tentative and difficult to verify.

4.1.3 VI Field Investigation Conducted For CTO 222

This section discusses the field activities that occurred at Range 6 (SWMU 5) during the CTO 222 VI field investigation conducted in September and October 1995 by B&R Environmental. (B&R Environmental, February 1996)

4.1.3.1 Field Screening

Field test-kit screening was conducted at Range 6 to investigate the near-surface soils for the presence of TNT, HMX, and RDX. A site-specific sampling grid was established prior to the collection and screening of the near-surface soils at Range 6. A 425- by 300-foot grid, with 71-foot by 106-foot line spacings, was staked to the south of Archer Avenue using labeled wooden hubs (see Figure 4-2). The grid was established to encompass the area most intensively used during site activities. Prior to sampling the grid, a preliminary sample set was collected and analyzed with the field test-kits at 6-inch intervals (0-6", 6-12", 12-18", and 18-24") from one of the grid locations to determine which soil depth interval demonstrated the highest soil contamination. Location 06-SS-13 was selected based on the indication of the B&R Environmental unexploded ordnance (UXO) specialist that the location was in a heavily used area. The 6- to 12-inch-deep sample interval demonstrated the highest field test-kit readings. The second highest readings came from the 0- to 6-inch interval. Therefore, all of the remaining near-surface soil samples were collected from a depth of 0 to 12 inches at Range 6.

Based on visual observations made by the B&R Environmental UXO specialist during the field investigation, it was determined that a small area north of Archer Avenue may have been disturbed by previous site activities. Therefore, two near-surface soils samples were collected north of Archer Avenue and analyzed using the sample test-kit techniques. A total of 27 surface soil samples were collected and analyzed by field test-kit screening. In addition, three background samples were collected north of Archer Avenue and analyzed using the sample test-kit techniques. The results of the field test-kit samples were also used to locate soil boring (later converted to monitoring well) 5MW01. Field test-kit screening results are displayed in Figure 4-2.

One sample (06-SS-19) was diluted because of the high concentration of TNT. The sample contained a nitroglycerine-type odor, as observed by the B&R Environmental UXO specialist. A soil boring (converted to monitoring well 5GW01) was installed near this location.

4.1.3.2 Soil Investigation

For purposes of characterizing soil contamination at Range 6, one soil boring (5GW01) was drilled at the site. The location was determined based on the results of the field test-kit analyses. In addition, the B&R Environmental UXO specialist indicated that the boring location had potential for contamination based on past activities at the site. (The B&R Environmental UXO specialist assigned to the project had previously trained at Range 6 during his tenure in the military.) Two soil samples were collected from boring 5GW01. The first sample was collected from the 0- to 2-foot interval. The second soil sample was collected at the soil interval just above the water table (4 to 6 feet bgs). The samples were analyzed for the following parameters: Appendix IX VOAs, Appendix IX SVOAs, explosives, TAL metals and cyanide, ammonia, nitrate/nitrite, and TOC. A "nitroglycerine-type odor" at this location was reported by the UXO specialist. The soil boring was converted to monitoring well 5GW01.

4.1.3.3 Groundwater Investigation

One monitoring well (5GW01) was installed and sampled at the site to determine whether groundwater contamination was present in the shallow water-table aquifer at Range 6 (see Figure 4-4). The sample was analyzed for the following parameters: Appendix IX VOAs, Appendix IX SVOAs, explosives, TAL metals and cyanide, ammonia, nitrate/nitrite, phosphorus, sulfate, total Kjeldahl nitrogen (TKN), total organic carbon (TOC), and total organic halides (TOX).

As summarized in the following table, a groundwater-level measurement was obtained and recorded at the well on October 17, 1995:

Well Name	Elevation of Measuring Point (ft above MSL)	Depth to Groundwater (ft)	Groundwater Elevation (ft above MSL)
5MW01	10.02	8.51	1.51

Both rising-head and falling-head slug tests were performed on monitoring well 5GW01 to determine the permeability characteristics of the aquifer. The results of the aquifer testing are presented in Section 4.3.2.

4.2 RFI FIELD INVESTIGATION

This section discusses the field activities performed at SWMU 5 - Range 6 during the RFI conducted under CTO 287. These activities consisted of field screening (soil-gas sampling survey) and sampling of

surface soil, subsurface soil, groundwater, sediment, and surface water for fixed-base laboratory analysis. Soil-gas data are provided in Appendix A. Sample log sheets are provided in Appendices D through G.

4.2.1 Field Screening

The field screening for the RFI at SWMU 5 - Range 6 consisted of a soil-gas survey. A survey grid was installed consisting of 38 points at 100-foot and 50-foot line spacings covering an approximate area of 200,000 sq. ft. Soil-gas samples were collected and analyzed for VOCs from each of these grid points following procedures as described in Section 2.1.2 of this report. The soil-gas sampling locations are shown on Figure 4-3, and a summary of positive detections is presented in Table 4-3. The soil-gas target analyte list consisted of the following organic compounds:

- benzene
- toluene
- ethylbenzene
- xylenes
- total volatile hydrocarbons
- methylene chloride
- 1,1-dichloroethene
- 1,1-dichloroethane
- total-1,2-dichloroethene
- chloroform
- 1,2-dichloroethane
- 1,1,1-trichloroethane
- carbon tetrachloride
- trichloroethene
- tetrachloroethene

4.2.2 Soil Investigation

Nineteen soil borings were drilled at Range 6 to characterize the soil. The general locations were established in the B&R Environmental Work Plan Addenda (May 1997). The actual locations were selected during the field effort by the field crew, which included a B&R Environmental UXO specialist. The UXO specialist had site-specific experience, having previously trained at Range 6 during his tenure in the military. Figure 4-4 illustrates the locations of the soil borings in relationship to the detonation areas. Soil borings RN6SB01 through RN6SB08 and RN6SB19 were located in the large-scale detonation training area at locations having the potential for contamination, based on past activities at the SWMU. Soil boring RN6SB11 was located in the small-scale detonation training area. Soil borings RN6SB09, RN6SB18, and RN6SB10 were located in the grassy areas just west of both detonation areas. Soil borings RN6SB12, RN6SB15, RN6SB13, RN6SB14, RN6SB16, and RN6SB17 were located in grassy areas north of the detonation areas. Soil boring RN6SB16 was located adjacent to the suspected location of the arsenic pit.

Soil borings RN6SB01 through RN6SB10 were completed using direct-push, large-core sampling tools. One surface soil sample was collected at each soil boring location at a depth of 0 to 1 foot for a total of 10 samples. Additionally, one shallow subsurface soil sample was collected at each boring location for a

total of 10 subsurface soil samples. The samples were obtained over a 1-foot interval ranging from beginning depths of 1.7 to 3 feet bgs.

Soil borings RN6SB16 through RN6SB19 were completed using hollow-stem auger and split-spoon sampling techniques. One surface soil sample was collected at each soil boring location at a depth of 0 to 1 foot for a total of four samples. A total of 12 subsurface soil samples were collected from the four soil borings. The samples were obtained over 2-foot intervals from beginning depths ranging from 4 to 18 feet bgs.

The samples were collected for Appendix IX metals, Appendix IX VOA, Appendix IX semivolatile organic analytes (SVOA), explosives. Table 4-1 provides a summary of sampling and analytical methods. Figure 4-9 provides specific sampling depths and a summary of positive detections for each sample collected.

4.2.3 Groundwater Investigation

Four monitoring wells (RN6MW02 through RN6MW06) were installed and sampled and one existing well was sampled at the site to determine whether groundwater contamination was present in the shallow water-table aquifer at Range 6. Monitoring well locations are shown on Figure 4-4. The newly installed wells were generally placed in locations proposed by the EnSafe Work Plan (Ensafe, Allen, and Hoshell, 1995). The upgradient well (RN6MW05), however, was located approximately 100 feet southwest of the proposed location to avoid underground utilities and to place the well at a higher ground-surface elevation relative to the other wells. RN6MW04 was located downhill from the suspected arsenic pit area. Samples were collected for Appendix IX metals, Appendix IX VOA, Appendix IX SVOA, and explosives. Table 4-1 provides a summary of sampling and analytical methods. Table 4-2 presents monitoring well construction and groundwater-level data.

One round of synoptic groundwater-level measurements was collected at the site. The results are presented in Table 4-2, on a potentiometric surface map (Figure 4-5), and discussed in Section 4.3.2 of this report.

4.2.4 Surface Water and Sediment Investigation

Four surface water and sediment sample pairs were collected at locations proposed in the EnSafe Work Plan (Ensafe, Allen, and Hoshell, 1995), two from the Potomac River and two from Chicamuxen Creek. No surface drainage swales were found on the site; therefore, no addition samples were collected. The surface water and sediment sampling locations are shown on Figure 4-4. The samples were analyzed for Appendix IX metals, Appendix IX VOA, Appendix IX SVOA, and explosives.

4.2.5 Summary of Environmental Investigation

The RFI field activities for the Range 6 included field screening using soil-gas sampling survey techniques (38 sampling points). Collected for fixed-base laboratory analyses, were 5 groundwater samples from 4 newly installed and one previously installed well, 19 surface soil samples, 27 subsurface soil samples, and 4 sediment/surface water samples.

4.3 SITE CHARACTERISTICS

This section discusses the site-specific geology and hydrogeology at SWMU 5 - Range 6.

4.3.1 Geology

Subsurface soil conditions at the site were investigated through the drilling and logging of 19 soil borings in addition to using an existing monitoring well boring. The boring locations and cross-section locations are shown on Figure 4-4. Cross-section profiles A-A' and B-B', shown on Figures 4-6 and 4-7, respectively, were generated to illustrate the subsurface materials encountered beneath the Range 6.

Cross Section A-A'

Cross section A-A' traverses the site from the southern portion of the site (RN6MW02) to the northern portion (RN6MW05). At well RN6MW02, the subsurface material encountered at the ground surface to a depth of approximately 6 feet bgs consists of mottled, interlayered clay, silt, sand, and gravel (most likely reworked natural fill material). The fill material is underlain by peat approximately 5 feet thick. Gray sand was encountered below the peat and was present to the bottom of the boring at a depth of 19 feet bgs. At well RN6MW03, approximately 350-feet north of well RN6MW02, the peat is absent, and a 5-foot-thick layer of yellow-brown silt and sand (possibly reworked natural material) is underlain by dark yellow-brown sand and gravel to the bottom of the boring at a depth of 17 feet bgs. The materials encountered at well RN6MW04, located approximately 500 feet north of well RN6MW03, consist of 20 feet of brown sand at the ground surface, underlain by an approximately 7-foot-thick layer of mottled, yellow-brown clay and silt. The clay and silt layer overlies a yellow-brown sand. These materials extend approximately 200 feet to the north to well location RN6MW05. However, within the lower portion of the brown sand, silty clay and silty sand layers are encountered overlying the 7-foot-thick layer of mottled, yellow-brown clay and silt layer. An orange-brown sand and gravel is encountered beneath the clay and silt layer.

Cross Section B-B'

Cross section B-B' traverses west to east across the site from well RN6MW03 to well 5GW01. At well RN6MW03, a surficial 5-foot-thick layer of yellow-brown silt and sand (possibly reworked natural material) is underlain by dark yellow-brown sand and gravel to the bottom of the boring. At well 5GW01, subsurface material encountered at the ground surface to a depth of approximately 6 feet bgs consists of yellow-brown silt and sand (reworked natural material). The fill material is underlain by an approximately 6 feet of silt and clay, which gives way to a gray silt and sand with some gravel to the bottom of the boring at a depth of 18 feet bgs.

Summary

The subsurface materials at Range 6 varied significantly across the study area, both vertically and horizontally. In the low-lying areas the subsurface materials generally consisted of fine-grained sediments; silt, clay, and peat. In the upland areas the materials generally consisted of sand and gravel interlayered by silt and clay. In the detonation areas the reworked material generally consisted of yellow-brown clay, silt, sand, and gravel mixtures approximately 6 feet thick.

4.3.2 Hydrogeology

Hydrogeologic conditions at the site have been interpreted from data obtained during the field investigation activities. In addition, physical features, such as the ground surface topography (as shown on Figure 4-1) and the proximity to Chicamuxen Creek and the Potomac River, were considered in making generalized interpretations regarding groundwater flow directions. The groundwater beneath the site occurs primarily under locally semiconfining and unconfined (water-table) conditions. The water-table aquifer consists primarily of yellow-brown sand and gravel. The shallow groundwater is presumed to be flowing radially toward and discharging into both Chicamuxen Creek and the Potomac River. However, both water bodies are tidal, and during high tide, losing stream conditions may occur. These conditions may cause the water table to be slightly elevated near the stream (bank storage) and may change the groundwater flow pattern to show groundwater flowing away from Chicamuxen Creek and the Potomac River. The groundwater is primarily recharged by downward migration of precipitation through the unsaturated zone to the water table. In addition, recharge of the groundwater occurs along the edge of the steam as a result of the losing stream conditions during high tide.

The five site monitoring wells were used to characterize the site. Groundwater was encountered at varying depths during the drilling process, ranging from approximately 9 feet bgs at well RN6MW03, 11 feet at RN6MW02, 12 feet at 5GW01, and 26 feet at RN6MW04, to 28 feet at RN6MW05. However, once the

wells were installed and water levels stabilized, groundwater levels were higher in the following wells: 5GW01, RN6MW02, and RN6MW04 to 5.58 feet bgs, 2.55 feet bgs, and 22.67 feet bgs, respectively. This is an indication that semiconfining aquifer conditions occur around these wells.

Synoptic groundwater-level measurements were taken at the site. The resulting depths to groundwater, groundwater elevations, and well construction details are presented on Table 4-2. The groundwater elevation data were used to generate a potentiometric surface map (Figure 4-5) to show the groundwater flow pattern for the site. Groundwater elevations vary from 1.23 to 1.64 feet msl. Within the training area, groundwater flows from the central portion of the area to both the east and west, discharging into both Chicamuxen Creek and the Potomac River. A north-south aligned groundwater divide is located within the center of the study area. The slight mounding of the groundwater potentiometric surface in the detonation area probably results from a combination of the surface topography and the shallow subsurface material. The topography is flat, and the shallow subsurface fill material is relatively loose, porous, reworked fill material; a situation which readily permits greater amounts of surface rain water to migrate downward to the water table.

Both rising-head and falling-head slug tests were performed in monitoring well 5GW01 during a previous investigation to determine the permeability characteristics of the aquifer near the well. The average hydraulic conductivity was calculated to be approximately 0.27 ft/day (9.6 x 10-5 cm/sec). The horizontal hydraulic gradient varies across the study area, ranging from approximately 0.001 to 0.003.

4.4 NATURE AND EXTENT OF CONTAMINATION

This section presents the results of the sampling and analysis of environmental samples collected at Range 6 as described in Sections 2, 4.2, and 4.3. The results of the soil gas survey conducted by Tracer Research Corporation (Tracer) are summarized in Table 4-3. The results of the field screening for TNT and RDX conducted under CTO 222 are displayed in Figure 4-2. Table 4-1 provided a summary of the sampling and analytical program for environmental samples collected by B&R Environmental and analyzed by General Physics Environmental Services (GP), according to the methods specified in Section 2. Analytical results, provided by GP are summarized in Tables 4-4 through 4-8 and presented in detail in Appendix M. Soil gas survey data and field screening data are also presented in detail in Appendices A and C, respectively.

All data generated by GP were validated according to EPA National and Region III guidelines. The data validation was performed by B&R Environmental validation chemists, who routinely validate data from numerous laboratories producing data under the EPA Contract Laboratory Program (CLP). A copy of the

validation packages is available to the Navy, the State of Maryland Department of the Environment, and EPA Region III upon request. Additionally, data validation memoranda summarizing the results of the data validation are presented in Appendix N.

The soil gas survey data collected by Tracer were reviewed by a B&R Environmental project chemist familiar with the methodology used to conduct the survey. The results of the evaluation are discussed in Section 2.3.5, and the soil gas survey data are presented in Section 2.

4.4.1 Surface and Subsurface Soil

Surface and subsurface soil samples were collected at Range 6 during the field investigations conducted under CTOs 222 and 287 and were analyzed for the presence of site-related contamination. Summarizing from Sections, 4.1.3, the field investigation for CTO 222, consisted of field screening for TNT and RDX in shallow soil samples collected at 22 locations, and the collection of a surface and a subsurface soil sample at one location. The field investigation for CTO 287 consisted of the collection of soil gas samples at 38 locations, and surface and subsurface soil samples at 19 locations. Analytical results for any parameter detected at least once in the surface or subsurface soils samples sent to GP for analysis are presented in Tables 4-4, and 4-5, respectively. Additionally, descriptive statistics (i.e., frequency of detection, concentration range detected, arithmetic mean of positive detections, location of maximum positive detection) are summarized in Tables 4-11 and 4-12, the chemical of potential concern (COPC) selection tables for Range 6 soils. Table 4-9 provides as comparison of descriptive statistics for surface and subsurface soil samples. The locations of positive detections are depicted in Figures 4-8 and 4-9.

4.4.1.1 Surface Soil Characterization.

In overview, explosives and components of explosives (TNT, RDX, HMX, 2,4-dinitrotoluene, and 2,6-dinitrotoluene) and degradation by-products of explosives (2-amino-4,6-dinitrotoluene) are the predominant site-related contaminants detected in the Range 6 surface soils. One or more of these chemicals were detected in over 50 percent of the surface soil samples analyzed with maximum concentrations ranging from 500 µg/kg (2,6-dinitrotoluene) to 397,000 µg/kg (RDX). The majority of the detected contamination was noted in samples collected in the large scale detonation training area. Other organics were noted at maximum concentrations 1, 2, or 3 orders of magnitude less than those reported for the explosives. Seven volatile organic compounds were detected at maximum concentrations ranging from 1.5 µg/kg (4-methyl-2-pentanone) to 130 µg/kg (acetone). Thirteen semivolatile organic compounds, principally polycyclic aromatic hydrocarbons (PAHs) and phthalates, were reported at maximum concentrations ranging from 72 µg/kg (bis-2[ethylhexyl]phthalate) to 6,500 µg/kg (di-n-butyl phthalate).

None of the volatile or semi-volatile organic compounds detected in the surface soil samples were noted in more than 50 percent of the samples analyzed. With a few exceptions, metals concentrations reported in the surface soils samples collected outside the large scale detonation training area are within the range of concentrations reported for the background soil samples. The exceedances noted within the large scale detonation training area are often within 2 times background. The following paragraphs describe the surface soil data in detail.

Explosives

The results of the field screening for TNT and RDX in shallow soil samples collected at 22 locations during CTO 222 are displayed in Figure 4-2. TNT and RDX were detected at concentration ranges of 1.5 mg/kg to greater than 6 mg/kg and 1.5 mg/kg to 4.5 mg/kg, respectively in these field screening samples. The analytical data indicated a potential "hot spot" at location 06-SS-19. Consequently, monitoring well location 5MW01 was installed at that location during the field investigation for CTO 222.

The following explosive compounds, components of explosive compounds, or degradation by-products of explosives were detected in the surface soil samples collected at Range 6 and analyzed by GP:

Chemical	Maximum Concentration (µg/kg)
TNT	248,000
HMX	26,700
RDX	397,000
2,4-Dinitrotoluene	9,300
2,6-Dinitrotoluene	500
2-Amino-4,6-dinitrotoluene	16,000

TNT, HMX, and RDX are among the chemicals and materials reportedly used at Range 6 (B&R Environmental, June 1996). Dinitrotoluene is an intermediate in the synthesis of TNT. It is also is an important component in the manufacture of both gelatinous and powdery commercial explosives and is a component of gunpowder (Meyer, 1987). 2-Amino-4,6-dinitrotoluene is a degradation by-product of TNT (ASTDR, 1993). As will be discussed in the baseline human health risk assessment, explosive compounds (specifically TNT, RDX, and 2-amino-4,6-dinitrotoluene) were the only organics detected in the Range 6 surface soils at concentrations exceeding EPA Region 3 risk-based concentrations (RBCs). TNT, 2-amino-4,6-dinitrotoluene, and/or RDX concentrations at the following locations exceed EPA RBCs: RN6SS02, RN6SS04, RN6SS05, RN6SS06, and RN6SS07. All of these locations are within the large scale detonation training area.

With the exception of the explosives concentrations reported for location RN6SS15, the analytical results for explosives (displayed in Figures 4-8 and 4-9) indicate that most detonations occurred within the training ranges of the large scale detonation training area located to the south of Archer Avenue. With the exception of data for location RN6SS15, explosives concentrations for locations outside the large scale detonation training area are 1, 2, or 3 orders of magnitude less than those reported for several locations within the large scale detonation training area. These results confirm information (i.e., the location of the training ranges) gathered as a result of interviews conducted with active and retired military personnel during the CTO 222 field investigation (B&R Environmental, June 1996). The explosives concentrations reported for RN6SS15 are unexpected because the location is not within any Range 6 training or materials storage areas. However, the location (a relatively low-lying, flat, grassy area) is situated between an active storage bunker to the east and an inactive storage bunker to the west. Based on the local topography, surface water run-off from these storage areas could drain to location RN6SS15. Additionally, based on the aforementioned employee interviews, ancillary or preparatory activities (e.g., acid trepanning) to the actual training exercises did occur in areas outside the actual detonation training areas displayed in Figure 4-1.

Volatile and Semi-volatile Organics

The results of the analysis of soil gas samples collected at 38 locations during CTO 287 are summarized in Table 4-3. The target analyte list was provided in Section 4-3. The following parameters were detected at least once:

Chemical	Range Detected (µg/L)	Detection Frequency	Location of Maximum
Total volatile hydrocarbons	7-140	12	RN6SG25
Chloroform	0.03- 0.05	3	RN6SG04
1,1,1-Trichloroethane	0.02	1	RN6SG28
Carbon Tetrachloride	0.002	1	RN6SG28
Trichloroethene	0.005-0.1	18	RN6SG31,37,38
Tetrachloroethene	0.008-0.1	20	RN6SG28

The majority of the chlorinated hydrocarbon detections were reported in samples collected from the large scale detonation training area. However, several total volatile hydrocarbon detections were noted at locations at the western edge of the detonation training areas and in the uplands to the west of the detonation training areas. The source of the volatile organic contamination suggested by the soil gas screening is not readily evident based on visual evidence of contamination or based on the structures

small amounts to clean threads on munitions, etc., in small "set-up" sheds long since demolished. These "set-up" sheds were allegedly located on both sides of Archer Avenue, up-range (north) of the detonation training areas. (B&R Environmental, January 1997).

The following volatile and semi-volatile organics compounds were detected in the Range 6 surface soil samples analyzed by GP:

Volatile Organics	Maximum Concentration (µg/kg)
4-Methyl-2-pentanone	1.5
Acetone	130
Chloroform	2.5
Ethylbenzene	1
Methylene chloride	77
Toluene	0.3
Trichlorofluoromethane	2

Semi-volatile Organics	Maximum Concentration (µg/kg)
Benzo(a)anthracene	97
Benzo(a)pyrene	73
Benzo(b)fluoranthene	170
Benzo(ghi)perylene	90
Benzo(k)fluoranthene	110
Bis(2-ethylhexyl)phthalate	72
Chrysene	130
Di-n-butyl phthalate	6500
Fluoranthene	220
Indeno(1,2,3-CD)pyrene	90
N-nitrosodiphenylamine	380
Phenanthrene	130
Pyrene	310

The maximum detected concentrations were 1 to 4 orders of magnitude less than those reported for the explosive compounds. In contrast to detection frequencies reported for the explosive compounds (approximately 50 %), the detection frequency for most of these target analytes was less than 16 % (1, 2, or 3 positive detections in 19 samples collected). The exceptions were methylene chloride (7 positive detections/19 samples collected) and di-n-butyl phthalate (8 positive detections/19 samples collected).

Several organic compounds detected (e.g., 4-methyl-2-pentanone, acetone, chloroform, methylene chloride, di-n-butyl phthalate, bis(2-ethylhexyl)phthalate) are common laboratory contaminants. However, it should be noted that the detections were not qualified as possible "blank contamination" during the data validation process.

The chlorinated hydrocarbons frequently noted in the soil gas survey samples (trichloroethene, tetrachloroethene) were not detected in the fixed-base laboratory samples. This may a consequence of the fact that the volatile organic content of a soil sample may decrease (i.e., the chemicals volatilize, degrade) in the time interval between sample collection and transport, and analysis at a fixed-base lab. Fixed-base laboratory samples may be held as long as 7 days prior to analysis. In constrast, the soil gas survey samples are analyzed within hours of collection.

A variety of site-related and non-site related sources may have contributed to the organic chemicals detected in the surface soils. Trichlorofluoromethane is a solvent which is also used as a chemical intermediate, a "blowing agent" (a substance incorporated in a mixture for the purpose of producing a foam), and a component in fire extinguishers (Hawley, 1993). Di-n-butyl phthalate and bis(2-ethylhexyl)phthalate are also common plasticizers. They may be present in the soils as a result of the widespread use of plastics in the products produced and used in our industrialized society (including, possibly, the components of certain explosives). The bis (2-ethylhexyl) phthalate concentration detected in background soil samples exceed those reported for the Range 6 samples. N-Nitroso-diphenylamine was used as a vulcanization retarder in rubber compounds. It has been suggested (but not concluded) that the compound may be released from tires as they are worn away (ASTDR, 1987). At least two of the volatile organics (ethylbenzene, toluene) and the polycyclic aromatic hydrocarbons (e.g., benzo(a)pyrene) are fuel constituents and/or by-products of the combustion process. These chemicals may not be directly related to the detonation activities at Range 6; they may be the result, in part, of the past and current use of gasoline fueled vehicles in the Range 6 area. With few exceptions and as noted on Figure 4-8, the fuel-related chemicals were not detected at sampling locations within the large scale detonation training area.

Metals

Several inorganics were detected in Range 6 surface soil samples at maximum concentrations exceeding the 95 percent upper tolerance limits ($UTL_{95\%}$) calculated for the basewide background soil dataset:

Metal	Maximum Concentration (mg/kg)	$UTL_{95\% \text{ BACKGROUND}}$ (mg/kg)	Eastern[1] United States Soils (mg/kg)	Maryland[2] Soils (mg/kg)
Antimony	1.9	Not detected	<1 - 8.8	NA
Arsenic	5.6	4.25	<0.1 - 73	1.1 - 7.1
Beryllium	0.98	0.905	<1 - 7	ND - 3
Cadmium	2.1	0.26	NA	<0.01 - 5.6
Copper	217	18.7	<1 - 700	5 -70
Lead	181	149	<10 - 300	10 - 50
Mercury	1.6	0.087	0.01 - 3.4	0.04 - 0.14
Nickel	20.9	18.2	<5 - 700	ND - 30
Selenium	2.3	1.09	<0.1 - 3.9	<0.1 - 0.5
Silver	0.27	Not detected	NA	NA
Tin	9	Not detected	<0.1 - 10	NA
Zinc	446	38.1	<5 - 2900	8 - 113

Note:

(1) Shacklette and Boerngen, 1984
(2) Dragun, 1991
NA Not available
ND Not detected

However, the maximum detected concentrations only of arsenic, beryllium, lead, nickel, and silver exceeded the respective $UTLs_{95\%}$ calculated for the background dataset. Additionally, the positive detections reported for these metals are within the concentration range reported in the literature for soils of the Eastern United States and most are within the range reported to the State of Maryland (Dragun, 1991). Arsenic is the only metal detected in the Range 6 surface soils at concentrations exceeding EPA Region 3 RBCs developed assuming an industrial land use scenario.

Positive detections reported for cadmium, copper, mercury, selenium, and zinc for sampling locations within the large scale detonation area and at sampling locations RN6SS09 and RN6SS18 generally exceed metals concentrations reported for the small scale detonation area and areas upgradient of Range 6. (Sampling locations RN6SS09 and RN6SS18 are situated in the vicinity of a bunker located to the west of the large scale detonation area.) Most of these metals, if not all, were/are components of munitions and have been detected in the environmental media at other detonation sites (B&R Environmental, January 1998). While all of these metals were detected at more than one location at concentrations exceeding site-specific background, none were reported outside the range of metals concentrations reported for soils of the eastern United States. All except cadmium were detected at maximum concentrations outside the range reported for soils in the State of Maryland. In many cases, the exceedances of background are

best described as marginal (i.e., similar to or within two times the State of Maryland background concentrations presented in Dragun, 1991).

Antimony and tin were detected the Range 6 surface soil samples; however, they were not detected in the background dataset for Indian Head. The concentrations reported are within the concentration range reported for soils of the eastern United States.

4.4.1.2 Subsurface Soil Characterization

In overview, the target analytes detected in the subsurface soils are similar to those detected in the surface soils except the predominant site-related contaminants were detected less frequently and at maximum concentrations less than those noted in the surface soils. Additionally, the fuel-related contaminants noted in the surface soils (toluene, ethylbenzene, the PAHs) were not noted in the subsurface soils.

Explosives

The following explosives, components of explosives, or degradation by-products of explosives were detected in the subsurface soils at Range 6 at maximum concentrations that are approximately one order of magnitude less than those reported for the surface soils:

Chemical	Maximum Concentration (µg/kg)
TNT	19,200
HMX	3,010
RDX	8,720
2,4-Dinitrotoluene	840
2,6-Dinitrotoluene	290
2-Amino-4,6-dinitrotoluene	11,000

The detection frequency reported for most of these compounds was less than 30 percent. The chemical concentrations reported for the majority of the samples collected within the large scale detonation training area are approximately an order of magnitude greater than those reported for samples collected outside the area; concentrations exceeding 1,000 µg/kg were not reported for locations outside the large scale detonation training area. In contrast to the data reported for the surface soils and as will be discussed in the baseline human health risk assessment, explosive compounds were not detected in the subsurface soils at concentrations exceeding EPA Region 3 RBCs developed for the industrial land use scenario.

Also in contrast to the analytical data reported for the surface soils, the explosives concentrations reported for location RN6SB15 are not anomalous.

Volatile and Semi-volatile Organics

The following volatile and semi-volatile organics compounds were detected in the Range 6 subsurface soils:

Volatile Organics	Maximum Concentration (µg/kg)
Acetone	2,700
Chloroform	3.5
Toluene	1.3
Methylene chloride	73
Trichlorofluoromethane	2
1,1,1-Trichloroethane	1
Carbon disulfide	8
Tetrachloroethene	1

Semi-volatile Organics	Maximum Concentration (µg/kg)
Di-n-butyl phthalate	1500
N-nitrosodiphenylamine	110
Bis(2-ethylhexyl) phthalate	1100
Di-N-octyl phthalate	110
Diethyl phthalate	57

As displayed in Figure 4-9, these volatile and semi-volatile organics were detected sporadically in the twenty-seven subsurface soil samples collected at Range 6. In contrast to the explosive compounds detected in the surface soils, a clear, site-related pattern of contamination was not observed. However, the majority of the volatile organic detections were reported in samples collected within or in the vicinity of the detonation training areas. None of the organics were detected in the subsurface soils at maximum concentrations exceeding EPA Region 3 RBCs.

With the exception of acetone and methylene chloride, volatile organic compounds were detected in one, two, or three samples only. The maximum concentration of methylene chloride (73 µg/kg) was reported for a sample collected at boring RNSB006, located within the large scale detonation training area. The maximum concentration of acetone (2,700 µg/kg) was reported for a sample collected from boring RNSB016, the suspected location of the arsenic pit. However, acetone was detected in upgradient

background soil samples at a maximum concentration of 1,800 µg/kg. The chlorinated hydrocarbons frequently noted in the soil gas survey samples (trichloroethene, tetrachloroethene) were detected infrequently or not at all in the fixed-base laboratory samples. As noted previously, this may a consequence of the fact that the volatile organic content of a soil sample may decrease (i.e., the chemicals volatilize, degrade) in the time interval between sample collection and transport, and analysis at a fixed-base lab. In contrast, the soil gas survey samples are analyzed within hours of collection.

Four compounds used as plasticizers (e.g., bis(2-ethylhexyl)phthalate) and N-nitrosodiphenylamine were the only semi-volatile organics detected in the subsurface soils. Given the widespread use of plastics in our industrialized society, these organics may be present as the result of site-related as well as non-site related activities. As noted previously, N-nitrosodiphenylamine is a vulcanizing compound historically used to make tires.

Metals

The following metals were detected in Range 6 soil samples at maximum concentrations exceeding the 95 percent upper tolerance limits ($UTL_{95\%}$) calculated for the background soil dataset:

Metals	Maximum Concentration (mg/kg)	$UTL_{95\%\ BACKGROUND}$ (mg/kg)	Eastern[1] United States Soils (mg/kg)	Maryland[2] Soils (mg/kg)
Cadmium	1.3	0.39	NA	<0.01 - 5.6
Copper	96.8	56.5	<1 - 700	5 - 70
Lead	59.4	37.5	<10 - 300	10 - 50
Mercury	0.79	0.13	0.01 - 3.4	0.04 - 0.14

Note:

(1) Shacklette and Boerngen, 1984
(2) Dragun, 1991
NA Not available
ND Not detected

With few exceptions (e.g., cadmium at location RNSB016), the exceedances of basewide background concentrations ($UTL_{95\%\ BACKGROUND}$) are associated with samples collected within the large scale detonation training area. None of the metals were detected at maximum concentrations exceeding the concentration range reported for soils of the eastern United States. However, copper, lead, and mercury were noted at concentrations exceeding the concentration range reported for soils of the State of Maryland. All of these metals were/are components of munitions and have been detected in the environmental media at other detonation sites (B&R Environmental, January 1998).

The maximum metals concentrations reported in the subsurface soils are approximately 50 percent of those reported in the surface soils and all are associated with locations within the large scale detonation area. Metals concentrations reported for multiple sampling depths at locations RN6SB017, RN6SB019, RNSB016 are generally similar or decrease with depth. The metals concentrations reported for soil boring RNSB016, the boring located to investigate the suspected arsenic pit are not remarkable. Arsenic concentrations reported at this location do not exceed basewide background concentrations.

4.4.2 Groundwater

Unfiltered and filtered groundwater samples were collected from the following monitoring wells located at Range 6:

Monitoring Well	Screened Interval (feet below ground surface)	Turbidity Reading Unfiltered Sample
5GW01	8 to 18	999
RN6MW002	9 to 19	44
RN6MW003	7 to 17	23
RN6MW004	124 to 134	999
RN6MW005	121 to 131	999

Summarizing from Section 4.3, monitoring well 5GW01 was installed during the CTO 222 field investigation; the remaining wells were installed during the CTO 287 field investigation. Monitoring well RN6MW005 is located upgradient of the Range 6 area of investigation and the actual site monitoring wells (i.e., 5GW01, RN6MW002, RN6MW003, RN6MW004). Monitoring well RN6MW004 was installed at the suspected location of the arsenic pit. Monitoring well RN6MW003 is located in the uplands to the west of the detonation training areas. RN6MW02 and 5GW01 are located within the large detonation training area to the south of Archer Avenue.

Groundwater samples were collected for analysis by GP during CTOs 222 and 287. Analytical data available as a result of the analysis of groundwater samples collected from monitoring well 5GW01 during CTO 222 are presented in Table 4-10. The results of the sampling and analysis of groundwater samples collected during CTO 287 are presented in Tables 4-6 and displayed in Figure 4-10. Additionally, descriptive statistics (i.e., frequency of detection, concentration range detected, arithmetic mean of positive detections, location of maximum positive detection) are summarized in Table 4-14, the chemical of potential concern (COPC) selection tables for Range 6 groundwater.

Explosives Compounds

The following explosive compounds and degradation by-products of the explosive compounds were the only significant organic compounds detected in the groundwater samples collected during the field investigation for CTO 287:

Chemical	Maximum Concentration (µg/L)
TNT	44.1
HMX	41.2
RDX	352
4-Dinitrotoluene	1.8
1,3,5-Trinitrobenzene	0.6
2-Amino-4,6-dinitrotoluene	58.7
2,4-Dinitroluene	1.9

This observation is consistent with the soils characterization for Range 6 and suggests that the soils are a source of the target analyte concentrations noted in the groundwater. Maximum concentrations were reported for monitoring well RN6MW003 located downgradient of the detonation training areas. Explosives were not detected in the samples from RN6MW002 located in the southern portion of the large scale detonation training area. The groundwater and soil data for this area suggest that limited detonations may have actually occurred in this area. In contrast to the positive detections reported for the sample collected from 5GW01 during CTO 222 (Table 4-10), 2-amino-4,6-dinitrotoluene, a degradation by-product of TNT, was the only energetic detected in the groundwater sample collected from 5GW01 during the field investigation for CTO 287. The difference in the 2 rounds of samples (CTO 222 versus CTO 287) could be attributable, in part, to tidal influences potentially affecting surface and groundwater quality in the vicinity of Range 6. TNT, RDX, and 2-amino-4,6-dinitrotoluene were the only organics detected in the groundwater at maximum concentrations exceeding the EPA Region 3 RBCs.

Volatile and Semi-volatile Organics

Volatile organic compounds were not detected in any of the groundwater samples collected for CTOs 222 or 287. This observation is consistent with the relatively low-level, sporadic volatile organic contamination noted in the surface and subsurface soil samples.

Two plasticizers (bis[2-ethylhexyl]phthalate (C_{max} = 3 µg/L) and di-n-butyl phthalate (C_{max} = 1µg/L)) were the only semi-volatile organic compounds detected in the groundwater. The low-level presence of these compounds in the shallow groundwater aquifer at Range 6 attests to the wide-spread domestic and industrial use of plastics (including the use of plastic materials as components of explosives). The

concentrations detected in the actual site monitoring wells do not exceed those reported for upgradient monitoring well RN6MW005.

Metals

The following metals were detected in unfiltered groundwater samples from actual site monitoring wells (RN6MW003, RN6MW002, RN6MW004, 5GW01) at maximum concentrations exceeding the $UTLs_{95\%}$ reported for the background dataset:

Metal	Maximum Concentration (µg/L)	$UTL_{95\%}$ (µg/L)
Arsenic	16.4	Not detected
Barium	307	253.5
Chromium	55.7	20.9
Cobalt	47.8	39.6
Copper	54.5	22.4
Lead	33	Not detected
Mercury	0.23	0.13
Selenium	2.5	Not detected
Vanadium	75.7	24.1

For most of these metals, maximum concentrations were reported for the unfiltered sample collected from monitoring well 5GW01 located within the large scale detonation training area. However, with the exception of mercury, metals concentrations reported for the unfiltered sample from RN6MW005, the upgradient well at Range 6, exceed those reported for the actual site monitoring wells. The turbidity levels reported for samples from these 2 wells (NTU = 999) suggest that the metals concentrations may be due, in part, to the suspended solids content of the sample. Metals concentrations reported for groundwater samples demonstrating relatively low turbidity levels (RN6MW002 [NTU = 44]; RN6MW003 [NTU = 23]) are less than or within 2 times the background $UTL_{95\%}$. Four of these metals (barium, chromium, cobalt, and vanadium) were not detected in site-specific soil samples at maximum concentrations exceeding the basewide background $UTL_{95\%}$.

Maximum arsenic, barium, chromium, cobalt, and vanadium concentrations reported for filtered groundwater samples (Table 4-6) exceed the background $UTL_{95\%}$. However, with the exception of arsenic, none of these metals were noted in site-specific soil samples at concentrations exceeding the basewide background $UTL_{95\%}$. The arsenic detections reported for the filtered groundwater samples exceed the EPA Region 3 RBC; but, the results do not exceed the current federal SDWA MCL (50 µg/L). As noted

previously, arsenic concentrations in the site-specific surface soils may exceed facility background concentrations; however, the positive detections reported are within the range of concentrations reported for soils of the Eastern United States and the State of Maryland.

4.4.3 Surface Water

Surface water quality data collected as a result of the CTO 287 field investigation suggest that historic activities at Range 6 have had minimal impact on surface water quality in the vicinity of Range 6 (Figure 4-11; Table 4-7). The site-related organic compounds (e.g., TNT) reported in soils and groundwater were not detected. Metals (specifically barium, copper, vanadium, and zinc) were the only target analytes detected in the surface water samples collected from 4 locations in the surface water bodies surrounding the Range 6 area (2 in Chicamuxen Creek; 2 in the Potomac River). The positive detections are displayed in Figure 4-11; descriptive statistics are presented in Table 4-15.

As shown in Figure 4-11, the metals concentrations do not vary significantly from location to location. Site-specific background data are not available for surface waters in the vicinity of Range 6. However, the concentrations detected do not exceed metals concentrations reported for the basewide background groundwater datasets or EPA Region 3 RBCs for tap water. These benchmarks are noted for the reader's benefit only; neither the background groundwater datasets nor the EPA Region 3 RBCs are directly suitable for a background or human health evaluation of surface waters in the vicinity of Range 6.

The analytical results available for the CTO 287 surface water samples should be considered a "snapshot" of surface water quality in the vicinity of Range 6. Surface water quality may fluctuate over time in response to factors such as tidal influence.

4.4.4 Sediments

Sediment quality data collected as a result of the CTO 287 field investigation suggest that historic activities at Range 6 have had minimal impact on sediment quality in the vicinity of Range 6 (Figure 4-12, Table 4-8). Eight semi-volatile organic compounds and several metals were detected in the 4 sediment samples collected. None of the site-related explosive compounds were detected. The organic compounds reported were 6 polycyclic aromatic hydrocarbons and 2 phthalate compounds:

Chemical	Maximum Concentration (µg/kg)
Benzo(a)anthracene	71
Benzo(a)pyrene	60
Benzo(b)fluoranthene	100
Chrysene	56
Di-n-butyl phthalate	390
Di-n-octyl phthatate	95
Fluoranthene	77
Pyrene	63

One or more of the organic compounds were detected at 3 of the 4 locations sampled at maximum concentrations that do not exceed EPA Region 3 RBCs for soil ingestion. Although all of these constituents were detected in the Range 6 soil samples and some were detected in the Range 6 groundwater samples, site-related as well as non-site related activities may have contributed to the chemical concentrations noted in the sediments. The PAH compounds reported (e.g., benzo(a)pyrene) are fuel compounds or combustion by-products often found in environmental media (particularly soils and sediments) at locations not associated with hazardous material/waste activities (e.g., rural or urban background locations). The phthalates are common plasticizers.

The metals concentrations detected are also unremarkable. The reported detections are less than or within the range of background soils concentrations and sediment concentrations reported for 3 Potomac estuary stations monitored by the Maryland Department of the Environment:

Metal	Range Detected (mg/kg)	Site-Specific Soil[1] Background Concentration (mg/kg)	Literature Background[2] Concentration (mg/kg)
Antimony	0.29	ND/3.6	NA
Arsenic	0.47 - 3	4.25/24.4	6 - 36.4
Barium	6.5 - 24.1	144/191	NA
Beryllium	0.31	0.9/2.46	NA
Cadmium	0.22 - 0.8	0.26/0.388	0.4 - 2.01
Chromium	3.6 - 10.9	24.2/101	36 - 66.6
Cobalt	0.67 - 3.3	39.7/133	NA
Copper	2.2 - 50.5	18.7/56.5	28 - 43.4
Lead	2.4 - 28	149/37.5	20 - 52.8
Mercury	0.02 - 0.13	0.87/0.13	0.08 - 0.74
Nickel	2.3 - 12.8	18.2/22.1	29 - 64.1

Metal	Range Detected (mg/kg)	Site-Specific Soil[1] Background Concentration (mg/kg)	Literature Background[2] Concentration (mg/kg)
Selenium	0.35 - 0.96	1.09/8.93	NA
Vanadium	3 - 17.4	53.5/133	NA
Zinc	7.5 - 43.5	38.1/79.5	168 - 251

Note:
(1) Site-specific background surface/subsurface soil data (B&R Environmental, December 1997).
(2) Data obtained from the Maryland Department of the Environment (B&R Environmental, December 1997).
ND Not detected.
NA Not analyzed.

As noted in Table 4-15, the metals concentrations reported are also less than available $UTL_{95\%}$ values developed for the basewide background freshwater sediment samples.

4.5 CONTAMINANT FATE AND TRANSPORT

Explosives (TNT, RDX, HMX, 2,4-dinitrotoluene, and 2,6-dinitrotoluene) and degradation by-products (2-amino-4,6-dinitrotoluene) have been detected in surface soil and subsurface soil within the large scale detonation training area. Explosives and degradation by-products of explosives have also been detected in groundwater from monitoring well RN6MW03 which is located downgradient of the large scale detonation training area. Explosives are soluble in water and do not readily bind to soil. This suggests that the explosives are degrading and are migrating from soil to groundwater at Range 6. Explosives and degradation by-products of explosives were not detected in surface water or sediment samples for Range 6.

Volatiles and semi-volatiles were detected sporadically in soil at Range 6 and were detected less frequently and at lower concentrations in subsurface soil than in surface soil. Except for phthalates, organics were not detected in groundwater at Range 6. This suggests that some migration of volatiles and semi-volatiles from surface soil to subsurface soil has occurred, but that these compounds are not migrating to groundwater. No organics were detected in surface water samples. PAHs were detected in sediment sample RN6SD001 and phthalates in sediment sample RN6SD002 from Chicamuxen Creek at concentrations which exceeded background concentrations. It is not known if the presence of these semi-volatile compounds in sediment samples from Chicamuxen Creek are site related.

Concentrations of several metals in surface and subsurface soils exceed basewide background concentrations, but, with a few exceptions, were within the range of concentrations reported in literature for the State of Maryland. Metals in unfiltered an filtered groundwater samples from monitoring wells 5GW01 and RN6MW005 were detected at concentrations exceeding basewide background groundwater

values. RN6MW005 is located upgradient of the Range 6 area of investigation. The turbidity levels reported for samples from these two wells (NTU = 999) suggest that the metal concentrations may be due, in part, to the suspended solids content of the sample. Concentrations of meals in filtered samples from these wells were within background levels. Consequently, metals are not believed to be migrating from soil to groundwater at Range 6.

4.6 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section contains the site-specific risk assessment for the identified exposure scenarios for Range 6 (SWMU 5). The risk assessment methodology was described in Section 2.5, and detailed calculations are contained in Appendix P.

4.6.1 Data Evaluation/Selection of Chemicals of Potential Concern

4.6.1.1 Data Evaluation SWMU 5 - Range 6

All field samples collected for fixed-base laboratory analysis for the RFI/VI at NSWC Indian Head underwent the data validation process as described in Section 2.3. This section summarizes the SWMU-specific data validation results for SWMU 5 - Range 6. Analytical data for samples collected from Range 6 were contained in SDGs 9706216, 9706217, 9708030, 9708042, 9707065, and 9706232.

Some positive analytical results for acetone, methylene chloride, di-n-butyl phthalate, antimony, beryllium, copper, silver, and thallium associated with Range 6 soils were flagged "B" during data validation indicating that they are false positives attributable to field/laboratory blank contamination. Additionally, all positive analytical results for acetone, methylene chloride, and lead associated with Range 6 surface water and sediments were flagged "B" during data validation indicating that they are false positives attributable to field/laboratory blank contamination. Silver, thallium, tin, and beryllium were qualified "B" as false positives resultant of blank contamination in sediment samples collected from Range 6. Additionally, some antimony, beryllium, nickel, silver, thallium, and vanadium results in groundwater samples were qualified, "B," as false positives attributable to field/laboratory blank contamination.

Nondetected results for the following organic compounds were qualified as rejected, "UR," during data validation for most soil, surface water, sediment and groundwater samples: 2-butanone, acrolein, acrylonitrile, acetonitrile, propionitrile, isobutyl alcohol, vinyl acetate, 4-nitroquinoline-1-oxide, famphur, and kepone. Nondetected results for methapyrilene were qualified as rejected, "UR," in the soil samples RN6SB0050101, RN6SB0060101, RN6SB0070101, RN6SB0080101, RN6SB0090101, RN6SS0060101, RN6DUP001, and RN6SS0080101. Nondetected results for aramite were qualified as rejected, "UR," in

the soil samples RN6SS0040101and RN6SS0050101. No positive results were reported for any of these noted compounds. The rejection of results for the noted compounds were a result of extremely low (0.050 unitless) initial and continuing calibration relative response factors. These low response factors indicate that the laboratory's instruments could not achieve satisfactory sensitivity for the aforementioned compounds which severely compromises the associated positive and nondetected results.

The method of analysis for the determination of these volatile and semivolatile organic compounds utilizes Gas Chromatography/Mass Spectrometry (GC/MS). Isobutyl alcohol and 2-butanone are soluble in water and are difficult to purge effectively. There are technical adjustments the laboratory could have made that would have improved the responses for isobutyl alcohol and 2-butanone. Vinyl acetate may react under certain chromatographic conditons thus yielding a poor instrument response. Kepone is best analyzed by GC using an Electron Capture Detector (ECD). Acrolein and acrylonitrile, chemically, are more suited for analysis by High Performance Liquid Chromatography (HPLC). Acetonitrile may be analyzed using GC with a Nitrogen-Phosphorus Detector (NPD). The chemical properties of propionitrile, methapyrilene, aramite, 4-nitroquinoline-1-oxide, and famphur may restrict these compounds from yielding satisfactory chromatographic response regardless of the analytical method of detection. However, the substitution of alternative analytical methods would be cost prohibitive in comparison to the value they would add to the final data. Therefore, the poor response of the aforementioned compounds is attributable to both the specific chemical properties and the use of GC/MS as all encompassing method of analysis in an attempt to eliminate a variety of complex alternatives. Furthermore, the rejection of result for these compounds in environmental matrices does not create any significant data gaps that would warrant resampling.

Nondetected results for antimony in soil samples RN6SB0180201 and RN6SS0170101 were qualified as rejected as a result of extremely low matrix spike recoveries. These rejections are considered to be insignificant since a total of 46 soil samples were collected and only the antimony results for two samples were considered unreliable. Antimony was detected in 40 of the remaining 44 soil samples. The very infrequent number of rejections for antimony do not warrant the need for resampling, as no data gaps were identified. No other inorganic analyte results were rejected during the data validation process.

4.6.1.2 Selection of Chemicals of Potential Concern

Chemicals of potential concern at this site were selected using the risk-based COPC screening levels (i.e., the Section 2.0 benchmarks) described in Section 2.5.1. COPC summary screening tables for all media are presented in Tables 4-11 through 4-16. The list of COPCs for Range 6 is summarized in Table 4-17.

Maximum chemical concentrations in soil were compared to EPA Region III RBCs and site-specific background levels. Additionally, maximum concentrations in soil were compared to EPA SSLs for transfers from soil to air and for migration to groundwater to justify the exclusion of the inhalation pathway and to provide a cursory evaluation of potential transport of soil chemicals to groundwater. Since the current and expected future site use is nonresidential only those compounds with concentrations exceeding nonresidential RBCs will be retained as COPCs.

A discussion of the chemicals identified as COPCs and the rationale for their selection is provided in the following subsections.

Surface Soil

Seven VOCs, 15 SVOCs (primarily PAHs and phthalates), four explosives, and 21 inorganics were detected in surface soil samples (0 to 2 feet bgs) collected at Range 6. A comparison of the maximum detected soil concentrations to EPA Region III RBCs and EPA SSLs for soil to air is presented in Table 4-11. No VOCs and SVOCs were present in surface soil samples at concentrations in excess of the RBCs or SSLs. Three explosives (TNT, 2-amino-4,6-dinitrotoluene, and RDX) and one inorganic (arsenic) had maximum concentrations which exceeded the RBCs for industrial exposures. Three explosives (TNT, 2-amino-4,6-dinitrotoluene, and RDX) and three inorganics (arsenic, beryllium, and iron) had maximum concentrations which exceeded the RBCs for residential exposures. Future site use is anticipated to be nonresidential so only those compounds exceeding nonresidential RBCs will be retained as COPCs. Therefore, only TNT, 2-amino-4,6-dinitrotoluene, RDX, and arsenic were selected as a COPC for surface soil.

Maximum surface soil concentrations were also compared to EPA SSLs for migration to groundwater (Table 4-13). Maximum concentrations of TNT, 2-amino-4,6-dinitrotoluene, HMX, RDX, methylene chloride, 2,4-dinitrotoluene, and 2,6-dinitrotoluene in surface soil exceeded their respective SSLs. Several of these compounds were detected in site groundwater underlying Range 6.

Surface/Subsurface Soil

Ten VOCs, 17 SVOCs (primarily PAHs and phthalates), four explosives, and 21 inorganics were detected in surface/subsurface soil (0 to >10 feet bgs) at Range 6. A comparison of the maximum detected soil concentrations to EPA Region III RBCs and EPA SSLs for soil to air is presented in Table 4-12. No VOCs or SVOCs were present in surface/subsurface soil at concentrations in excess of the RBCs or SSLs. Three explosives (TNT, 2-amino-4,6-dinitrotoluene, and RDX) and one inorganic (arsenic) had maximum

concentrations which exceeded the RBCs for industrial exposures. Three explosives (TNT, 2-amino-4,6-dinitrotoluene, and RDX) and three inorganics (arsenic, beryllium, and iron) had maximum concentrations which exceeded the RBCs for residential exposures. Future site use is anticipated to be nonresidential so only those compounds exceeding nonresidential RBCs will be retained as COPCs. Therefore, only TNT, 2-amino-4,6-dinitrotoluene, RDX, and arsenic were selected as a COPC for surface/subsurface soil.

Maximum surface/subsurface soil concentrations were also compared to EPA SSLs for migration to groundwater (Table 4-13). Maximum concentrations of TNT, 2-amino-4,6-dinitrotoluene, HMX, RDX, methylene chloride, 2,4-dinitrotoluene, and 2,6-dinitrotoluene in surface/subsurface soil exceeded their respective SSLs. Several of these compounds were detected in site groundwater.

Groundwater

Two SVOCs (phthalates), six explosives, and 12 inorganics were detected in unfiltered groundwater samples at Range 6. Nine inorganics were found in the filtered groundwater samples. A comparison of the maximum detected groundwater concentrations to EPA Region III RBCs is presented in Table 4-14. The maximum detected concentrations of three explosives (2,4,6-trinitribenzene, 2-amino-4,6-dinitroluene, and RDX) and six inorganics (antimony, arsenic, barium, total chromium, lead, and vanadium) in unfiltered groundwater samples exceeded the RBCs for tap water ingestion and, therefore, were selected as COPCs.

Surface Water/Fish

Four inorganics were detected in surface water samples at Range 6. A comparison of the maximum detected surface water concentrations to EPA Region III RBCs for tap water and fish ingestion is presented in Table 4-15. There were no chemicals selected as a COPC, since no maximum concentrations exceeded COPC screening levels. In addition, estimated concentrations in fish tissue were well below fish screening levels and this exposure scenario was eliminated from further consideration.

Sediment

Eight SVOCs (PAHs and phthalates) and 14 inorganics were detected in sediment samples at Range 6. A comparison of the maximum detected sediment concentrations to EPA Region III RBCs for soil is presented in Table 4-16. The maximum concentration of all compounds were less than the RBCs for industrial exposures to soil. The residential RBCs were exceeded by the maximum concentrations of

arsenic and beryllium, but no residential exposures are anticipated for Range 6. No chemicals were selected as COPCs, since no maximum concentrations exceeded applicable RBCs.

4.6.2 Exposure Assessment

The location of Range 6 is shown on Figure 4-1. Range 6 is an inactive training area located at the end of Archer Avenue. Historically, Range 6 consisted of five ranges used for open detonation training. Currently, the Range 6 training areas are inactive. Because of the potential for unexploded ordinance at the site, it is anticipated that future use of the site will remain nonresidential. Potential receptors for Range 6 include current/future maintenance workers, current/future full-time employees, and future construction workers. Since access to Range 6 is restricted by fencing and a gate located on Archer Avenue, civilian trespassers were not considered as potential human receptors.

Maintenance workers and full-time employees are assumed to enter the site to conduct maintenance (such as mowing) and related activities. The only medium of concern for these workers would be surface soil (0 to 2 feet bgs). Exposure to subsurface soil is expected to be limited to ground-intrusive activities. Although no major construction projects are planned for the site or the surrounding areas, construction workers are evaluated as potential receptors to assess future exposure to subsurface soil (assumed to be exposed to surface and subsurface soil to an estimated maximum depth of 10 feet bgs or greater).

The primary routes of exposure for potential human receptors at Range 6 are incidental ingestion of soil and dermal contact with soil. Exposure routes associated with soil contact are evaluated for maintenance workers, full-time employees, and future construction workers. Other potential exposure routes included incidental dermal contact with groundwater by construction workers.

Ingestion of groundwater, inhalation of fugitive dust and volatile emissions, direct contact with surface waters and sediments, and ingestion of wildlife were not considered for the following reasons:

- The shallow aquifer at NSWC is not used as a potable water supply either on base or in surrounding off-base areas. Shallow groundwater at the site is tidally influenced and the source of potable water is the deeper aquifers. The deeper aquifers are not believed to be impacted by the surficial aquifer. Thus, groundwater exposures by base personnel are eliminated.

- Potential exposure to fugitive dust and volatile emissions from Range 6 is considered to be minimal, thereby eliminating the need for quantitative evaluation of this exposure pathway. As shown in Tables

4-11 and 4-12 all reported surface and subsurface soil concentrations are less than the EPA SSLs for transfers from soil to air (USEPA, 1996a).

- Direct contact with surface water and sediment by potential human receptors was not evaluated because there were no COPCs identified for these media. Additionally, no COPCs were identified for consumption of fish taken from nearby surface waters.

- Ingestion of wildlife by hunters and their families was eliminated as a significant exposure pathway. The large size of the home ranges for game species at NSWC Stump Neck relative to the size of Range 6 is not expected to result in significant foraging at the site. Moreover, the restrictive nature of the site would limit access both to the game species and to human receptors.

Exposure assumptions for these receptors are presented in Table 2-14. Table 4-17 presents a summary of the COPCs and exposure site concentrations for Range 6. A summary of the potentially significant exposures identified for quantitative evaluation for Range 6 is provided in Table 4-18. The dose-response factors (RfDs and CSFs) for COPCs at Range 6 were presented in Tables 2-10 and 2-11. Appendix P contains the toxicological profiles for the COPCs.

4.6.3 Risk Characterization

Potential cancer risks and hazard indices were calculated for maintenance workers, full-time employees, and construction workers (future land use) using the methodology presented in Section 2.0. Both RME and CTE exposure scenarios were evaluated. Table 4-19 contains a summary of the estimated risks for Range 6. All spreadsheets containing the detailed, chemical-specific risks for the site are included in Appendix P. The following text presents a summary of the results of the risk characterization.

4.6.3.1 Carcinogenic Effects

All estimated cancer risks for exposures to surface and subsurface soil were within EPA's target risk range of 10^{-4} to 10^{-6}. The estimated cancer risk for maintenance workers based on RME and CTE exposures to surface soil were 1.2×10^{-5} and 2.0×10^{-6}, respectively. The estimated cancer risk for the full-time employee based on RME and CTE exposures to surface soil were 6.0×10^{-5} and 2.0×10^{-5}, respectively. The estimated cancer risk for construction workers based on RME and CTE exposures like these, etc. make them exponents to surface and subsurface soil were 3.1×10^{-6} and 2.4×10^{-6}, respectively.

The cancer risk for construction workers exposed to groundwater was 4.6×10^{-8} for RME exposures and 2.6×10^{-8} for CTE exposures, below EPA's Target risk range of 10^{-4} to 10^{-6}.

The combined cancer risks for construction workers exposed to both soil and groundwater were within EPA's target risk range of 10^{-4} to 10^{-6}. The cancer risk for construction workers exposed to soil and groundwater was 3.1×10^{-6} for RME exposures and 2.4×10^{-6} for CTE exposures.

4.6.3.2 Noncarcinogenic Effects

The hazard indices for maintenance workers exposed to surface soil were 0.81 for RME exposures and 0.097 for CTE exposures which is below the acceptable level of 1.0. The hazard indices for full-time employees exposed to surface soil was 4.0 for RME exposures and 0.97 for CTE exposures. Dermal contact with TNT (HI = 2.2 RME, HI = 0.53 CTE) and 2-amino-4,6-dinitroluene (HI = 1.3 RME, HI = 0.33 CTE) contributed significantly to the hazard index. The hazard indices for construction workers exposed to surface and subsurface soil was 4.8 for RME exposures and 1.2 for CTE exposures. Incidental ingestion and dermal contact with TNT (HI = 2.6 RME, HI = 0.68 CTE) and 2-amino-4,6-dinitroluene (HI = 1.6 RME, HI = 0.41 CTE) contributed significantly to the hazard index.

The hazard indices for construction workers exposed to groundwater were below the acceptable level of 1.0. The hazard index for construction workers exposed to groundwater was 0.14 for RME exposures and 0.057 for CTE exposures.

The combined hazard indices for construction workers exposed to both soil and groundwater was above the acceptable level of 1.0. The hazard index for construction workers exposed to both soil and groundwater was 4.9 for RME exposures and 1.3 for CTE exposures.

4.6.3.3 Qualitative Evaluation of Groundwater

Because site groundwater from surficial aquifers is not currently used or expected to be used in the future as a potable water supply and since potential exposure to this medium is not quantitatively addressed in the human health risk assessment (i.e., future residential use is not considered), a brief qualitative assessment of groundwater is included in this section. Table 4-20 contains a summary of the qualitative assessment of this medium.

Maximum detected concentrations in unfiltered and filtered groundwater samples collected at Range 6 were compared to EPA MCLs, SMCLs, and EPA Region III RBCs for tap water. As previously indicated, the shallow aquifer at the site is not used as a source of drinking water either on- or off-base. Therefore,

the comparison of site concentrations to primary MCLs, SMCLs, and RBCs serves as a conservative assessment of potential risks.

RDX, TNT, and 2-amino-4,6-dinitroluene were the only organics detected at concentrations exceeding RBCs in unfiltered groundwater samples. Antimony, arsenic, barium, beryllium, chromium, lead, and vanadium were the only inorganics detected in the unfiltered groundwater samples at maximum concentrations in excess of RBCs. Concentrations of all compounds were below MCLs in unfiltered groundwater samples. No RBC or MCL is available for lead. Lead was detected at concentrations in the unfiltered samples in excess of the 15 μg/L Safe Drinking Water Act Action Level

No organics were detected in filtered groundwater samples. Arsenic was the only inorganic detected in the filtered groundwater samples at concentrations exceeding RBCs. Concentrations of all inorganics were below MCLs in filtered groundwater samples.

The qualitative analysis indicates that groundwater may not be suitable for potable use in its untreated state because of observed concentrations of explosives and inorganics.

4.6.4 Uncertainty Analysis

A detailed discussion of uncertainties associated with the various aspects of risk assessment in general was provided in Section 2.8. There are no site-specific uncertainties for Range 6.

4.6.5 Summary of Risk Assessment

The following items summarize the human health risk assessment for Range 6.

- The human health risk assessment for Range 6 considered exposures to maintenance workers, full-time employees, and construction workers. Potential exposure pathways for direct contact with soil for all receptors included incidental ingestion and dermal contact with soil. Inhalation of fugitive dust and volatiles from soil were not considered since concentrations of all COPCs in soil were less than the EPA soil to air SSLs. In additional dermal contact with groundwater was evaluated for construction workers.

- Incremental lifetime cancer risks for all receptors exposed to soil and groundwater were within EPA's target risk range of 10^{-4} to 10^{-6}.

- Noncarcinogenic risk estimates (HIs) for maintenance workers were less than unity.

- Noncarcinogenic risks for full-time employees exposed to soil exceeded unity. Dermal contact with TNT and 2-amino-4,6-dinitroluene were the main contributors to the hazard index for full-time employees. Noncarcinogenic risks (HIs) for construction workers exposed to soil exceeded unity. Incidental ingestion and dermal contact with TNT and 2-amino-4,6-dinitroluene were the main contributors to the hazard index for construction workers.

- Noncarcinogenic risk estimates (HIs) for all receptors were less than 1.0 indicating that no toxic effects are anticipated for these receptors under the defined exposure scenarios.

4.7 ECOLOGICAL ISSUES

This section presents the ERA, ecological risk management, ERA/risk management summary for SWMU 5, and site-specific uncertainties.

4.7.1 Ecological Risk Assessment

This section presents the results of the ecological risk assessment performed at Range 6 (SWMU 5), and consists of a discussion of the preliminary problem formulation, effects characterization, exposure assessment, and risk characterization.

4.7.1.1 Preliminary Problem Formulation

This section includes a discussion of available habitats, ecological receptors, contaminant sources, release mechanisms, migration pathways, exposure routes, selection of preliminary contaminants of potential concern (PCOCs), assessment and measurement endpoints, and the conceptual site model.

Habitat Types and Ecological Receptors

Range 6 is located at the end of the Stump Neck annex peninsula. The Potomac River is located to the west and Chicamuxen Creek to the east and south (Figure 4-1). The northern portion of the site is slightly higher in elevation than the remainder of the site, and slopes gently down to the southern portion. Most of the site, including the entire central portion of the site, is comprised of disturbed, bare soil with scattered, mowed turfgrass; the access road enters the site from the north and terminates near the southern end of the site. The perimeter of the site contains a thin strip of small trees, mostly maples (*Acer* spp.), tulip poplar (*Liriodendron tulipera*) and black cherry (*Prunus serotina*).

A small spit of land curls around to the east at the end of the peninsula, and is fully covered with trees and brush. A duck blind is located at the end of this spit of land. A strip of grasses, brush, and a few small trees that ranges from 10 to 20 feet wide runs adjacent to the treeline around the edge of the peninsula. This area has been undisturbed for several years and is in the early stages of ecological succession. A small 5 to 10-foot wide gravel beach is located on the Potomac River shore of the site, while the Chicamuxen Creek shore of the site is comprised of unconsolidated sediments and sparse emergent vegetation. The northern edge of the site is wooded, containing the tree species mentioned above, along with some mature oaks (*Quercus* spp.).

Although the site slopes gently to the south, the topography is still relatively flat resulting in ponding and infiltration of precipitation. Also, the strip of brush and trees around the site perimeter probably traps soil erosion from the site. Nonetheless, it is likely that runoff from the site drains to the Potomac and Chicamuxen Creek via overland flow. No drainage swales or ditches are present on the site. Additionally, communication between shallow groundwater under the site and the Potomac River and Creek probably exists.

No rare, threatened or endangered species are known to occur on Range 6. The shoreline area may be small, forested and emergent wetlands (no wetland delineations have been performed), and as such, can be considered a sensitive habitat. Most of the site is bare soil and turfgrass, providing poor habitat for terrestrial receptors. The strip of brush and small trees provides fair, but limited, terrestrial habitat. An abundance of deer tracks were noted along this area during an October 1997 site visit. The Potomac River and Chicamuxen Creek support a large, tidal freshwater fishery. These waters remain fresh throughout most of the year (0 - 0.5 ppt salinity), although the surface horizon of the Potomac and Chicamuxen Creek may reach up to 1.0 ppt (slightly oligohaline), during a few months of the year (Lippson et al., 1979).

Contaminant Sources, Release Mechanisms, and Migration Pathways

The potential major contaminant sources at Range 6 are soil contaminants. In particular, residual contamination stems from open detonation training. The contaminant release pathways from this area include wind erosion, overland runoff, and infiltration of contaminants. Contaminated fugitive dust can be generated during ground-disturbing activities on the bare soil areas, such as during detonation activities. The contaminants could then be dispersed in the surrounding environment and transported to downwind locations and deposited in surface soil, surface water, or sediment. However, the site is currently inactive,

minimizing ground disturbance, and the turfgrass and weeds on and around the site perimeter serve to minimize the airborne contaminant transport pathway by binding soil and reducing fugitive dust.

Precipitation runoff can carry contaminants via overland runoff to the Potomac River and Chicamuxen Creek. As mentioned above, though, the thick grassy and brushy areas around the site parameter may trap surface runoff. Infiltrating precipitation can cause the potential contamination of subsurface soil and groundwater, which probably is the major contaminant transport mechanism, because most of the site is relatively flat and precipitation will tend to pond. Contaminants can be deposited subsequently in sediment or surface water, and can potentially accumulate in the tissues of aquatic organisms in the Potomac River and Chicamuxen Creek.

Exposure Routes

Terrestrial animals at Range 6 can be exposed to soil contaminants through the ingestion of contaminated food items. In addition, animals can incidentally ingest soil while grooming fur, preening feathers, digging, grazing close to the soil, or feeding on items that are covered with soil (such as roots and tubers). Terrestrial vegetation can be exposed to contaminants through direct aerial deposition and root translocation. Terrestrial receptors can also come into contact with contaminants in surface water by using it for drinking, although this exposure route generally represents a negligible portion of total exposure for most receptors. Aquatic and semi-aquatic organisms can be exposed to contaminants through direct contact with surface water and sediments in the Potomac and Chicamuxen Creek, incidental ingestion of surface water and sediments in the Potomac and Chicamuxen Creek, and consumption of contaminated food items. Exposure to contaminants in the soil via dermal contact can occur but is unlikely to represent a major exposure pathway because fur, feathers, and chitinous exoskeletons minimize the transfer of contaminants across dermal tissue.

Volatile constituents could be present in some site soils and soil-bound contaminant airborne suspension could occur at Range 6 since bare soil exists. However, the data indicate that volatile contamination is minimal at the site. In addition, inhalation does not represent a significant exposure pathway because this investigation assumes that air contaminant concentrations are quite low, even for burrowing wildlife. Furthermore, inhalation ecotoxicity data for chronic exposure are lacking. Hence, the air pathway was not considered for ecological receptors.

Selection of Preliminary Contaminants of Concern (PCOCs)

The PCOC selection process for this ERA is described in Section 2.6.

Assessment and Measurement Endpoints

A description of assessment and measurement endpoints for this ERA is presented in Section 2.6.

Conceptual Site Model

Figure 4-13 shows the conceptual model for Range 6.

4.7.1.2 Ecological Effects Characterization

Ecologically-based screening levels (e.g., concentrations of contaminants in various media protective of ecological receptors) were compared to exposure point concentrations of detected analytes in surface water, groundwater, sediment, and surface soil to determine if the analytes qualify as ecological PCOCs at Range 6. The thresholds were USEPA Region III BTAG screening levels (EPA, 1995), although AWQC were used for groundwater. The derivation of toxicity reference values (TRVs) for Range 6 foodchain modeling is also described in Section 2.6, as well as the selection of representative receptors. Briefly, the great blue heron, red fox, red-tailed hawk, meadow vole, short-tailed shrew, and woodcock were selected as representative ecological receptors for the foodchain modeling at Range 6.

4.7.1.3 Exposure Assessment

This section presents the ecological exposure assessment for Range 6 and includes a discussion of exposure point contaminant concentrations.

Exposure Point Contaminant Concentrations

The maximum detected contaminant concentrations in surface water, groundwater, sediment, and soil were used as exposure point concentrations for screening against USEPA Region III BTAG screening levels and AWQC. The maximum and mean concentrations of contaminants detected in Site 6 media were used in the foodchain modeling.

4.7.1.4 Risk Characterization

This section presents the results of the ecological risk assessment for Range 6.

Results - Ecological Screening Assessment

No contaminants detected in surface water exceeded BTAG screening levels (Table 4-21). Arsenic and copper were retained as sediment PCOCs since their maximum concentrations exceeded BTAG screening levels (Table 4-22). Barium, beryllium, cobalt, selenium and vanadium were retained as sediment PCOCs since no BTAG screening levels were available.

Aluminum, antimony, beryllium, chromium, copper, iron, lead, mercury, nickel, selenium, silver, tin and zinc were retained as inorganic surface soil PCOCs since their maximum concentrations exceeded BTAG screening levels (Table 4-23). Several PAHs, di-n-butyl phthalate and N-nitrosodiphenylamine were retained as organic surface soil PCOCs since their maximum concentrations exceeded BTAG screening levels (Table 4-23). Bis(2-ethylhexyl)phthalate, 4-methyl-2-pentanone, acetone, trichlorofluoromethane and several explosives/energetics were retained as surface soil PCOCs since no BTAG screening levels were available.

The inorganics antimony, arsenic, barium, chromium, cobalt, copper, lead and vanadium had maximum groundwater concentrations in excess of AWQC and were retained as groundwater PCOCs (Table 4-24). Several explosives/energetics in groundwater were retained as groundwater PCOCs since no AWQC were available.

Results - Foodchain Modeling

Arsenic and copper were retained as PCOCs based on the aquatic foodchain modeling because at least one EEI value exceeded 1.0 when maximum detected concentration were evaluated (Table 4-25). These two constituents also had at least one EEI greater than one when mean concentrations were evaluated (Table 4-25). Beryllium was retained as a PCOC after the aquatic foodchain modeling since no toxicity data were available.

Aluminum, antimony, beryllium, chromium, copper, iron, lead, mercury, selenium and zinc were retained as inorganic PCOCs after the terrestrial foodchain modeling because at least one EEI value developed for these metals exceeded 1.0 (Table 4-26) where maximum concentrations were evaluated. Di-n-butyl phthalate, RDX, 2,4,6-trinitrotoluene, and 2,4-dinitrotoluene were retained as terrestrial PCOCs since at least one EEI value exceeded 1.0 (Table 4-26). All of the inorganics listed above, except beryllium, and the organics listed above had at least one EEI value exceeding one when mean concentrations were evaluated (Table 4-27). N-Nitrosodiphenylamine, 4-methyl-2-pentanone, and 2-amino-4,6-dinitrotoluene were retained as PCOCs after the terrestrial foodchain modeling since no toxicity data were available.

4.7.2 Risk Management

Risk management considerations for Range 6 sediments and surface soils are discussed below.

4.7.2.1 Sediments

Arsenic, beryllium, and copper were retained as sediment PCOCs after the aquatic foodchain modeling. Arsenic's maximum concentration (3 mg/kg) was less than its average base-wide background concentration (3.3 mg/kg) and its most conservative alternate guideline, the MOE LEL (6 mg/kg; Table 4-28). Beryllium was detected in 1 of 4 sediment samples at a maximum concentration (0.31 mg/kg) less than its average base-wide background concentration (0.52 mg/kg). No BTAG screening level or alternate guideline was available for beryllium. Copper's maximum concentration (50.5 mg/kg) was greater than its base-wide background concentration in sample SD01 (Table 4-28), which was collected in Chicamuxen Creek (Figure 4-13). The maximum concentration of copper was approximately halfway between the LEL and the SEL for copper. The average concentration of copper (16.8 mg/kg) was less than the BTAG screening level (34 mg/kg, an ER-L), and approximately equal to the LEL (Table 4-28). All three other detections of copper were less than the BTAG screening level and the LEL. Its concentrations do not appear to be significantly elevated.

Copper is an AVS metal, and hence, may be bound to the AVS in sediments, reducing bioavailability. Yet, the site-specific bioavailability of copper in site sediments is not known. The collection of additional samples for AVS/SEM is questionable, since other AVS metals were not elevated in sediments and the other 3 detections of copper were below conservative guidelines. It also appears that contaminants in SWMU 5 surface soil and groundwater are not migrating to adjacent Potomac River and Chicamuxen Creek sediments. Thus, no final sediment PCOCs are selected for SWMU 5.

4.7.2.2 Surface Soil

Several metals were retained as surface soil PCOCs after the terrestrial foodchain modeling at Range 6. The following paragraphs discuss the risk management considerations for each metal and organic initially retained as a surface soil PCOC.

Aluminum's maximum concentration (6,290 mg/kg) was less than the average base-wide background concentration (7,874 mg/kg; Table 4-28) and less than the range of regional background concentrations (10,000-20,000 mg/kg; Boerngen and Shacklette, 1981).

Antimony's maximum concentration (1.9 mg/kg) was slightly higher than regional background (<1-1 mg/kg) and its average concentration (0.47 mg/kg) was within this range. Antimony was not detected in the base-wide background. The concentrations detected were within the range of concentrations reported for soils of the eastern United States (Shacklette and Boerngen, 1984). No alternate guideline was available for antimony.

Beryllium's maximum concentration (0.98 mg/kg) was higher than the average base-wide background concentration (0.4 mg/kg), but within the regional background range (<1-7 mg/kg; Boerngen and Shacklette, 1981). The average concentration of beryllium (0.36 mg/kg) was less than the average base-wide background concentration (Table 4-28). No alternate guideline was available for this metal.

Chromium's maximum concentration (24.1 mg/kg) was slightly higher than the maximum detected concentration in base-wide background (20.8 mg/kg) and twice the average background concentration (Table 4-28). The maximum concentration was slightly higher than the range of regional background (15-20 mg/kg; Boerngen and Shacklette, 1981) and the average concentration (12.6 mg/kg) was similar to the average concentration in the base-wide background (12 mg/kg).

Copper's maximum detected concentration (217 mg/kg) was greater than the base-wide background and regional background. It also exceeded the ORNL alternate guidelines (Table 4-28), which are values that are indicative of toxicity to soil organisms. Copper's EEI (calculated using mean concentrations and comparing to NOAELs) exceeded one. The average concentration (33.1 mg/kg) was also elevated relative to base-wide and regional background concentrations, but was less than the ORNL alternate guidelines (50 and 100 mg/kg). All other detected concentrations of copper were an order of magnitude less than the maximum detected concentration (Section 4.4) and were less than the 100 mg/kg alternate guideline indicative of toxicity to soil microbes.

Iron's maximum detected concentration (14,400 mg/kg) was slightly higher than the average base-wide concentration and the regional range of concentrations (5,000-10,000), but this was most likely due to naturally-occurring conditions. Iron is a common element in soils and an essential nutrient.

Lead's maximum detected concentration (181 mg/kg) was significantly greater than the average base-wide background concentration (20 mg/kg) and the regional range of background concentrations (10-15 mg/kg; Boerngen and Shacklette, 1981). All EEI values for lead calculated using means (LOAELs and NOAELs) were greater than 1.0. However, the maximum concentration was much less than the alternate guidelines (Table 4-28), which are indicative of toxicity to soil organisms. Lead's average soil concentration (25.82 mg/kg) was slightly higher than the average base-wide background concentration

(20 mg/kg). Sixteen of 19 lead detection in surface soil were an order of magnitude less than the maximum detected concentration.

Mercury's maximum detected concentration (1.6 mg/kg) and its average concentration (0.18 mg/kg) exceeded the average base-wide background concentration (0.04 mg/kg) and the regional background ranges (0.04-0.07 mg/kg; Boerngen and Shacklette, 1981). Mercury's EEI calculated using mean concentrations for all receptors and comparing to AOAELs exceeded one. However, seventeen of the 19 mercury detections in surface soil were an order of magnitude less than the maximum detected concentration. Mercury's maximum concentration exceeded the alternate guideline for toxicity to earthworms but was an order of magnitude less than the alternate guideline for toxicity to soil microbes (Table 4-28).

Selenium's maximum detected concentration (2.3 mg/kg) was greater than its average base-wide background (0.54 mg/kg) and regional background (<0.01-0.4 mg/kg). Selenium's average concentration (0.83 mg/kg) slightly exceeded the average base-wide concentration. Selenium's maximum concentration was one and two orders of magnitude lower than the two alternate guidelines (Table 4-28), which are indicative of toxicity to soil organisms.

Zinc's maximum detected concentration (446 mg/kg) was significantly greater than the average base-wide background concentration (18.1 mg/kg) and regional ranges of background (15-26 mg/kg). It was also greater than the alternate guidelines (Table 4-28), which are indicative of toxicity to soil organisms. Using mean concentrations and NOAELs, EEIs calculated for the short-tailed shrew, red-tailed hawk, and woodcock were all greater than 1.0, although all of those EEIs were relatively low (2.47 or less). All other zinc detections but one (165 mg/kg, sample SS008) were an order of magnitude less than the maximum (Section 4.4) and consequently less than the lower alternate guideline of 100 mg/kg. The average concentration (39.5 mg/kg) was much lower than the lesser alternative guideline from ORNL.

In summary, aluminum, antimony, beryllium and iron maximum concentrations were lower than or comparable to average base-wide background and regional background concentrations. Chromium's maximum detected concentration was only slightly higher than the regional range of background concentrations and the average concentration was approximately equal to the average base-wide background concentration. Selenium's maximum detected concentration was higher than average base-wide background and regional background, but the average concentration only slightly exceeded the average base-wide concentration. Selenium's maximum concentration was one and two orders of magnitude lower than the two alternate guidelines. Although the maximum concentrations of some of

these metals were slightly elevated relative to background, they did not appear to be significantly elevated relative to background. For these reasons, none of these metals were retained as a final PCOC.

The maximum concentrations of copper, mercury, lead, and zinc were significantly higher than the base-wide and regional background. Therefore, they were retained as final soil PCOCs. However, it does not appear that elevated concentrations of these metals, and related potential risks, were widespread. All other detected concentrations of copper, seventeen of the 19 surface soil hits of mercury, and all but one zinc detection were an order of magnitude lower than the maximum. The average concentrations of copper and zinc were lower than both alternate guidelines and the average concentration of mercury was less than one of two alternate guidelines. Lead's maximum detected concentration was significantly higher than the average base-wide background concentration and the regional range of background concentrations, but was much less than alternate guidelines. The average concentration of lead in soils was slightly higher than the average base-wide background concentration, and 16 of 19 lead detections in surface soil were an order of magnitude less than the maximum. The maximum concentrations of mercury and zinc are in sample SS09 and the maximum concentrations of copper and lead are in samples SS08 and SS07, respectively. Samples SS08 and SS07 were collected within the detonation area, and SS09 was collected just west of the detonation area (Figure 4-4).

It should also be noted that metals at hazardous wastes sites are typically in poorly available forms (Will and Suter, 1995), although the site-specific bioavailability of metals in Range 6 surface soils is not known. The portions of the site that have not been in recent use support a diverse and abundant flora that is common on similar habitats in the regional and on base, indicating the absence of stressed vegetation.

Several organics were also retained as PCOCs in surface soil after the terrestrial foodchain modeling:

- Di-n-butyl phthalate
- N-Nitrosodiphenyamine
- 4-Methyl-2-pentanone
- Trichlorofluoromethane

Di-n-butyl phthalate's maximum concentration (6,500 µg/kg) exceeded the alternate guideline of 3005 µg/kg (Table 4-28), a Dutch guideline based primarily on ecological endpoints. The compound was detected in 8 of 19 samples. All other detections of this compound were less than the alternate guideline and an order of magnitude less than the maximum (sample SS05), except sample SS002 (2,200 µg/kg). N-Nitrosodiphenylamine was detected in 2 of 19 samples, and its maximum concentration (380 µg/kg) was several orders of magnitude less than the alternate guideline of 20,000 µg/kg, which is based on toxicity to

soil organisms. 4-Methyl-2-pentanone and trichlorofluoromethane were detected in one and two of 19 samples, respectively (Table 4-28). No BTAG screening level or toxicity data were available for these organics, but the concentrations appear to be low (2 µg/kg or less). Qualitative statements about the significance of these compounds can only be made due to general absence of toxicity data.

Several explosives/energetics were detected in Range 6 surface soils:

- TNT
- 2-Amino-4,6-dinitrotoluene
- HMX
- RDX
- 2,4-Dinitrotoluene

TNT was detected in 13 of 19 samples at a maximum of 248,000 µg/kg (sample SS015). No BTAG screening level was available, making interpretation of soil concentrations difficult. TNT is rapidly detoxified in the liver and excreted primarily by the kidneys (Ryon et. al., 1984). Only small amounts of the compound or its metabolites are distributed to the organs (Ryon et al., 1984). Yet, qualitatively, several detections other than the maximum appear to be elevated, including sample SS008 (10,500 mg/kg) and sample SS007 (9270 µg/kg). All of the other detections were 2340 µg/kg or less (Section 4.4). Using a mean concentration and comparing to NOAELs, only the EEI values for the short-tailed shrew (1.49) and the woodcock (1.29) were greater than one. 2-Amino-4,6-dinitrotoluene was detected in 13 of 19 samples at a maximum of 16,000 µg/kg. All other detections of this compound were one to two orders of magnitude lower than the maximum, with an average of 1150 µg/kg. No toxicity data were available for this compound.

HMX was detected in 7 of 19 samples at a maximum concentration of 26,700 µg/kg (sample SS015). Samples SS007 and SS008 had concentrations of 17,600 and 10,600 µg/kg, respectively, and all other detections were at least an order of magnitude lower than these two values. No avian toxicity data were available for HMX, but all EEI values derived using mean concentrations were less than one for the other terrestrial receptors investigated in the foodchain modeling. Studies in rodents indicate that HMX is not well absorbed (less than 5 percent) in the gastrointestinal tract (ATSDR, 1994). Based on data for RDX, bioaccumulation is unlikely, although bioaccumulation data for HMX are lacking (ATSDR, 1994).

RDX was detected in 10 of 19 surface soils samples at a maximum concentration of 397,000 µg/kg (sample SS015). Sample SS007 had a RDX concentration of 111,000 µg/kg. All other detections were two orders of magnitude lower than that concentration. RDX is extensively metabolized and does not

accumulate in any tissue (Ryon et al., 1984). Toxicity studies reveal that after oral dosing in rats, less than 10 percent of the dose remain in the body after 4 days (Ryon et al., 1984).

2,4-Dinitrotoluene was detected in 8 of 37 samples at a maximum concentration of 9,300 µg/kg (sample SS005). Sample SS008 had a concentration of 3,530 µg/kg, sample SS002 had a concentration of 1,800 µg/kg, and all other detections were at least an order of magnitude lower. Only one EEI value, derived using a mean concentration and comparing to the NOAEL (short-tailed shrew), was greater than 1.0. No avain toxicity data were available for this compound, but bioaccumulation of DNT in animal tissues is negligible (ATSDR, 1989).

HMX, RDX, 2-amino-4,6-dinitrotoluene, and TNT were detected sporadically in groundwater samples. No explosives/energetics were detected in adjacent Potomac River or Chicamuxen Creek surface water or sediments. This indicates that explosives/energetics in Range 6 surface soils and groundwater are not migrating to off-site aquatic habitats. Hence, potential risks from these compounds are confined to risks to terrestrial receptors. HMX, RDX, 2-amino-4,6-dinitrotoluene, 2,4-dinitrotoluene, and TNT are retained as final surface soil PCOCs.

In general, samples SS005, SS006, SS007, SS008, SS015, and to a lesser extent SS002 and SS003, appear to contain the highest concentrations of explosives/energetics in surface soils. All of these sampling locations are located in the detonation training area, except for SS015, which is located about 100 feet north of that area (Figure 4-4). Nearly all other samples contain 1000 µg/kg or less for these compounds, with non-detects as the norm outside of the detonation area.

4.7.3 ERA and Risk Management Summary and Conclusions

The maximum concentrations of contaminants detected in Range 6 surface water, groundwater, sediment, and surface soil were compared to BTAG screening levels. All of the contaminants with maximum concentrations that exceeded BTAG screening levels were retained as PCOCs and the PCOCs in sediments and surface soils were included in foodchain modeling at the site for several representative ecological receptors. Contaminants that had at least one EEI greater than 1.0 in the foodchain modeling (for all representative receptors) using maximum concentrations were retained as PCOCs. Finally, those PCOCs were assessed using risk management considerations to develop list of final PCOCs. As a result of these analyses, the following conclusions are drawn:

- No contaminants in Potomac River or Chicamuxen Creek surface water samples exceeded BTAG screening levels.

- The concentration of copper in sediment sample SD01 was slightly elevated, but copper concentrations in other sediment samples suggest that risks associated with copper would be insignificant.

- Copper, mercury, and zinc had maximum concentrations in surface soils in excess of basewide background concentrations and most alternate guidelines presented, and were retained as PCOCs. However, nearly all other detections of these metals were comparable to or lower than background concentrations and alternate guidelines. Potential risks from spotty elevated concentrations of these metals (nearly all in the detonation training area) did not appear to be significant when weighed against the potential risks from explosives in surface soils, as described below.

- Despite the low bioaccumulation potential of most explosives, the concentrations of five of them appeared to be significantly elevated, and those contaminants were retained as final PCOCs. Samples SS005, SS006, SS008, SS015, and to a lesser extent samples SS002 and SS003 contained the highest concentrations of explosives; all of these sampling locations are located in the detonation training area except for sample SS015, which is located approximately 100 feet north of that area.

- Two elevated detections of di-n-butyl phthalate were in surface soil samples SS02 and SS05, which are located in the detonation training area.

- The detonation training area is covered with bare soil and some scattered turf grass, thus providing limited terrestrial habitat and somewhat mitigating potential risks. Nonetheless, if Navy activities would cease at the site, it is likely that native vegetation would proliferate in these areas, thus attracting terrestrial wildlife and increasing the likelihood of contaminant exposure.

4.7.4 Site-Specific Uncertainties

The following items summarize site-specific uncertainties for the ERA at Range 6:

- Sample numbers in surface water and sediment were low, reducing confidence in the use of the average concentration as a representative exposure concentration.

- No BTAG sediment screening levels or alternate guidelines were available for beryllium, although this metal was present in a maximum concentration less than the average base-wide background concentration.

- No alternate guidelines were available for antimony, beryllium, and iron in surface soils, although their maximum concentrations were comparable to regional background concentrations. Nonetheless, the generally lack of toxicity data for these metals precludes a thorough toxicological evaluation of their presence in site sediments.

- No BTAG surface soil screening levels or alternate guidelines were available for several SVOCs and one VOC. At least qualitatively, the concentrations appear to be relatively low and they were not PCOCs in surface soil, but without adequate toxicity data, the potential risks associated with their concentrations in sediments cannot be fully determined.

- The maximum concentrations of several metals in surface soils exceeded base-wide and regional background concentrations, but did not appear to be significantly elevated relative to background, and were much less than alternate guidelines. As mentioned earlier, metals at hazardous waste sites are usually in poorly available forms (Will and Suter, 1995). However, the lack of site-specific bioavailability data introduces uncertainty into the ERA.

- Several explosives and di-n-butyl phthalate were present in what appear to be significantly elevated concentrations, but the lack of ecotoxicity data preclude a thorough interpretation of those concentrations.

4.8 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Section 4.8 summarizes the environmental investigations conducted to date, the nature and extent of the chemicals detected in the environmental media, and the results of the human health and the ecological risk assessments. Conclusions and recommendations are provided.

The following items summarize the investigative work conducted to date:

1. The field investigation for CTO 222 included the field screening of 22 shallow soil samples for TNT and RDX. The majority of the samples were collected from locations within the large-scale detonation training area.

2. The field investigation for the CTO 287 RFI/VI included the collection of soil-gas survey samples at 38 locations within the detonation training areas and adjoining areas. Fourteen aromatic

hydrocarbons (e.g., benzene) and chlorinated hydrocarbons (e.g., tetrachloroethene) were the target analytes of concern.

3. Surface and subsurface soil samples were collected from 20 locations and submitted to a fixed-base laboratory (GP) for analysis.

4. Five monitoring wells (one upgradient; four downgradient) were installed. One round of synoptic water- level measurements was recorded. Rising-head and falling-head slug tests were performed at monitoring well location 5GW01 (B&R Environmental, 1995).

5. Surface water and sediment samples were collected at four locations in the surface water bodies surrounding Range 6. Samples were collected from two locations within Chicamuxen Creek and two locations within the Potomac River.

6. Environmental samples collected for analysis by the fixed-base laboratory were analyzed for a comprehensive suite of analytes, including volatile organic and semivolatile organic compounds, metals, and explosives.

The following items summarize the environmental conditions at Range 6:

1. In the low-lying areas to the south of Archer Avenue, the soils materials generally consist of fine-grained sediments, silt, clay and peat. In the uplands, the soils materials generally consist of sand and gravel interlayered by silt and clay. In the detonation areas the reworked material generally consists of yellow-brown clay, silt, sand, and gravel mixtures approximately 6 feet thick.

2. The groundwater beneath the site occurs primarily under locally semiconfining and unconfined (water table) conditions. The water-table aquifer consists primarily of yellow-brown sand and gravel. The shallow groundwater is presumed to be flowing radially toward and discharging into both the Chicamuxen Creek and the Potomac River. However, both water bodies are tidal, and during high tide, losing-stream conditions may occur.

3. The groundwater resource is probably recharged by downward migration of precipitation through the unsaturated zone to the water table. In addition, groundwater along the edge of the stream is also recharged as a result of the losing-stream conditions during high tide.

4. A groundwater divide occurs north-south down the center of the Range 6 study area. A slight mounding of the groundwater potentiometric surface in the detonation area probably results from a combination of surface topography and the shallow subsurface material.

5. Explosives and components of explosives (TNT, RDX, HMX, 2,4-dinitrotoluene, 2,6-dinitrotoluene), and degradation by-products of explosives (2-amino-4,6-dinitrotoluene) were the predominant site-related organic contaminants detected in the Range 6 soil and groundwater samples. One or more of these chemicals were detected in more than 50 percent of the surface soil samples. The chemical concentrations noted in soil samples from the large-scale training area exceed those noted in samples from most other sampling locations by an order of magnitude. However, these chemicals were not noted in surface water and sediment samples collected from the surrounding surface water bodies (Chixamuxen Creek and the Potomac River).

6. Volatile and semivolatile organic compounds (other than the explosives) were detected less frequently than the explosive compounds and at maximum concentrations often orders of magnitude less than those reported for the explosive compounds. The organics detected include phthalate compounds (e.g., bis(2-ethylhexyl)phthalate), polyaromatic hydrocarbons (e.g., benzo(a)pyrene), fuel related compounds (e.g., toluene), and volatile organic solvents (e.g., acetone). Site-related as well as non-site-related activities may have contributed to the presence of these compounds in the environmental media. The detection of several of these compounds in areas outside the immediate detonation training areas may be evidence of the fact that preparatory or ancillary activities for/to the detonation exercises occurred in areas adjoining the large-scale and small-scale detonation training areas.

7. The environmental investigations conducted to date have not confirmed the location of the alleged arsenic disposal pit at Range 6. Arsenic results for soil and groundwater samples collected at the location identified by a former Navy employee reflect background conditions.

8. Several metals (e.g., cadmium, copper, mercury, selenium, and zinc) were detected at sampling locations, particularly within the large-scale training area, at concentrations exceeding basewide background concentrations. Although the maximum detected concentrations clearly exceed background concentrations, the exceedances noted at many of the locations are best described as marginal (i.e., similar to or within two times background). Several metals were noted in Range 6 groundwater samples at concentrations exceeding those noted in background monitoring wells. However, the turbidity levels reported for many of the samples indicate that the metals concentrations noted in some of the samples may be attributable, in part, to the suspended

particulates in the groundwater samples. Metals concentrations detected in surface waters and sediments suggest that historic activities at Range 6 have had minimal impact on surface water and sediment quality in the vicinity of Range 6.

The following items summarize the baseline human health risk assessment conducted for Range 6:

1. The human risk assessment for Range 6 considered exposures to maintenance workers, full-time employees, and construction workers. Potential exposure pathways for direct contact with soil for all receptors included incidental ingestion and dermal contact with soil. Inhalation of fugitive dust and volatiles from soil were not considered since concentrations of all COPCs in soil were less than the SSLs developed by the EPA for the migration of contaminants from soil to air. In addition, dermal contact with groundwater was evaluated for construction workers.

2. The following chemicals were selected as COPCs for soils: TNT, RDX, 2-amino-4,6-ninitrotoluene, and arsenic. Three explosives (TNT, 2-amino-4,6-dinitrotoluene, and RDX) and six inorganics (antimony, arsenic, barium, total chromium, lead, and vanadium) were selected as COPCs for groundwater. No chemicals were selected as COPCs in surface water or sediment.

3. Incremental lifetime cancer risk estimates for all receptors hypothetically exposed to COPCs in soil and groundwater were within the EPA's target risk range of 10^{-4} to 10^{-6} (USEPA, 1989).

4. Noncarcinogenic risk estimates (HIs) calculated for the maintenance workers were less than unity. Thus, adverse noncarcinogenic health effects are not anticipated under the conditions established in the exposure assessment.

5. Noncarcinogenic risk estimates for full-time employees hypothetically exposed to soil exceeded unity. The HI calculated for the RME was 4. There is a potential for adverse noncarcinogenic health effects when the HI exceeds unity. TNT and 2-amino-4,6-dinitrotoluene (dermal contact route of exposure) were the main contributors to risk.

6. Noncarcinogenic risk estimates for construction workers hypothetically exposed to soil exceed unity. The HI calculated for the RME was 4.8. TNT and 2-amino-4,6-dinitrotoluene (incidental ingestion and dermal contact routes of exposure) were the main contributors to risk.

The following items summarize the baseline ecological risk assessment conducted for Range 6:

1. No final potential chemicals of concern were identified based on the evaluation of analytical results for surface water and sediment samples collected at Range 6. It does not appear that the site-related contamination detected in the soil and groundwater samples has impacted the adjacent aquatic habitats.

2. Copper, mercury, and zinc were retained as final potential chemicals of concern for soil. However, the sporadic elevated concentrations of these metals limit the potential for widespread risks to terrestrial receptors.

3. Five explosive compounds (TNT,HMX, RDX, 2-amino-4,6-dinitrotoluene, and 2,4-dintrotoluene) and di-n-butyl phthalate, a semivolatile compound, were retained as final potential chemicals of concern for soil. The majority of the contamination was noted in the large-scale detonation training area. Minimal data exist regarding the ecotoxicity of these compounds. It should be noted that the detonation area is sparsely vegetated and currently provides limited terrestrial habitat.

It is recommended that risk managers for NSWC Indian Head consider a feasibility study or land use restrictions for Range 6 if site conditions and use are anticipated to change in the future. Baseline human health risk assessment results indicate a potential (albeit low) for adverse noncarcinogenic health effects for full time employees or construction workers hypothetically exposed to surface soils at Range 6. It should be noted that these risk estimates are for site workers in the future; full time employees or construction workers do not currently work at the site. The results of the baseline ecological risk assessment also suggest a potential for adverse effects to terrestrial receptors. However, the site currently provides limited terrestrial habitat. Consequently, few ecological receptors are currently exposed.

TABLE 4-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE	MEDIA	Explosives SW846 8330	APP IX Metals SW846 6010A/7000	APP IX SVOA SW846 8270B	APP IX VOA SW846 8240B	TOC SW846 9060	TOX SW846 9020B	Miscellaneous
5GW01	Groundwater	X	X	X	X	X	X	
5GW01F	Groundwater		X					
RN6MW002F001	Groundwater		X					
RN6MW002U001	Groundwater	X	X	X	X			
RN6MW003F001	Groundwater		X					
RN6MW003F001-D	Groundwater		X					
RN6MW003U001	Groundwater	X	X	X	X			
RN6MW003U001-D	Groundwater	X	X	X	X			
RN6MW004F001	Groundwater		X					
RN6MW004U001	Groundwater	X	X	X	X			
RN6SB0010101	Subsurface soil	X	X	X	X			
RN6SB0020101	Subsurface soil	X	X	X	X			
RN6SB0030101	Subsurface soil	X	X	X	X			
RN6SB0040101	Subsurface soil	X	X	X	X			
RN6SB0050101	Subsurface soil	X	X	X	X			
RN6SB0060101	Subsurface soil	X	X	X	X			
RN6SB0060101-D	Subsurface soil	X	X	X	X			
RN6SB0070101	Subsurface soil	X	X	X	X			
RN6SB0080101	Subsurface soil	X	X	X	X			
RN6SB0090101	Subsurface soil	X	X	X	X			
RN6SB0100101	Subsurface soil	X	X	X	X			
RN6SB0110101	Subsurface soil	X	X	X	X			
RN6SB0110101-D	Subsurface soil	X	X	X	X			
RN6SB0120101	Subsurface soil	X	X	X	X			
RN6SB0130101	Subsurface soil	X	X	X	X			
RN6SB0140101	Subsurface soil	X	X	X	X			
RN6SB0150101	Subsurface soil	X	X	X	X			

TABLE 4-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE	MEDIA	Explosives SW846 8330	APP IX Metals SW846 6010A/7000	APP IX SVOA SW846 8270B	APP IX VOA SW846 8240B	TOC SW846 9060	TOX SW846 9020B	Miscellaneous
RN6SB0160101	Subsurface soil	X	X	X	X			
RN6SB0160201	Subsurface soil	X	X	X	X			
RN6SB0160301	Subsurface soil	X	X	X	X			
RN6SB0160401	Subsurface soil	X	X	X	X			
RN6SB0170101	Subsurface soil	X	X	X	X			
RN6SB0170201	Subsurface soil	X	X	X	X			
RN6SB0170401	Subsurface soil	X	X	X	X			
RN6SB0180101	Subsurface soil	X	X	X	X			
RN6SB0180201	Subsurface soil	X	X	X	X			
RN6SB0190101	Subsurface soil	X	X	X	X			
RN6SB0190201	Subsurface soil	X	X	X	X			
RN6SD0010001	Sediment	X	X		X			
RN6SD0020001	Sediment	X	X	X	X			
RN6SD0030001	Sediment	X	X	X	X			
RN6SD0040001	Sediment	X	X	X	X			
RN6SS0010101	Surface Soil	X	X	X	X			
RN6SS0020101	Surface Soil	X	X	X	X			
RN6SS0030101	Surface Soil	X	X	X	X			
RN6SS0040101	Surface Soil	X	X	X	X			
RN6SS0050101	Surface Soil	X	X	X	X			
RN6SS0060101	Surface Soil	X	X	X	X			
RN6SS0070101	Surface Soil	X	X	X	X			
RN6SS0080101	Surface Soil	X	X	X	X			
RN6SS0090101	Surface Soil	X	X	X	X			
RN6SS0100101	Surface Soil	X	X	X	X			
RN6SS0110101	Surface Soil	X	X	X	X			
RN6SS0120101	Surface Soil	X	X	X	X			

TABLE 4-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE	MEDIA	Explosives SW846 8330	APP IX Metals SW846 6010A/7000	APP IX SVOA SW846 8270B	APP IX VOA SW846 8240B	TOC SW846 9060	TOX SW846 9020B	Miscellaneous
RN6SS0130101	Surface Soil	X	X	X	X			
RN6SS0140101	Surface Soil	X	X	X	X			
RN6SS0140101-D	Surface Soil	X	X	X	X			
RN6SS0150101	Surface Soil	X	X	X	X			
RN6SS0160101	Surface Soil	X	X	X	X			
RN6SS0180101	Surface Soil	X	X	X	X			
RN6SS0180101-D	Surface Soil	X	X	X	X			
RN6SS0190101	Surface Soil	X	X	X	X			
RN6SS0190101-D	Surface Soil	X	X	X	X			
RN6SW0010001	Surface Water	X	X	X	X			
RN6SW0020001	Surface Water	X	X	X	X			
RN6SW0030001	Surface Water	X	X	X	X			
RN6SW0040001	Surface Water	X	X	X	X			
S5-MW01-01	Groundwater	X	X	X	X	X		X
S5-MW01-01-D	Groundwater	X	X			X		X
S5-MW01-02	Groundwater	X	X	X	X	X		X
S5-MW01-02-D	Groundwater			X	X			

APP IX - Appendix IX
VOA - Volatile organic analyte
SVOA - Semi-volatile organic analyte
TOC - Total organic carbon
TOH - Total organic halides
Miscellaneous - Parmeters include ammonia and nitrate/nitrite.

TABLE 4-2

WELL CONSTRUCTION SUMMARY FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Well Number	Ground Elevation (Ft. msl)	Top of Riser Elevation (Ft. msl)	Total Well Depth (Ft. bgs)	Monitored Interval (Ft. bgs)	Depth to Groundwater (Ft tor)	Depth to Groundwater (Ft. bgs)	Groundwater Elevation (Ft. msl)
5GW01	7.09	9.55	18	8-18	8.04	5.58	1.51
RN6MW02	4.19	6.28	19	9-19	4.64	2.55	1.64
RN6MW03	10.02	12.27	17	7-17	10.93	8.68	1.34
RN6MW04	24.01	26.23	34.5	24-34	24.89	22.67	1.34
RN6MW05	30.07	32.17	31	21-31	30.94	28.84	1.23

* Water levels measured 8/17/97
Ft. msl - Feet above mean sea level.
Ft bgs - Feet below ground surface.
Ft tor - Feet below top of riser.

TABLE 4-3

SUMMARY OF SOIL GAS POSITIVE DETECTS FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Grid Location Identification	Laboratory Sample Identification	Total Volatile Hydrocarbons (ug/l)	Chloroform (ug/l)	1,1,1-Trichloroethane (ug/l)	Carbon tetrachloride (ug/l)	Trichloroethene (ug/l)	Tetrachloroethene (ug/l)
RN6SG01	RN6SG0010101	<4	<0.006	<0.01	<0.002	<0.005	0.04
RN6SG03	RN6SG0030101	<4	0.03	<0.01	<0.002	<0.005	0.03
RN6SG04	RN6SG0040101	<4	0.05	<0.01	<0.002	<0.005	<0.005
RN6SG05	RN6SG0050101	<4	0.04	<0.01	<0.002	<0.005	<0.005
RN6SG14	RN6SG0140101	96	<0.006	<0.01	<0.002	0.02	0.04
RN6SG15	RN6SG0150101	130	<0.006	<0.01	<0.002	0.03	0.05
RN6SG19	RN6SG0190101	<4	<0.006	<0.01	<0.002	<0.005	0.008
RN6SG20	RN6SG0200101	7	<0.006	<0.01	<0.002	<0.005	0.01
RN6SG21	RN6SG0210101	36	<0.006	<0.01	<0.002	0.02	<0.005
RN6SG22	RN6SG0220101	<4	<0.006	<0.01	<0.002	<0.009	<0.005
RN6SG23	RN6SG0230101	39	<0.006	<0.01	<0.002	0.02	0.07
RN6SG24	RN6SG0240101	100	<0.006	<0.01	<0.002	<0.005	<0.005
RN6SG25	RN6SG0250101	140	<0.006	<0.01	<0.002	0.02	0.07
RN6SG26	RN6SG0260101	80	<0.006	<0.01	<0.002	0.02	0.05
RN6SG27	RN6SG0270101	11	<0.006	<0.01	<0.002	0.005	0.02
RN6SG28	RN6SG0280101	60	<0.003	0.02	0.002	0.06.	0.1
RN6SG29	RN6SG0290101	<4	<0.006	<0.01	<0.002	0.03	0.04
RN6SG30	RN6SG0300101	<4	<0.006	<0.01	<0.002	0.04	0.03
RN6SG31	RN6SG0310101	<4	<0.006	<0.01	<0.002	0.1	0.07
RN6SG32	RN6SG0320101	8	<0.006	<0.01	<0.002	0.08	0.06
RN6SG33	RN6SG0330101	7	<0.006	<0.01	<0.002	0.09	0.07
RN6SG34	RN6SG0340101	<4	<0.006	<0.01	<0.002	0.08	0.06
RN6SG35	RN6SG0350101	<4	<0.006	<0.01	<0.002	0.09	0.05
RN6SG36	RN6SG0360101	<4	<0.006	<0.01	<0.002	0.09	0.04
RN6SG37	RN6SG0370101	<4	<0.006	<0.01	<0.002	0.1	<0.06
RN6SG38	RN6SG0380101	NA	<0.006	<0.01	<0.002	0.1	0.06

TABLE 4-4
SUMMARY OF POSITIVE DETECTIONS IN SURFACE SOIL FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN6SS0010101	RN6SS0020101	RN6SS0030101	RN6SS0040101	RN6SS0050101	RN6SS0060101	RN6SS0070101
SAMPLE DATE:	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97
LOCATION:	RN6SS0010101	RN6SS0020101	RN6SS0030101	RN6SS0040101	RN6SS0050101	RN6SS0060101	RN6SS0070101
FIELD DUPLICATE OF:							
VOLATILES (µg/kg)							
ACETONE							130
ETHYLBENZENE							1 J
METHYLENE CHLORIDE	23	30	30	19	37	52	77
SEMIVOLATILES (µg/kg)							
2,4-DINITROTOLUENE-OS		1800			9300 J		85 J
2,6-DINITROTOLUENE		130 J			500 J		
BENZO(A)ANTHRACENE			44 J				
CHRYSENE			51 J				
DI-N-BUTYL PHTHALATE	230 J	2200 J			6500 J		130 J
N-NITROSODIPHENYLAMINE		90 J			380 J		
PYRENE			63 J				
ENERGETICS (µg/kg)							
2,4,6-TRINITROTOLUENE	297	325	767	319	1740	2340	9270
2,4-DINITROTOLUENE-EXP						290	
2-AMINO-4,6-DINITROTOLUENE	324	411	827	389	859	2060	16000
HMX			941		454	907	17600
RDX		269	1190	243	307	1440	111000
METALS (mg/kg)							
ANTIMONY	0.46 L	1.9 L	0.50 L	0.80 L	0.71 L	0.26 L	0.23 L
ARSENIC	2.4	4.1	3.3	3.7	4.1	2.3	2.4
BARIUM	25.4	27.8	27.5	32.3	41.9	32.0	27.3
BERYLLIUM	0.26	0.24	0.26	0.27	0.33	0.31	0.46
CADMIUM	0.99	1.5	1.3	2.1	1.3	1.3	0.66 K

TABLE 4-4
SUMMARY OF POSITIVE DETECTIONS IN SURFACE SOIL FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN6SS0010101	RN6SS0020101	RN6SS0030101	RN6SS0040101	RN6SS0050101	RN6SS0060101	RN6SS0070101
SAMPLE DATE:	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97
LOCATION:	RN6SS0010101	RN6SS0020101	RN6SS0030101	RN6SS0040101	RN6SS0050101	RN6SS0060101	RN6SS0070101
FIELD DUPLICATE OF:							
METALS (mg/kg)							
CHROMIUM	9.7	14.8	15.8	15.8	21.1	10.1	18.1
COBALT	4.1	5.9	3.5	3.6	3.6	4.0	3.1
COPPER	60.2	72.2	69.7	56.4	69.5	68.5	25.3
LEAD	35.7	111	39.2	30.9	30.2	24.4	181
MERCURY	0.16	0.12	0.12	0.18	0.12	0.28	0.41
NICKEL	4.8	5.6	4.6	7.3	7.6	6.0	7.0
SELENIUM	0.62	0.94	1.0	1.1	1.3	0.76	0.78
VANADIUM	15.1	22.6	20.5	25.5	28.7	15.8	19.9
ZINC	33.8	39.3	32.1	67.7	45.5	46.0	23.6

TABLE 4-4
SUMMARY OF POSITIVE DETECTIONS IN SURFACE SOIL FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN6SS0080101	RN6SS0090101	RN6SS0100101	RN6SS0110101	RN6SS0120101	RN6SS0130101	RN6SS0140101
SAMPLE DATE:	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97
LOCATION:	RN6SS0080101	RN6SS0090101	RN6SS0100101	RN6SS0110101	RN6SS0120101	RN6SS0130101	RN6SS0140101
FIELD DUPLICATE OF:							
VOLATILES (µg/kg)							
ACETONE		100 J					
ETHYLBENZENE	1 J						
TRICHLOROFLUOROMETHANE		2 J				1 J	
SEMIVOLATILES (µg/kg)							
2,4-DINITROTOLUENE-OS	160 J						
2,6-DINITROTOLUENE	120 J						
BENZO(A)ANTHRACENE		97 J					
BENZO(A)PYRENE		73 J					
BENZO(B)FLUORANTHENE		170 J					
CHRYSENE		130 J					
DI-N-BUTYL PHTHALATE						48 J	83 J
FLUORANTHENE		220 J					
PHENANTHRENE		130 J					
PYRENE		310 J					
ENERGETICS (µg/kg)							
2,4,6-TRINITROTOLUENE	10500		139	163			
2,4-DINITROTOLUENE-EXP	3530						
2-AMINO-4,6-DINITROTOLUENE	7730		476				
HMX	10600						
RDX	3420	684					
METALS (mg/kg)							
ANTIMONY	0.45 L	0.71 L	0.24 L	0.29 L	0.40 L	0.27 L	0.40 L
ARSENIC	2.9	2.7	2.1	1.2	3.3	1.8	3.1

TABLE 4-4
SUMMARY OF POSITIVE DETECTIONS IN SURFACE SOIL FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN6SS0080101	RN6SS0090101	RN6SS0100101	RN6SS0110101	RN6SS0120101	RN6SS0130101	RN6SS0140101
SAMPLE DATE:	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97
LOCATION:	RN6SS0080101	RN6SS0090101	RN6SS0100101	RN6SS0110101	RN6SS0120101	RN6SS0130101	RN6SS0140101
FIELD DUPLICATE OF:							
METALS (mg/kg)							
BARIUM	30.3	84.0	24.6	21.2	29.2	44.9	109
BERYLLIUM	0.98	0.38	0.27		0.34	0.40	0.47
CADMIUM	1.7	1.3	0.21 K	0.28 K	0.43 K	0.23 K	0.27 K
CHROMIUM	16.8	11.3	7.2	5.0	16.0	7.5	11.1
COBALT	10.4	8.1	6.4	5.5	5.4	6.3	7.2
COPPER	217	74.5	24.4	6.8	43.4	7.9	7.4
LEAD	49.5	108	14.9 K	5.3 K	22.8 K	6.2 K	6.1 K
MERCURY	0.47	1.6	0.02	0.02	0.03	0.04	0.02
NICKEL	20.9	10.4	4.9	4.2	7.4	5.6	6.7
SELENIUM	1.0	1.0	0.60 L	0.54 L	0.98 L	0.57 L	0.72 L
TIN		6.1 L					
VANADIUM	28.1	16.6	12.0	9.4	17.6	14.1	18.1
ZINC	165	446	16.6	17.9	31.9	18.3	25.0

TABLE 4-4
SUMMARY OF POSITIVE DETECTIONS IN SURFACE SOIL FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN6SS0140101-D	RN6SS0150101	RN6SS0160101	RN6SS0170101	RN6SS0180101	RN6SS0180101-D	RN6SS0190101
SAMPLE DATE:	06/25/97	06/25/97	07/09/97	07/09/97	07/10/97	07/10/97	07/10/97
LOCATION:	RN6DUP003	RN6SS0150101	RN6SS0160101	RN6SS0170101	RN6SS0180101	RN6DUP007	RN6SS0190101
FIELD DUPLICATE OF:	RN6SS0140101					RN6SS0180101	
VOLATILES (µg/kg)							
ACETONE			81 J	13000 L			
SEMIVOLATILES (µg/kg)							
2,4-DINITROTOLUENE-OS		55 J					
BENZO(B)FLUORANTHENE						170 J	
BENZO(G,H,I)PERYLENE						90 J	
BENZO(K)FLUORANTHENE						110 J	
BIS(2-ETHYLHEXYL)PHTHALATE			72 J	640 J			
CHRYSENE						73 J	
DI-N-BUTYL PHTHALATE		470					
INDENO(1,2,3-CD)PYRENE						90 J	
ENERGETICS (µg/kg)							
2,4,6-TRINITROTOLUENE		248000					167
2-AMINO-4,6-DINITROTOLUENE							344
HMX		26700					
RDX		397000					
METALS (mg/kg)							
ANTIMONY	0.69 L	0.40 L	0.38 L		0.47 L	0.79 L	0.24 L
ARSENIC	2.3	2.2	2.3	1.6	2.6	5.6	2.1
BARIUM	111	64.4	44.7	36.6	33.8	33.6	16.5
BERYLLIUM	0.39	0.48	0.41	0.46	0.45	0.73	0.68
CADMIUM	0.27 K	0.53 K	0.30 K	0.23 K	0.46 K	0.93 K	0.39 K
CHROMIUM	10.7	9.0	7.8	6.8	11.3	24.1	10.3
COBALT	7.1	6.5	6.1 J	6.9 J	4.5 J	3.1 J	2.8 J

TABLE 4-4
SUMMARY OF POSITIVE DETECTIONS IN SURFACE SOIL FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN6SS0140101-D	RN6SS0150101	RN6SS0160101	RN6SS0170101	RN6SS0180101	RN6SS0180101-D	RN6SS0190101
SAMPLE DATE:	06/25/97	06/25/97	07/09/97	07/09/97	07/10/97	07/10/97	07/10/97
LOCATION:	RN6DUP003	RN6SS0150101	RN6SS0160101	RN6SS0170101	RN6SS0180101	RN6DUP007	RN6SS0190101
FIELD DUPLICATE OF:	RN6SS0140101					RN6SS0180101	
METALS (mg/kg)							
COPPER	7.3	19.1	8.5	6.6	62.5	47.8	34.1
LEAD	19.6 K	16.2 K	9.8	6.3	9.9	9.7	10.7
MERCURY		0.72	0.21	0.03	0.05	0.18	0.28
NICKEL	6.6	6.9	6.7	5.7	9.6	9.3	4.4
SELENIUM	0.69 L	0.77 L	0.62	0.47	1.1	2.3	0.57
TIN	9.0						
VANADIUM	18.1	21.4	14.7	12.0	20.9	30.3	14.7
ZINC	25.6	30.8	18.3	14.8	47.4	76.2	25.4

TABLE 4-4
SUMMARY OF POSITIVE DETECTIONS IN SURFACE SOIL FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN6SS0190101-D						
SAMPLE DATE:	07/10/97	/ /	/ /	/ /	/ /	/ /	/ /
LOCATION:	RN6DUP008						
FIELD DUPLICATE OF:	RN6SS0190101						
ENERGETICS (µg/kg)							
2,4,6-TRINITROTOLUENE	735						
2-AMINO-4,6-DINITROTOLUENE	4400						
METALS (mg/kg)							
ANTIMONY	0.52 L						
ARSENIC	2.7						
BARIUM	52.2						
BERYLLIUM	0.58						
CADMIUM	0.63 K						
CHROMIUM	12.6						
COBALT	4.5 J						
COPPER	31.4						
LEAD	20.1						
MERCURY	1.4						
NICKEL	8.0						
SELENIUM	1.1						
VANADIUM	24.6						
ZINC	43.8						

TABLE 4-5
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN6SB0010101	RN6SB0020101	RN6SB0030101	RN6SB0040101	RN6SB0050101	RN6SB0060101	RN6SB0060101-D
SAMPLE DATE:	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97
LOCATION:	RN6SB0010101	RN6SB0020101	RN6SB0030101	RN6SB0040101	RN6SB0050101	RN6SB0060101	RN6DUP001
FIELD DUPLICATE OF:							RN6SB0060101
VOLATILES (µg/kg)							
1,1,1-TRICHLOROETHANE					1 J		
ACETONE					97		
METHYLENE CHLORIDE	37	30	22	51	44	73	70
SEMIVOLATILES (µg/kg)							
2,4-DINITROTOLUENE-OS					190 J	74 J	
BIS(2-ETHYLHEXYL)PHTHALATE			41 J		110 J	38 J	
DI-N-BUTYL PHTHALATE	84 J	40 J			370 J		
DI-N-OCTYL PHTHALATE					110 J	47 J	
DIETHYL PHTHALATE	52 J		57 J				
ENERGETICS (µg/kg)							
2,4,6-TRINITROTOLUENE		19200	422	2820	1010	3570	3410
2,4-DINITROTOLUENE-EXP		216		630	306	955	984
2-AMINO-4,6-DINITROTOLUENE		2000	594	2930	1750	11600	10400
HMX		586		756		3010	2920
RDX		301		1160		7270	8720
METALS (mg/kg)							
ANTIMONY	0.59 L	2.0 L	0.51 L	0.48 L	0.55 L		
ARSENIC	2.6	3.3	3.4	5.3	3.0		
BARIUM	26.2	25.6	23.3	25.7	27.5		
BERYLLIUM	0.28	0.38	0.27	0.27	0.29		
CADMIUM	1.3	0.80 K	0.73 K	1.0	1.1		
CHROMIUM	9.3	20.5	16.3	21.6	18.8		
COBALT	4.8	5.6	3.3	4.3	3.2		

TABLE 4-5
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN6SB0010101	RN6SB0020101	RN6SB0030101	RN6SB0040101	RN6SB0050101	RN6SB0060101	RN6SB0060101-D
SAMPLE DATE:	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97
LOCATION:	RN6SB0010101	RN6SB0020101	RN6SB0030101	RN6SB0040101	RN6SB0050101	RN6SB0060101	RN6DUP001
FIELD DUPLICATE OF:							RN6SB0060101
METALS (mg/kg)							
COPPER	60.4	28.5	69.4	19.5	70.3		
LEAD	36.8	28.8	28.8	12.1	47.1		
MERCURY	0.16	0.03	0.16	0.13	0.24		
NICKEL	4.6	8.4	4.9	7.6	5.8		
SELENIUM	0.81	1.1	0.95	1.2	0.99		
VANADIUM	15.4	19.6	21.5	27.8	21.5		
ZINC	36.6	28.2	26.7	23.4	34.9		

TABLE 4-5
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN6SB0070101	RN6SB0080101	RN6SB0090101	RN6SB0100101	RN6SB0110101	RN6SB0110101-D	RN6SB0120101
SAMPLE DATE:	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97
LOCATION:	RN6SB0070101	RN6SB0080101	RN6SB0090101	RN6SB0100101	RN6SB0110101	RN6DUP002	RN6SB0120101
FIELD DUPLICATE OF:						RN6SB0110101	
VOLATILES (µg/kg)							
1,1,1-TRICHLOROETHANE						1 J	
METHYLENE CHLORIDE	42	24					
TETRACHLOROETHENE		1 J					
TRICHLOROFLUOROMETHANE		1 J	2 J				
SEMIVOLATILES (µg/kg)							
2,4-DINITROTOLUENE-OS	140 J						
2,6-DINITROTOLUENE	290 J						
DI-N-BUTYL PHTHALATE						56 J	38 J
ENERGETICS (µg/kg)							
2,4,6-TRINITROTOLUENE	6320				217	175	
2,4-DINITROTOLUENE-EXP	5790						
2-AMINO-4,6-DINITROTOLUENE	1170						
HMX	740						
RDX	5430						
METALS (mg/kg)							
ANTIMONY	0.41 L	0.28 L	0.40 L	0.32 L	0.23 L	0.29 L	
ARSENIC	3.2	2.4	4.2	2.9	1.3	0.98	1.3
BARIUM	24.3	29.6	37.7	46.5	21.7	16.4	25.0
BERYLLIUM	0.84	0.67	0.28	0.39			
CADMIUM	0.66 K	0.34 K	0.42 K		0.20 K	0.19 K	0.19 K
CHROMIUM	20.7	15.1	12.8	10.3	5.4	4.0	5.5
COBALT	2.8	3.2	4.4	8.0	7.6	4.4	4.3
COPPER	39.2	17.0	9.2				

TABLE 4-5
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN6SB0070101	RN6SB0080101	RN6SB0090101	RN6SB0100101	RN6SB0110101	RN6SB0110101-D	RN6SB0120101
SAMPLE DATE:	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97	06/25/97
LOCATION:	RN6SB0070101	RN6SB0080101	RN6SB0090101	RN6SB0100101	RN6SB0110101	RN6DUP002	RN6SB0120101
FIELD DUPLICATE OF:						RN6SB0110101	
METALS (mg/kg)							
LEAD	19.5	38.1	6.2	5.5	3.1 K	2.8 K	3.5 K
MERCURY	0.02	0.09	0.03	0.03	0.01	0.01	
NICKEL	5.1	6.9	5.4	8.4	4.0	3.5	3.9
SELENIUM	1.0	0.86	0.87	0.66	0.44 L	0.40 L	0.52 L
VANADIUM	23.4	28.1	24.9	18.8	9.2	6.8	9.5
ZINC	36.5	23.8	26.4	20.9	11.0	8.2	10.2

TABLE 4-5
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN6SB0130101	RN6SB0140101	RN6SB0150101	RN6SB0160101	RN6SB0160201	RN6SB0160301	RN6SB0160401
SAMPLE DATE:	06/25/97	06/25/97	06/25/97	07/09/97	07/09/97	07/23/97	07/23/97
LOCATION:	RN6SB0130101	RN6SB0140101	RN6SB0150101	RN6SB0160101	RN6SB0160201	RN6SB0160301	RN6SB0160401
FIELD DUPLICATE OF:							
VOLATILES (µg/kg)							
ACETONE					2700 L		
SEMIVOLATILES (µg/kg)							
BIS(2-ETHYLHEXYL)PHTHALATE				140 J		110 J	490 J
DI-N-BUTYL PHTHALATE	41 J	100 J	48 J	370 J			
ENERGETICS (µg/kg)							
2,4,6-TRINITROTOLUENE			142				
METALS (mg/kg)							
ANTIMONY	0.39 L	0.35 L	0.28 L	0.32 L	0.64 L		
ARSENIC	2.5	2.5	2.5	1.3	7.8	1.8	2.0
BARIUM	29.6	58.1	50.4	19.6	74.2	16.4	19.1
BERYLLIUM	0.27	0.26	0.29		0.47	0.31 K	0.26 K
CADMIUM	0.22 K	0.22 K	0.24 K	0.25 K	0.73 K	0.13 K	0.16 K
CHROMIUM	10.4	11.5	10.2	4.9	12.8	6.8	6.6
COBALT	7.5	7.7	7.3	5.5 J	6.1 J	4.5	5.5
COPPER	6.1	6.2	6.7	5.6	9.1	4.9	6.1
LEAD	5.1 K	6.7 K	6.0 K	3.5	8.4	3.2 K	3.9 K
MERCURY		0.02		0.01	0.03		0.01
NICKEL	7.5	4.8	6.8	3.7	8.6	4.3	5.6
SELENIUM	0.62 L	0.77 L	0.70 L	0.27	1.6	0.28 L	0.36 L
VANADIUM	17.4	18.2	17.6	8.5	25.7	10.8	10.6
ZINC	19.4	20.2	20.9	10.9	33.3	11.2	12.0

TABLE 4-5
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN6SB0170101	RN6SB0170201	RN6SB0170301	RN6SB0170301-D	RN6SB0170401	RN6SB0180101	RN6SB0180201
SAMPLE DATE:	07/09/97	07/10/97	07/23/97	07/23/97	07/23/97	07/10/97	07/10/97
LOCATION:	RN6SB0170101	RN6SB0170201	RN6SB0170301	RN6DUP012	RN6SB0170401	RN6SB0180101	RN6SB0180201
FIELD DUPLICATE OF:				RN6SB0170301			
VOLATILES (µg/kg)							
ACETONE						26 J	
SEMIVOLATILES (µg/kg)							
BIS(2-ETHYLHEXYL)PHTHALATE	1100 J	160 J			210 J		
METALS (mg/kg)							
ANTIMONY	0.53 L	0.44 L				0.20 L	
ARSENIC	4.3	4.4	2.1	2.0	2.6	3.2	1.6
BARIUM	27.4	56.6	14.2	20.7	45.9	6.8	6.6
BERYLLIUM	0.41	0.57		0.24 K	0.39 K		0.63
CADMIUM	0.48 K	0.47 K	0.15 K	0.16 K		0.17 K	0.85 K
CHROMIUM	13.4	19.5	6.1	6.3	15.6	12.4	5.7
COBALT	10.8 J	3.5 J	5.6	7.8	4.6	3.4 J	0.89 J
COPPER	10.6	15.6	4.6	5.0	9.1		
LEAD	6.6	11.2	3.8 K	4.1 K	8.9 K	2.3	1.7
MERCURY	0.02	0.05	0.01		0.06	0.02	
NICKEL	8.1	10.5	5.2	5.4	8.5	1.6	1.2
SELENIUM	1.2	0.97	0.28 L	0.31 L	0.72 L	0.44	0.58
VANADIUM	23.0	31.1	9.4	10.5	20.2	7.5	3.7
ZINC	22.4	38.4	10.4	12.5	30.7	8.3	7.1

TABLE 4-5
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER: SAMPLE DATE: LOCATION: FIELD DUPLICATE OF:	RN6SB0190101 07/10/97 RN6SB0190101	RN6SB0190201 07/10/97 RN6SB0190201	/ /	/ /	/ /	/ /	/ /
VOLATILES (µg/kg)							
ACETONE	69 J	67 J					
CARBON DISULFIDE		8					
SEMIVOLATILES (µg/kg)							
2,4-DINITROTOLUENE-OS	840 J						
2,6-DINITROTOLUENE	63 J						
BIS(2-ETHYLHEXYL)PHTHALATE	130 J						
DI-N-BUTYL PHTHALATE	1500 J						
N-NITROSODIPHENYLAMINE	110 J						
ENERGETICS (µg/kg)							
2,4,6-TRINITROTOLUENE	191						
2-AMINO-4,6-DINITROTOLUENE	186						
RDX	162						
METALS (mg/kg)							
ANTIMONY	0.29 L	0.40 L					
ARSENIC	3.0	2.8					
BARIUM	30.8	17.5					
BERYLLIUM	0.55	0.32					
CADMIUM	0.38 K	0.28 K					
CHROMIUM	14.5	8.9					
COBALT	2.9 J	5.0 J					
COPPER	21.5	7.5					
LEAD	42.6	5.4					
MERCURY	0.79	0.04					

TABLE 4-5
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN6SB0190101	RN6SB0190201	/ /	/ /	/ /	/ /	/ /
SAMPLE DATE:	07/10/97	07/10/97					
LOCATION:	RN6SB0190101	RN6SB0190201					
FIELD DUPLICATE OF:							
METALS (mg/kg)							
NICKEL	6.4	5.1					
SELENIUM	1.1	0.50					
VANADIUM	25.1	13.8					
ZINC	22.0	14.0					

TABLE 4-6
SUMMARY OF POSITIVE DETECTIONS IN GROUNDWATER FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	5GW01	5GW01F	RN6MW002U001	RN6MW002F001	RN6MW003U001	RN6MW003U001-D	RN6MW003F001
SAMPLE DATE:	08/03/97	08/03/97	08/04/97	08/04/97	08/04/97	08/04/97	08/04/97
LOCATION:	5GW01	5GW01F	RN6MW002U001	RN6MW002F001	RN6MW003U001	RN6DUP002	RN6MW003F001
FIELD DUPLICATE OF:						RN6MW003U001	
SEMIVOLATILES (µg/L)							
BIS(2-ETHYLHEXYL)PHTHALATE					1 J	3 J	
DI-N-BUTYL PHTHALATE			1 J			1 J	
ENERGETICS (µg/L)							
1,3,5-TRINITROBENZENE					0.6 J	0.6 K	
2,4,6-TRINITROTOLUENE					43.4	44.1 K	
2,4-DINITROTOLUENE-EXP					1.9	1.8 K	
2-AMINO-4,6-DINITROTOLUENE	2.8				57.7	58.7 K	
4-NITROTOLUENE					1.8	1.7 K	
HMX					38.3	41.2 K	
RDX					336 J	352 K	
METALS (mg/L)							
ARSENIC	16.4 L		3.0 L				
BARIUM	307		57.5		12.5	12.1	
CHROMIUM	55.7		4.8				
COBALT	47.8		2.4		2.0	1.6	
COPPER	54.5						
LEAD	33.0				1.4		
MERCURY	0.23				0.17	0.17	
NICKEL	28.7						
VANADIUM	75.7		5.2				
ZINC			2.7		5.1	3.8	
DISSOLVED METALS (µg/L)							
ARSENIC, FILTERED		9.0 L		2.8 L			

TABLE 4-6
SUMMARY OF POSITIVE DETECTIONS IN GROUNDWATER FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	5GW01	5GW01F	RN6MW002U001	RN6MW002F001	RN6MW003U001	RN6MW003U001-D	RN6MW003F001
SAMPLE DATE:	08/03/97	08/03/97	08/04/97	08/04/97	08/04/97	08/04/97	08/04/97
LOCATION:	5GW01	5GW01F	RN6MW002U001	RN6MW002F001	RN6MW003U001	RN6DUP002	RN6MW003F001
FIELD DUPLICATE OF:						RN6MW003U001	
DISSOLVED METALS (µg/L)							
BARIUM, FILTERED		189		60.8			11.8
CHROMIUM, FILTERED				4.7			
COBALT, FILTERED		33.0		2.6			1.3
COPPER, FILTERED				3.5			
MERCURY, FILTERED							0.14
NICKEL, FILTERED		1.8					
VANADIUM, FILTERED				4.7			
ZINC, FILTERED				4.2			4.9
MISCELLANEOUS PARAMETERS (mg/L)							
TOTAL ORGANIC CARBON	17						

TABLE 4-6
SUMMARY OF POSITIVE DETECTIONS IN GROUNDWATER FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN6MW003F001-D	RN6MW004F001	RN6MW004U001	RN6MW005F001	RN6MW005U001		
SAMPLE DATE:	08/04/97	08/05/97	08/05/97	08/04/97	08/04/97	/ /	/ /
LOCATION:	RN6DUP002-F	RN6MW004F001	RN6MW004U001	RN6MW005F001	RN6MW005U001		
FIELD DUPLICATE OF:	RN6MW003F001						
SEMIVOLATILES (µg/L)							
BIS(2-ETHYLHEXYL)PHTHALATE					6 J		
DI-N-BUTYL PHTHALATE					1 J		
METALS (mg/L)							
ARSENIC					19.1 L		
BARIUM			63.7		624		
BERYLLIUM					7.8		
CADMIUM					9.8		
CHROMIUM			21.5		97.0		
COBALT			4.2		641		
COPPER			12.6		78.7		
LEAD			10.1		46.0		
MERCURY			0.14		0.17		
NICKEL			7.5		77.6		
SELENIUM			2.5 K		14.1		
VANADIUM			32.7		120		
ZINC			30.8		254		
DISSOLVED METALS (µg/L)							
BARIUM, FILTERED	12.2	5.1		4.0			
COBALT, FILTERED	1.7	1.0		2.5			
COPPER, FILTERED				3.8			
LEAD, FILTERED				1.4			
MERCURY, FILTERED	0.15	0.14					
ZINC, FILTERED	7.6			7.3			

TABLE 4-7
SUMMARY OF POSITIVE DETECTIONS IN SURFACE WATER FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN6SW0010001	RN6SW0020001	RN6SW0030001	RN6SW0040001			
SAMPLE DATE:	06/26/97	06/26/97	06/26/97	06/26/97	/ /	/ /	/ /
LOCATION:	RN6SW0010001	RN6SW0020001	RN6SW0030001	RN6SW0040001			
FIELD DUPLICATE OF:							
METALS (µg/L)							
BARIUM	36.7	34.4	38.1	37.1			
COPPER	5.2	3.4	3.7	3.4			
VANADIUM	2.6	2.3	2.6	2.7			
ZINC	7.8	6.5	7.6	8.2			

TABLE 4-8
SUMMARY OF POSITIVE DETECTIONS IN SEDIMENT FOR SMWU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN6SD0010001	RN6SD0020001	RN6SD0030001	RN6SD0040001			
SAMPLE DATE:	06/26/97	06/26/97	06/26/97	06/26/97	/ /	/ /	/ /
LOCATION:	RN6SD0010001	RN6SD0020001	RN6SD0030001	RN6SD0040001			
FIELD DUPLICATE OF:							
SEMIVOLATILES (µg/kg)							
BENZO(A)ANTHRACENE	71 J						
BENZO(A)PYRENE	60 J						
BENZO(B)FLUORANTHENE	100 J						
CHRYSENE	56 J						
DI-N-BUTYL PHTHALATE		160 J		390			
DI-N-OCTYL PHTHALATE		95 J					
FLUORANTHENE	77 J						
PYRENE	63 J						
METALS (mg/kg)							
ANTIMONY	0.29 L						
ARSENIC	3.0	0.84 L	0.47 L	0.97 L			
BARIUM	24.1 J	7.7 J	6.5 J	10.3 J			
BERYLLIUM	0.31						
CADMIUM	0.80	0.40	0.22	0.33			
CHROMIUM	10.9 J	7.2 J	10.2 J	3.6 J			
COBALT	3.3	1.0	0.72	0.67			
COPPER	50.5	11.1	2.2	3.3			
LEAD	28.0	9.4	2.4	2.5			
MERCURY	0.12	0.11	0.13	0.02			
NICKEL	6.6	2.3	12.8	2.7			
SELENIUM	0.96 J	0.52 J	0.35 J	0.37 J			
VANADIUM	17.4	6.8	3.0	3.5			
ZINC	43.5	15.8	7.5	9.3			

TABLE 4-9

COMPARISON OF SURFACE SOILS AND SUBSURFACE SOILS DATA FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	SURFACE SOIL				SUBSURFACE SOIL			
	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum
Volatile Organic Compounds (µg/kg)								
1,1,1-Trichloroethane	ND	ND	ND	ND	2/27	1	1	RN6SB0050101/RN6SB0110101-D
4-Methyl-2-pentanone	1/19	1.5	1.50	S5-MW01-01	ND	ND	ND	ND
Acetone	3/19	81-130	103.67	RN6SS0070101	5/27	26-2700	591.80	RN6SB0160201
Carbon disulfide	ND	ND	ND	ND	1/27	8	8.00	RN6SB0190201
Chloroform	1/19	2.5	2.50	S5-MW01-01	1/27	1.1-3.5	2.30	S5-MW01-02-D
Ethylbenzene	2/19	1	1.00	SS0070101, RN6SS008	ND	ND	ND	ND
Methylene chloride	7/19	19-77	38.29	RN6SS0070101	8/27	22-73	40.19	RN6SB0060101
Tetrachloroethene	ND	ND	ND	ND	1/27	1	1.00	RN6SB0080101
Toluene	1/19	0.3	0.30	S5-MW01-01	1/27	1.3	1.30	S5-MW01-02-D
Trichlorofluoromethane	2/19	1-2	1.50	RN6SS0090101	2/27	1-2	1.50	RN6SB0090101
Semivolatile Organic Compounds (µg/kg)								
2,4-Dinitrotoluene	6/19	55-9300	2510.00	RN6SS0050101	6/27	216-5790	1458.58	RN6SB0070101
2,6-Dinitrotoluene	3/19	120-500	250.00	RN6SS0050101	2/27	63-290	176.50	RN6SB0070101
Benzo(a)anthracene	2/19	44-97	70.50	RN6SS0090101	ND	ND	ND	ND
Benzo(a)pyrene	1/19	73	73.00	RN6SS0090101	ND	ND	ND	ND
Benzo(b)fluoranthene	2/19	170	170.00	S0090101, RN6SS0180	ND	ND	ND	ND
Benzo(g,h,i)perylene	1/19	90	90.00	RN6SS0180101-D	ND	ND	ND	ND
Benzo(k)fluoranthene	1/19	110	110.00	RN6SS0180101-D	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	1/19	72	72.00	RN6SS0160101	10/27	41-1100	260.25	RN6SB0170101
Chrysene	3/19	51-130	84.67	RN6SS0090101	ND	ND	ND	ND
Di-n-butyl phthalate	8/19	48-6500	1300.13	RN6SS0050101	10/27	38-1500	264.70	RN6SB0190101
Di-n-octyl phthalate	ND	ND	ND	ND	2/27	47-110	78.50	RN6SB0050101
Diethyl phthalate	ND	ND	ND	ND	2/27	52-57	54.50	RN6SB0030101
Fluoranthene	1/19	220	220.00	RN6SS0090101	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	1/19	90	90.00	RN6SS0180101-D	ND	ND	ND	ND
N-nitrosodiphenylamine	2/19	90-380	235.00	RN6SS0050101	1/27	110	110.00	RN6SB0190101
Phenanthrene	1/19	130	130.00	RN6SS0090101	ND	ND	ND	ND
Pyrene	2/19	63-310	186.50	RN6SS0090101	ND	ND	ND	ND
Explosives (µg/kg)								
2,4,6-Trinitrotoluene	13/19	139-248000	22253.15	RN6SS0150101	10/27	142-19200	3522.10	RN6SB0020101
2-Amino-4,6-dinitrotoluene	11/19	324-16000	2899.41	RN6SS0070101	8/27	186-11600	2523.75	RN6SB0060101
HMX	7/19	454-26700	8251.21	RN6SS0150101	5/27	511-3010	1111.60	RN6SB0060101
RDX	10/19	243-397000	51804.80	RN6SS0150101	6/27	162-8720	3066.33	RN6SB0060101-D
Inorganics (mg/kg)								
Aluminum	1/1	5880-6290	6085.00	S5-MW01-01	1/1	6130	6130.00	S5-MW01-02
Antimony	18/19	0.23-1.9	0.53	RN6SS0020101	22/26	0.20-2.0	0.49	RN6SB0020101

TABLE 4-9

COMPARISON OF SURFACE SOILS AND SUBSURFACE SOILS DATA FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	SURFACE SOIL				SUBSURFACE SOIL			
	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum
Arsenic	19/19	1.2-5.6	2.78	RN6SS0180101-D	27/27	1.14-7.8	3.03	RN6SB0160201
Barium	19/19	16.5-111	39.94	RN6SS0140101-D	27/27	6.6-74.2	30.84	RN6SB0160201
Beryllium	18/19	0.19-0.98	0.40	RN6SS0080101	23/27	0.26-0.84	0.40	RN6SB0070101
Cadmium	19/19	0.21-2.1	0.88	RN6SS0040101	25/27	0.13-1.3	0.54	RN6SB0010101
Calcium	ND	ND	ND	ND	1/1	126	126.00	S5-MW01-02
Chromium	19/19	5-24.1	12.58	RN6SS0180101-D	27/27	4.7-21.6	12.55	RN6SB0040101
Cobalt	19/19	2.8-10.4	5.29	RN6SS0080101	27/27	0.89-10.8	5.01	RN6SB0170101
Copper	19/19	6.8-217	50.87	RN6SS0080101	22/27	4.9-96.8	24.73	RN6SB0060101-D
Iron	1/1	14300-14400	14350.00	S5-MW01-01-D	1/1	12900	12900.00	S5-MW01-02
Lead	19/19	5.3-181	39.52	RN6SS0070101	27/27	1.7-59.4	16.17	RN6SB0060101-D
Magnesium	1/1	281-323	302.00	S5-MW01-01	1/1	377	377.00	S5-MW01-02
Manganese	1/1	82.6-89.9	86.25	S5-MW01-01-D	1/1	97.4	97.40	S5-MW01-02
Mercury	19/19	0.02-1.6	0.30	RN6SS0090101	22/27	0.01-0.79	0.12	RN6SB0190101
Nickel	19/19	4.2-20.9	7.25	RN6SS0080101	27/27	1.2-12.1	6.13	RN6SB0060101
Potassium	1/1	257-311	284.00	S5-MW01-01	1/1	307	307.00	S5-MW01-02
Selenium	18/19	0.54-2.3	0.88	RN6SS0180101-D	27/27	0.17-1.6	0.76	RN6SB0160201
Silver	1/19	0.22-0.27	0.25	S5-MW01-01	1/27	0.22	0.22	S5-MW01-02
Tin	2/19	6.1-9	5.75	RN6SS0140101-D	ND	ND	ND	ND
Vanadium	19/19	9.4-30.3	19.15	RN6SS0180101-D	27/27	3.7-31.1	18.19	RN6SB0170201
Zinc	19/19	16.6-446	62.67	RN6SS0090101	27/27	7.1-54.1	23.31	RN6SB0060101-D
Miscellaneous (mg/kg)								
Ammonia	1/1	16.1-21.6	18.85	S5-MW01-01-D	1/1	23.1	23.10	S5-MW01-02
Nitrate/nitrite	1/1	3-3.8	3.40	S5-MW01-01	1/1	3	3.00	S5-MW01-02
Total organic carbon	1/1	1400-2770	2085.00	S5-MW01-01-D	1/1	2540	2540.00	S5-MW01-02

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.

TABLE 4-10

SUMMARY OF POSITIVE DETECTS IN GROUNDWATER
SWMU 5 - RANGE 6 FROM CTO 222 VI REPORT
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Parameter[1]		Monitoring Well 5MW01[2]
VOLATILE ORGANICS		
NOT DETECTED		
SEMIVOLATILE ORGANICS (µg/L)		
2,4-Dinitrotoluene[3]		**6.0/6.7**
2,6-Dinitrotoluene		1.4^{U}/**2.5**
3-Nitroaniline		**6.6^{J}/7.3^{J}**
Bis(2-ethylhexyl)phthalate		**1.8^{J}/1.6^{J}**
ENERGETICS (µg/L)		
1,3-Dinitrobenzene		**4.4^{J}/4.5^{J}**
2-Amino-4,6-dinitrotoluene		**4230^{J}/4700^{J}**
2,4-Dintrotoluene[3]		**17.3^{J}/16.2^{J}**
2,4,6-Trinitrotoluene		**242^{J}/173^{J}**
Nitroguanidine (NQ)		**42.1/50.2**
RDX		**658^{J}/426^{J}**
INORGANICS (µg/L)		
Aluminum	U	**7980^{J}/12600^{J}**
	F	110^{UL}/110^{UL}
Barium	U	**98.1/131**
	F	**43.7/42.0**
Calcium	U	**9830^{K}/10400**
	F	**10200/10600**
Chromium	U	**16.0^{L}/29.6**
	F	10.0^{UL}/10.0^{UL}
Cobalt	U	**28.1/31.8**
	F	**22.2/18.7**
Copper	U	**32.9/40.8**
	F	15.0^{U}/15.0^{U}
Iron	U	**19600/29000**
	F	**6900/6320**
Lead	U	**27.3/19.1**
	F	0.6^{U}/0.6^{U}
Magnesium	U	**8930^{K}/9700^{K}**
	F	**9930^{K}/9840^{K}**
Manganese	U	**1360/1400**
	F	**1600/1610**
Mercury	U	0.29^{B}/0.34^{B}
	F	0.10^{U}/**0.12**
Potassium	U	**3990/4110**
	F	**3760/3870**
Sodium	U	**18600/18700**
	F	**20100/20700**
Thallium	U	2.5^{UJ}/2.5^{UJ}
	F	2.5^{U}/**2.6^{K}**
Vanadium	U	**25.8/43.8**
	F	22.0^{U}/22.0^{U}
Zinc	U	**79.8**/64.4^{B}
	F	**18.5/19.2**

TABLE 4-11

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT
SURFACE SOIL (0 TO 2 FEET) SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tol. Limit for Background	Greater Than Background?	SSL Transfe from Soil to Air (5)	Selected as COPC?
					Industrial	Residential					
Volatile Organic Compounds (µg/kg)											
4-Methyl-2-pentanone	1/19	1.5	1.50	S5-MW01-01	16000000	630000	N	ND (6)	Yes (7)	(8)	No
Acetone	3/19	81-130	103.67	RN6SS0070101	20000000	780000	N	13000	No	100000000	No
Chloroform	1/19	2.5	2.50	S5-MW01-01	940000	100000	C	ND	Yes (7)	300	No
Ethylbenzene	2/19	1	1.00	N6SS0070101, RN6SS00801	2000000	780000	N	ND	Yes (7)	400000	No
Methylene chloride	7/19	19-77	38.29	RN6SS0070101	760000	85000	C	ND	Yes (7)	13000	No
Toluene	1/19	0.3	0.30	S5-MW01-01	41000000	1600000	N	ND	Yes (7)	650000	No
Trichlorofluoromethane	2/19	1-2	1.50	RN6SS0090101	61000000	2300000	N	ND	Yes (7)	-	No
Semivolatile Organic Compounds (µg/Kg)											
2,4-Dinitrotoluene	6/19	51.6-1800	407.00	RN6SS0020101	410000	16000	N	ND	Yes (7)	-	No
2,6-Dinitrotoluene	3/19	120-500	250.00	RN6SS0050101	200000	7800	N	ND	Yes (7)	-	No
Benzo(a)anthracene	2/19	44-97	70.50	RN6SS0090101	7800	880	C	ND	Yes (7)	-	No
Benzo(a)pyrene	1/19	73	73.00	RN6SS0090101	780	88	C	ND	Yes (7)	-	No
Benzo(b)fluoranthene	2/19	170	170.00	6SS0090101, RN6SS018010	7800	880	C	ND	Yes (7)	-	No
Benzo(g,h,i)perylene	1/19	90	90.00	RN6SS0180101-D	-	-	-	ND	Yes (7)	-	No (9)
Benzo(k)fluoranthene	1/19	110	110.00	RN6SS0180101-D	78000	8800	C	ND	Yes (7)	-	No
Bis(2-ethylhexyl)phthalate	1/19	72	72.00	RN6SS0160101	410000	46000	C	640	No	31000000	No
Chrysene	3/19	51-130	84.67	RN6SS0090101	780000	88000	C	ND	Yes (7)	-	No
Di-n-butyl Phthalate	8/19	48-6500	1300.13	RN6SS0050101	20000000	780000	N	ND	Yes (7)	2300000	No
Fluoranthene	1/19	220	220.00	RN6SS0090101	8200000	310000	N	ND	Yes (7)	-	No
Indeno(1,2,3-cd)pyrene	1/19	90	90.00	RN6SS0180101-D	7800	880	C	ND	Yes (7)	-	No
N-Nitrosodiphenylamine	2/19	90-380	235.00	RN6SS0050101	1200000	130000	C	ND	Yes (7)	-	No
Phenanthrene	1/19	130	130.00	RN6SS0090101	-	-	-	ND	Yes (7)	-	No (9)
Pyrene	2/19	63-310	186.50	RN6SS0090101	6100000	230000	N	ND	Yes (7)	-	No
Explosives (µg/kg)											
2,4,6-Trinitrotoluene	13/19	139-248000	22253.15	RN6SS0150101	**190000***	**21000**	C	ND	Yes (7)	-	Yes
2-Amino-4,6-dinitrotoluene	11/19	324-16000	2899.41	RN6SS0070101	**12000**	**470**	N	ND	Yes (7)	-	Yes
HMX (10)	7/19	454-26700	8251.21	RN6SS0150101	10000000	390000	N	ND	Yes (7)	-	No
RDX (10)	10/19	243-397000	51804.80	RN6SS0150101	**52000**	**5800**	C	ND	Yes (7)	-	Yes
Inorganics (mg/kg)										-	
Aluminum	1/1	5880-6290	6085.00	S5-MW01-01	100000	7800	N	18329	No	-	No
Antimony	18/18	0.23-1.9	0.53	RN6SS0020101	82	3.1	N	ND	Yes (7)	-	No
Arsenic	19/19	1.2-5.6	2.78	RN6SS0180101-D	**3.8**	**0.43**	C	4.25	Yes	750	Yes
Barium	19/19	16.5-111	39.94	RN6SS0140101-D	14000	550	N	144	No	690000	No
Beryllium	18/19	0.19-0.98	0.40	RN6SS0080101	1.3	**0.15**	C	0.905	Yes	1300	No
Cadmium	19/19	0.21-2.1	0.88	RN6SS0040101	100	3.9	N	0.26	Yes	1800	No
Chromium (11)	19/19	5-24.1	12.58	RN6SS0180101-D	1000	39	N	24.2	No	270	No
Cobalt	19/19	2.8-10.4	5.29	RN6SS0080101	12000	470	N	39.7	No	-	No

TABLE 4-10

SUMMARY OF POSITIVE DETECTS IN GROUNDWATER
SWMU 5 - RANGE 6 FROM CTO 222 VI REPORT
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Parameter[1]	Monitoring Well 5MW01[2]
INDICATOR PARAMETERS	
Ammonia (mg/L)	**1.9/1.8**
Nitrate + Nitrite (mg/L)	0.05^{UL}/0.05^{UL}
Sulfate (mg/L)	**38.5^{L}/38.5^{L}**
Total Kjeldahl Nitrogen (mg/L)	**2.2^{L}/1.9^{L}**
Total Organic Carbon (mg/L)	**5.6/4.2**
Total Organic Halides (mg/L)	**43.0^{L}/23.8^{L}**
Total Phosphorus (mg/L)	**0.37/0.12**

NOTE: All positive detections have been bolded.

1 U - Unfiltered sample
F - Filtered sample

2 Duplicate samples taken from this location.
3 Analytical results for 2,4-Dinitrotoluene are available from analyses for energetics and from analyses for semivolatile organics.

B Positive result qualified as a result of method or field quality control blank contamination. Compound is not considered to be present in sample.
J Positive detection is qualified as an estimate.
K Positive detection is qualified as biased high.
L Positive result is qualified as biased low
U Analyte not detected. Reported result is the detection limit.
UJ Analyte not detected. Reported result is the estimated detection limit.
UL Nondetect of analyte considered biased low.

TABLE 4-11

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT
SURFACE SOIL (0 TO 2 FEET) SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tol. Limit for Background	Greater Than Background?	SSL Transfe from Soil to Air (5)	Selected as COPC?
					Industrial	Residential					
Copper	19/19	6.8-217	50.87	RN6SS0080101	8200	310	N	18.7	Yes	-	No
Iron	1/1	4300-1440	14350.00	S5-MW01-01-D	61000	**2300**	N	43170	No	-	No
Lead	19/19	5.3-181	39.52	RN6SS0070101	2000 (12)	400 (12)	N	149	Yes	-	No
Magnesium	1/1	281-323	302.00	S5-MW01-01	-	-	-	1382	No	-	No (13)
Manganese	1/1	82.6-89.9	86.25	S5-MW01-01-D	4700	180	N	2248	No	-	No
Mercury	19/19	0.02-1.6	0.30	RN6SS0090101	61	2.3	N	0.087	Yes	10	No
Nickel	19/19	4.2-20.9	7.25	RN6SS0080101	4100	160	N	18.2	Yes	13000	No
Potassium	1/1	257-311	284.00	S5-MW01-01	-	-	-	1874	No	-	No (13)
Selenium	18/19	0.54-2.3	0.88	RN6SS0180101-D	1000	39	N	1.09	Yes	-	No
Silver	1/19	0.22-0.27	0.25	S5-MW01-01	1000	39	N	ND	Yes (7)	-	No
Tin	2/19	6.1-9	5.75	RN6SS0140101-D	100000	4700	N	ND	Yes (7)	-	No
Vanadium	19/19	9.4-30.3	19.15	RN6SS0180101-D	1400	55	N	53.5	No	-	No
Zinc	19/19	16.6-446	62.67	RN6SS0090101	61000	2300	N	38.1	Yes	-	No
Miscellaneous (mg/kg)											
Ammonia	1/1	16.1-21.6	18.85	S5-MW01-01-D	-	-	-	49.9	No	-	No
Nitrate/Nitrite	1/1	3-3.8	3.40	S5-MW01-01	-	-	-	1.9	Yes	-	No
Total Organic Carbon	1/1	1400-2770	2085.00	S5-MW01-01-D	-	-	-	30695	No	-	No

* Screening level exceeded by maximum site concentration.

1 Statistics calculated considering a duplicate pair as one data point.

2 Duplicate samples are considered as individual data points.

3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.

4 N = noncarcinogenic basis; C = carcinogenic basis.

5 Soil Screening Levels (SSLs) for transfers from soil to air (USEPA, 1996) included for qualitative evaluation only.

6 ND = not detected; NA = not applicable.

7 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
Organic background data presented for information purposes, but not for COPC selection.

8 Data not available.

9 Sufficient toxicity criteria not available; maximum concentration below screening levels of related chemicals (naphthalene, fluoranthene,fluorene).

10 HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine; RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine.

11 Considered as hexavalent chromium.

12 OSWER screening level for lead in soil (USEPA, 1993).

13 Essential nutrient, eliminated from further consideration.

TABLE 4-12

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT
ALL SOIL - SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tolerance Limit for Background		Greater Than Background?	SSL Transfer from Soil to Air (5)	Selected as COPC?
					Industrial	Residential		Surface	Subsurface			
Volatile Organic Compounds (µg/kg)												
1,1,1-Trichloroethane	2/46	1	1.00	6SB0050101, RN6SB0110101	4100000	160000	N	ND (6)	ND	Yes (7)	1200000	No
4-Methyl-2-pentanone	1/46	1.5	1.50	S5-MW01-01	16000000	630000	N	ND	ND	Yes (7)	(8)	No
Acetone	8/46	26-2700	408.75	RN6SB0160201	20000000	780000	N	13000	1800	Yes	100000000	No
Carbon disulfide	1/46	8	8.00	RN6SB0190201	20000000	780000	N	ND	ND	Yes (7)	720000	No
Chloroform	2/46	1.1-3.5	2.40	S5-MW01-02-D	940000	100000	C	ND	ND	Yes (7)	300	No
Ethylbenzene	2/46	1	1.00	N6SS0070101, RN6SS008010	2000000	780000	N	ND	ND	Yes (7)	400000	No
Methylene chloride	15/46	19-77	39.30	RN6SS0070101	760000	85000	C	ND	ND	Yes (7)	13000	No
Tetrachloroethene	1/46	1	1.00	RN6SB0080101	110000	12000	C	ND	ND	Yes (7)	11000	No
Toluene	1/46	0.3-1.3	0.30	S5-MW01-02-D	41000000	1600000	N	ND	ND	Yes (7)	650000	No
Trichlorofluoromethane	4/46	1-2	1.50	N6SS0090101, RN6SB009010	61000000	2300000	N	ND	ND	Yes (7)	-	No
Semivolatile Organic Compounds (µg/Kg)												
2,4-Dinitrotoluene	12/46	51.6-5790	933.0	RN6SB0070101	410000	16000	N	ND	ND	Yes (7)	-	No
2,6-Dinitrotoluene	5/46	63-500	220.60	RN6SS0050101	200000	7800	N	ND	ND	Yes (7)	-	No
Benzo(a)anthracene	2/46	44-97	70.50	RN6SS0090101	7800	880	C	ND	ND	Yes (7)	-	No
Benzo(a)pyrene	1/46	73	73.00	RN6SS0090101	780	88	C	ND	ND	Yes (7)	-	No
Benzo(b)fluoranthene	2/46	170	170.00	6SS0090101, RN6SS0180101	7800	880	C	ND	ND	Yes (7)	-	No
Benzo(g,h,i)perylene	1/46	90	90.00	RN6SS0180101-D	-	-		ND	ND	Yes (7)	-	No (9)
Benzo(k)fluoranthene	1/46	110	110.00	RN6SS0180101-D	78000	8800	C	ND	ND	Yes (7)	-	No
Bis(2-ethylhexyl)phthalate	11/46	38-1100	243.14	RN6SB0170101	410000	46000	C	640	ND	No	31000000	No
Chrysene	3/46	51-130	84.67	RN6SS0090101	780000	88000	C	ND	ND	Yes (7)	-	No
Di-n-butyl Phthalate	18/46	38-6500	724.89	RN6SS0050101	20000000	780000	N	ND	ND	Yes (7)	2300000	No
Di-n-octyl Phthalate	2/46	47-110	113.00	RN6SB0050101	4100000	160000	N	ND	ND	Yes (7)	10000000	No
Diethyl phthalate	2/46	52-57	54.50	RN6SB0030101	100000000	6300000	N	ND	ND	Yes (7)	-	No
Fluoranthene	1/46	220	220.00	RN6SS0090101	8200000	310000	N	ND	ND	Yes (7)	-	No
Indeno(1,2,3-cd)pyrene	1/46	90	90.00	RN6SS0180101-D	7800	880	C	ND	ND	Yes (7)	-	No
n-Nitrosodiphenylamine	3/46	90-380	193.33	RN6SS0050101	1200000	130000	C	ND	ND	Yes (7)	-	No
Phenanthrene	1/46	130	130.00	RN6SS0090101	-	-		ND	ND	Yes (7)	-	No (9)
Pyrene	2/46	63-310	186.50	RN6SS0090101	6100000	230000	N	ND	ND	Yes (7)	-	No
Explosives (µg/kg)												
2,4,6-Trinitrotoluene	23/46	139-248000	14109.22	RN6SS0150101	**190000***	**21000**	C	ND	ND	Yes (7)	-	Yes
2-Amino-4,6-dinitrotoluene	19/46	186-16000	2741.24	RN6SS0070101	**12000**	**470**	N	ND	ND	Yes (7)	-	Yes
HMX (10)	12/46	454-26700	5276.38	RN6SS0150101	10000000	390000	N	ND	ND	Yes (7)	-	No
RDX (10)	16/46	162-397000	33527.88	RN6SS0150101	**52000**	**5800**	C	ND	ND	Yes (7)	-	Yes
Inorganics (mg/kg)												
Aluminum	2/2	5880-6290	6107.50	S5-MW01-01	100000	7800	N	18329	34406	No	-	No
Antimony	40/45	0.2-2	0.51	RN6SB0020101	82	3.1	N	ND	3.6	No	-	No
Arsenic	46/46	0.98-7.8	2.93	RN6SB0160201	**3.8**	**0.43**	C	4.25	24.4	Yes	750	Yes
Barium	46/46	6.6-111	34.60	RN6SS0140101-D	14000	550	N	144	191	No	690000	No
Beryllium	41/46	0.19-0.98	0.40	RN6SS0080101	1.3	**0.15**	C	0.905	2.46	Yes	1300	No
Cadmium	44/46	0.13-2.1	0.69	RN6SS0040101	100	3.9	N	0.26	0.388	Yes	1800	No
Calcium	1/2	126	126.00	S5-MW01-02	-	-		409	196	No	-	No (11)
Chromium (12)	46/46	4-24.1	12.56	RN6SS0180101-D	1000	39	N	24.2	101	No	270	No
Cobalt	46/46	0.89-10.8	5.13	RN6SB0170101	12000	470	N	39.7	133	No	-	No

TABLE 4-12

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT
ALL SOIL - SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tolerance Limit for Background		Greater Than Background?	SSL Transfer from Soil to Air (5)	Selected as COPC?
					Industrial	Residential		Surface	Subsurface			
Copper	41/46	4.9-217	36.84	RN6SS0080101	8200	310	N	18.7	56.5	Yes	-	No
Iron	2/2	12900-14350	13625.00	S5-MW01-01-D	61000	2300	N	43170	151453	No	-	No
Lead	46/46	1.7-181	25.82	RN6SS0070101	2000 (13)	400 (13)	N	149	37.5	Yes	-	No
Magnesium	2/2	281-377	339.50	S5-MW01-02	-	-		1382	4307	No	-	No (11)
Manganese	2/2	82.6-97.4	91.83	S5-MW01-02	4700	180	N	2248	1270	No	-	No
Mercury	41/46	0.01-1.6	0.20	RN6SS0090101	61	2.3	N	0.087	0.13	Yes	10	No
Nickel	46/46	1.2-20.9	6.59	RN6SS0080101	4100	160	N	18.2	22.1	Yes	13000	No
Potassium	2/2	257-311	295.50	S5-MW01-01	-	-		1874	5998	No	-	No (11)
Selenium	45/46	0.17-2.3	0.81	RN6SS0180101-D	1000	39	N	1.09	8.93	Yes	-	No
Silver	2/46	0.22-0.27	0.23	S5-MW01-01	1000	39	N	ND	0.63	No	-	No
Tin	2/46	6.1-9	5.75	RN6SS0140101-D	100000	4700	N	ND	ND	Yes (7)	-	No
Vanadium	46/46	3.7-31.1	18.59	RN6SB0170201	1400	55	N	53.5	133	No	-	No
Zinc	46/46	7.1-446	39.57	RN6SS0090101	61000	2300	N	38.1	79.5	Yes	-	No
Miscellaneous (mg/kg)												
Ammonia	2/2	16.1-23.1	20.98	S5-MW01-02	-	-	N	49.9	9.5	Yes	-	No
Nitrate/Nitrite	2/2	3-3.8	3.20	S5-MW01-01	-	-	N	1.9	ND	Yes	-	No
Total Organic Carbon	2/2	1400-2770	2312.50	S5-MW01-01-D	-	-		30695	4243	No	-	No

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 Soil Screening Levels (SSLs) for transfers from soil to air (USEPA, 1996) included for qualitative evaluation only.
6 ND = not detected; NA = not applicable.
7 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
Organic background data presented for information purposes, but not for COPC selection.
8 Data not available.
9 Sufficient toxicity criteria not available; maximum concentration below screening levels of related chemicals (naphthalene, fluoranthene,fluorene).
10 HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine; RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine.
11 Essential nutrient, eliminated from further consideration.
12 Considered as hexavalent chromium.
13 OSWER screening level for lead in soil (USEPA, 1993).

TABLE 4-13

SOIL CONCENTRATION VERSUS SOIL SCREENING LEVELS (SSLs) FOR PROTECTION OF GROUNDWATER
ALL SOIL - SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Upper Tolerance Limit for Background		Greater Than Background?	SSL Transfer from Soil to GW-20DAF(3)
					Surface	Subsurface		
Volatile Organic Compounds (µg/kg)								
1,1,1-Trichloroethane	2/46	1	1.00	6SB0050101, RN6SB0110101	ND (4)	ND	Yes (5)	2000
4-Methyl-2-pentanone	1/46	1.5	1.50	S5-MW01-01	ND	ND	Yes (5)	(6)
Acetone	8/46	26-2700	408.75	RN6SB0160201	13000	1800	Yes	16000
Carbon disulfide	1/46	8	8.00	RN6SB0190201	ND	ND	Yes (5)	32000
Chloroform	2/46	1.1-3.5	2.40	S5-MW01-02-D	ND	ND	Yes (5)	600
Ethylbenzene	2/46	1	1.00	N6SS0070101, RN6SS008010	ND	ND	Yes (5)	13000
Methylene chloride	15/46	19-77	39.30	RN6SS0070101	ND	ND	Yes (5)	**20***
Tetrachloroethene	1/46	1	1.00	RN6SB0080101	ND	ND	Yes (5)	60
Toluene	1/46	0.3-1.3	0.30	S5-MW01-02-D	ND	ND	Yes (5)	12000
Trichlorofluoromethane	4/46	1-2	1.50	N6SS0090101, RN6SB009010	ND	ND	Yes (5)	-
Semivolatile Organic Compounds (µg/Kg)								
2,4-Dinitrotoluene	12/46	51.6-5790	933.0	RN6SB0070101	ND	ND	Yes (5)	**1025***
2,6-Dinitrotoluene	5/46	63-500	220.60	RN6SS0050101	ND	ND	Yes (5)	**0.71***
Benzo(a)anthracene	2/46	44-97	70.50	RN6SS0090101	ND	ND	Yes (5)	2000
Benzo(a)pyrene	1/46	73	73.00	RN6SS0090101	ND	ND	Yes (5)	8000
Benzo(b)fluoranthene	2/46	170	170.00	6SS0090101, RN6SS0180101	ND	ND	Yes (5)	5000
Benzo(g,h,i)perylene	1/46	90	90.00	RN6SS0180101-D	ND	ND	Yes (5)	-
Benzo(k)fluoranthene	1/46	110	110.00	RN6SS0180101-D	ND	ND	Yes (5)	49000
Bis(2-ethylhexyl)phthalate	11/46	38-1100	243.14	RN6SB0170101	640	ND	No	3600000
Chrysene	3/46	51-130	84.67	RN6SS0090101	ND	ND	Yes (5)	160000
Di-n-butyl phthalate	18/46	38-6500	724.89	RN6SS0050101	ND	ND	Yes (5)	2300000
Di-n-octyl phthalate	2/46	47-110	113.00	RN6SB0050101	ND	ND	Yes (5)	10000000
Diethyl phthalate	2/46	52-57	54.50	RN6SB0030101	ND	ND	Yes (5)	470000
Fluoranthene	1/46	220	220.00	RN6SS0090101	ND	ND	Yes (5)	4300000
Indeno(1,2,3-cd)pyrene	1/46	90	90.00	RN6SS0180101-D	ND	ND	Yes (5)	14000
n-Nitrosodiphenylamine	3/46	90-380	193.33	RN6SS0050101	ND	ND	Yes (5)	1000
Phenanthrene	1/46	130	130.00	RN6SS0090101	ND	ND	Yes (5)	-
Pyrene	2/46	63-310	186.50	RN6SS0090101	ND	ND	Yes (5)	4200000
Explosives (µg/kg)								
2,4,6-Trinitrotoluene	23/46	139-248000	14109.22	RN6SS0150101	ND	ND	Yes (5)	55.0
2-Amino-4,6-dinitrotoluene	19/46	186-16000	2741.24	RN6SS0070101	ND	ND	Yes (5)	14.2
HMX (7)	12/46	454-26700	5276.38	RN6SS0150101	ND	ND	Yes (5)	7450
RDX (7)	16/46	162-397000	33527.88	RN6SS0150101	ND	ND	Yes (5)	4.9

TABLE 4-13

SOIL CONCENTRATION VERSUS SOIL SCREENING LEVELS (SSLs) FOR PROTECTION OF GROUNDWATER
ALL SOIL - SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Upper Tolerance Limit for Background		Greater Than Background?	SSL Transfer from Soil to GW-20DAF(3)
					Surface	Subsurface		
Inorganics (mg/kg)								
Aluminum	2/2	5880-6290	6107.50	S5-MW01-01	18329	34406	No	-
Antimony	40/45	0.2-2	0.51	RN6SB0020101	ND	3.6	No	5
Arsenic	46/46	0.98-7.8	2.93	RN6SB0160201	4.25	24.4	Yes	29
Barium	46/46	6.6-111	34.60	RN6SS0140101-D	144	191	No	1600
Beryllium	41/46	0.19-0.98	0.40	RN6SS0080101	0.905	2.46	Yes	63
Cadmium	44/46	0.13-2.1	0.69	RN6SS0040101	0.26	0.388	Yes	8
Calcium	1/2	126	126.00	S5-MW01-02	409	196	No	-
Chromium (8)	46/46	4-24.1	12.56	RN6SS0180101-D	24.2	101	No	38
Cobalt	46/46	0.89-10.8	5.13	RN6SB0170101	39.7	133	No	-
Copper	41/46	4.9-217	36.84	RN6SS0080101	18.7	56.5	Yes	-
Iron	2/2	12900-14400	13625.00	S5-MW01-01-D	43170	151453	No	-
Lead	46/46	1.7-181	25.82	RN6SS0070101	149	37.5	Yes	-
Magnesium	2/2	281-377	339.50	S5-MW01-02	1382	4307	No	-
Manganese	2/2	82.6-97.4	91.83	S5-MW01-02	2248	1270	No	-
Mercury	41/46	0.01-1.6	0.20	RN6SS0090101	0.087	0.13	Yes	2
Nickel	46/46	1.2-20.9	6.59	RN6SS0080101	18.2	22.1	Yes	130
Potassium	2/2	257-311	295.50	S5-MW01-01	1874	5998	No	-
Selenium	45/46	0.17-2.3	0.81	RN6SS0180101-D	1.09	8.93	Yes	5
Silver	2/46	0.22-0.27	0.23	S5-MW01-01	ND	0.63	No	34
Tin	2/46	6.1-9	5.75	RN6SS0140101-D	ND	ND	Yes (5)	-
Vanadium	46/46	3.7-31.1	18.59	RN6SB0170201	53.5	133	No	6000
Zinc	46/46	7.1-446	39.57	RN6SS0090101	38.1	79.5	Yes	12000

TABLE 4-13

SOIL CONCENTRATION VERSUS SOIL SCREENING LEVELS (SSLs) FOR PROTECTION OF GROUNDWATER
ALL SOIL - SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Upper Tolerance Limit for Background		Greater Than Background?	SSL Transfer from Soil to GW-20DAF(3)
					Surface	Subsurface		
Miscellaneous (mg/kg)								
Ammonia	2/2	16.1-23.1	20.98	S5-MW01-02	49.9	9.5	Yes	-
Nitrate/Nitrite	2/2	3-3.8	3.20	S5-MW01-01	1.9	ND	No	-
Total Organic Carbon	2/2	1400-2770	2312.50	S5-MW01-01-D	30695	4243	No	-

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Soil Screening Levels (SSLs) for migration from soil to groundwater (USEPA, 1996) corresponding to a dilution and attenuation factor (DAF) of 20.
4 ND = not detected; NA = not applicable.
5 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
Organic background data presented for information purposes, but not for COPC selection.
6 Data not available.
7 HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine; RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine.
8 Considered as hexavalent chromium.

TABLE 4-14A

SELECTION OF CHEMICALS OF POTENTIAL CONCERN
GROUNDWATER, UNFILTERED - SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	UTL for Background (5)	Greater Than Background?	Selected as COPC?
Semivolatile Organic Compounds (µg/L)									
Bis(2-ethylhexyl)phthalate	1/4	1-3	2.00	RN6MW003U001-D	4.8	C	1	Yes	No
Di-n-butyl phthalate	2/4	1	1.00	RN6MW002U001, RN6MW003U001-D	370	N	1	No	No
Explosives (µg/L)									
1,3,5-Trinitrobenzene	1/4	0.6	0.60	RN6MW003U001, RN6MW003U001-D	11	N	ND (6)	Yes (7)	No
2,4,6-Trinitrotoluene	1/4	43.75	43.75	RN6MW003U001-D	**2.2***	C	ND	Yes (7)	Yes
2-Amino-4,6-dinitrotoluene	2/4	2.8-58.2	30.50	RN6MW003U001	**0.2**	N	ND	Yes (7)	Yes
4-Nitrotoluene	1/4	1.75	1.75	RN6MW003U001-D	6.1	N	ND	Yes (7)	No
HMX (8)	1/4	39.75	39.75	RN6MW003U001	180	N	ND	Yes (7)	No
RDX (8)	1/4	344	344.00	RN6MW003U001-D	**0.61**	C	1.2	Yes	Yes
Inorganics (µg/L)									
Antimony	1/4	1.775	1.78	RN6MW003U001-D	**1.5**	N	ND	Yes (7)	Yes
Arsenic	2/4	3-16.4	9.70	5GW01	**0.045**	C	ND	Yes (7)	Yes
Barium	4/4	12.1-307	110.13	5GW01	**260**	N	253.5	Yes	Yes
Chromium (9)	3/4	4.8-55.7	27.33	5GW01	**18**	N	20.9	Yes	Yes
Cobalt	4/4	1.6-47.8	14.05	5GW01	220	N	39.6	Yes	No
Copper	2/4	12.6-54.5	33.55	5GW01	150	N	22.4	Yes	No
Lead	3/4	1.4-33	14.71	5GW01	**15 (9)**	N	ND	Yes (7)	Yes
Mercury	3/4	0.14-0.23	0.18	5GW01	1.1	N	0.13	Yes	No
Nickel	2/4	7.5-28.7	18.10	5GW01	73	N	39	No	No
Selenium	1/4	2.5	2.50	RN6MW004U001	18	N	ND	Yes (7)	No
Vanadium	3/4	5.2-75.7	37.87	5GW01	**26**	N	24.1	Yes	Yes
Zinc	3/4	2.7-30.8	12.65	RN6MW004U001	1100	N	45.2	No	No
Miscellaneous (mg/L)									
Total Organic Carbon	1/1	17	17.00	5GW01	-		45	No	No

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 Only nonturbid background samples included.
6 ND = not detected; NA = not applicable.
7 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background. Organic background data presented for information purposes, but not for COPC selection.
8 HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine; RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine.
9 Considered as hexavalent chromium.
10 Safe Drinking Water Act Action Level.

TABLE 4-14B

SELECTION OF CHEMICALS OF POTENTIAL CONCERN
GROUNDWATER, FILTERED - SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	Upper Tol. Limit for Background	Greater Than Background?
Inorganics (µg/L)								
Arsenic, Filtered	2/4	2.8-9	5.90	5GW01F	**0.045***	C	ND (5)	Yes (6)
Barium, Filtered	4/4	5.1-189	66.73	5GW01F	260	N	114	Yes
Chromium, Filtered (7)	1/4	4.7	4.70	RN6MW002F001	18	N	ND	Yes (6)
Cobalt, Filtered	4/4	1-33	9.53	5GW01F	220	N	13	Yes
Copper, Filtered	1/4	3.5	3.50	RN6MW002F001	150	N	3.8	No
Mercury, Filtered	2/4	0.14-0.15	0.14	RN6MW003F001-D	1.1	N	0.16	No
Nickel, Filtered	1/4	1.8	1.80	5GW01F	73	N	41.4	No
Vanadium, Filtered	1/4	4.7	4.70	RN6MW002F001	26	N	ND	Yes (6)
Zinc, Filtered	2/4	4.2-7.6	5.23	RN6MW003F001-D	1100	N	10.3	No

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6. or a target cancer risk of 1E-6. Unfiltered data and screening levels presented only for qualitative analysis, not for COPC selection.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 ND = not detected; NA = not applicable.
6 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background. Organic background data presented for information purposes, but not for COPC selection.
7 Considered as hexavalent chromium.

TABLE 4-15

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT
SURFACE WATER - SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	Biocon-centration Factor (5)	Estimated Maximum Fish Conc. (6)	Risk-Based Screening Level, Fish (3)	Selected as COPC?
Inorganics (µg/L)										
Barium	4/4	34.4-38.1	36.58	RN6SW0030001	260	N	10 (7)	381	95000	No
Copper	4/4	3.4-5.2	3.93	RN6SW0010001	150	N	36	187.2	4700000	No
Vanadium	4/4	2.3-2.7	2.55	RN6SW0040001	26	N	10 (7)	270	9500	No
Zinc	4/4	6.5-8.2	7.53	RN6SW0040001	1100	N	47	385.4	410000	No

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 USEPA, June 14, 1991 unless otherwise noted.
6 Estimated by multiplying Bioconcentration Factor times maximum site concentration.
7 Factor assumed, because no value is available.

TABLE 4-16

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT
SEDIMENTS - SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tol. Limit for Background	Greater Than Background?	Selected as COPC?
					Industrial	Residential				
Semivolatile Organic Compounds (µg/kg)										
Benzo(a)anthracene	1/4	71	71.00	RN6SD0010001	7800	880	C	ND (5)	Yes (6)	No
Benzo(a)pyrene	1/4	60	60.00	RN6SD0010001	780	88	C	ND	Yes (6)	No
Benzo(b)fluoranthene	1/4	100	100.00	RN6SD0010001	7800	880	C	ND	Yes (6)	No
Chrysene	1/4	56	56.00	RN6SD0010001	780000	88000	C	ND	Yes (6)	No
Di-n-butyl phthalate	2/4	160-390	275.00	RN6SD0040001	20000000	780000	N	ND	Yes (6)	No
Di-n-octyl phthalate	1/4	95	95.00	RN6SD0020001	410000	160000	N	ND	Yes (6)	No
Fluoranthene	1/4	77	77.00	RN6SD0010001	8200000	310000	N	ND	Yes (6)	No
Pyrene	1/4	63	63.00	RN6SD0010001	6100000	230000	N	ND	Yes (6)	No
Inorganics (mg/kg)										
Antimony	1/4	0.29	0.29	RN6SD0010001	82	3.1	N	ND	Yes (6)	No
Arsenic	4/4	0.47-3	1.32	RN6SD0010001	3.8	**0.43***	C	63	No	No
Barium	4/4	6.5-24.1	12.15	RN6SD0010001	14000	550	N	577	No	No
Beryllium	1/4	0.31	0.31	RN6SD0010001	1.3	**0.15**	C	10.9	No	No
Cadmium	4/4	0.22-0.8	0.44	RN6SD0010001	100	3.9	N	1.85	No	No
Chromium (7)	4/4	3.6-10.9	7.98	RN6SD0010001	1000	39	N	79.2	No	No
Cobalt	4/4	0.67-3.3	1.42	RN6SD0010001	12000	470	N	118	No	No
Copper	4/4	2.2-50.5	16.78	RN6SD0010001	8200	310	N	297	No	No
Lead	4/4	2.4-28	10.58	RN6SD0010001	2000 (8)	400 (8)	N	476	No	No
Mercury	4/4	0.02-0.13	0.10	RN6SD0030001	61	2.3	N	0.778	No	No
Nickel	4/4	2.3-12.8	6.10	RN6SD0030001	4100	160	N	382	No	No
Selenium	4/4	0.35-0.96	0.55	RN6SD0010001	1000	39	N	6.45	No	No
Vanadium	4/4	3-17.4	7.68	RN6SD0010001	1400	55	N	196	No	No
Zinc	4/4	7.5-43.5	19.03	RN6SD0010001	61000	2300	N	1660	No	No

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 ND = not detected; NA = not applicable.

TABLE 4-16

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT
SEDIMENTS - SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

6 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
Organic background data presented for information purposes, but not for COPC selection.
7 Considered as hexavalent chromium.
8 OSWER screening level for lead in soil (USEPA, 1993).

TABLE 4-17

CHEMICALS OF POTENTIAL CONCERN AND EXPOSURE CONCENTRATIONS
SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Medium	Organics		Inorganics	
	Chemical	Exposure Point Concentration[1]	Chemical	Exposure Point Concentration[1]
Surface Soil	2,4,6-Trinitrotoluene 2-Amino-4,6-dinitrotoluene RDX[2]	248 mg/kg (max.) 16.0 mg/kg (max.) 397 mg/kg (max.)	Arsenic	3.10 mg/kg
All Soil (Surface/ Subsurface Soil)	2,4,6-Trinitrotoluene 2-Amino-4,6-dinitrotoluene RDX	248 mg/kg (max.) 16.0 mg/kg (max.) 397 mg/kg (max.)	Arsenic	3.25 mg/kg
Sediments	None[3]	-	None[3]	-
Groundwater (Unfiltered)	2,4,6-Trinitrotoluene 2-Amino-4,6-dinitrotoluene RDX	43.8 µg/L (max.) 58.2 µg/L (max.) 30.5 µg/L (ave.) 344 µg/L (max.)	Antimony Arsenic Barium Chromium III[4] Chromium VI[4] Lead Vanadium	1.78 µg/L (max.) 16.4 µg/L (max.) 9.70 µg/L (ave.) 307 µg/L (max.) 110 µg/L (ave.) 50.1 µg/L (max.) 24.6 µg/L (ave.) 5.6 µg/L (max.) 2.73 µg/L (ave.) 33.0 µg/L (max.) 14.7 µg/L (ave.) 75.7 µg/L (max.) 37.9 µg/L (ave.)
Surface Water/Fish Tissue	None[3]	-	None[3]	-

1 95 Percent UCLs of the arithmetic mean were used as exposure point concentrations for RME and CTE, unless they exceeded the maximum concentration or fewer than 10 sample were analyzed. In these instances, the maximum concentrations were used for the RME. The mean of positive detects for data sets with fewer than 10 samples (if less than the maximum) were used for the CTE. Statistics for distribution of data sets and 95 percent UCLs are presented in Appendix I.
2 RDX = hexahydro-1,3,5-trinitro-1,3,5,-triazine.
3 No maximum analyte concentrations exceeded screening levels and\or background concentrations.
4 10 Percent evaluated as hexavalent chromium and 90 percent evaluated as trivalent chromium.

TABLE 4-18

SUMMARY OF EXPOSURE SCENARIOS FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Medium	Receptor	Exposure Route
Current Scenario		
Surface Soil[1]	Maintenance Worker/ Full-Time Employee	Incidental Ingestion Dermal Contact
Future Scenario		
Surface Soil	Maintenance Worker/ Full-Time Employee	Incidental Ingestion Dermal Contact
Surface/Subsurface Soil[2]	Construction Worker	Incidental Ingestion Dermal Contact
Groundwater	Construction Worker	Dermal Contact

1 Surface soil is defined as soil collected from depths of 0 to 2 feet bgs.

2 Surface soil/subsurface soil is defined as soil collected from depths of 0 to >10 feet bgs.

TABLE 4-19

SUMMARY OF CANCER RISKS AND HAZARD INDICES [1] SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

EXPOSURE ROUTE	MAINTENANCE WORKER [2]		FULL-TIME EMPLOYEE [2]		CONSTRUCTION WORKER [3]	
	RME [4]	CTE [5]	RME	CTE	RME	CTE
INCREMENTAL CANCER RISK						
Soil						
Incidental Ingestion of Soil	2.3E-06	2.1E-07	1.2E-05	2.1E-06	1.1E-06	4.7E-07
Dermal Contact with Soil	9.7E-06	1.7E-06	4.8E-05	1.7E-05	1.9E-06	1.9E-06
Total Risk - Soil	**1.2E-05**	**2.0E-06**	**6.0E-05**	**2.0E-05**	**3.1E-06**	**2.4E-06**
Groundwater						
Dermal Contact with Groundwater	NA	NA	NA	NA	4.6E-08	2.6E-08
Cumulative Risk	**1.2E-05**	**2.0E-06**	**6.0E-05**	**2.0E-05**	**3.1E-06**	**2.4E-06**
HAZARD INDEX						
Soil						
Incidental Ingestion of Soil	0.11	0.027	0.53	0.27	1.3	0.53
Dermal Contact with Soil	0.7	0.07	3.5	0.7	3.5	0.7
Total Hazard Index - Soil	**0.81**	**0.097**	**4.0**	**0.97**	**4.8**	**1.2**
Groundwater						
Dermal Contact with Groundwater	NA	NA	NA	NA	0.14	0.057
Total Hazard Index	**0.81**	**0.097**	**4.0**	**0.97**	**4.9**	**1.3**

Notes:

1 - Chemical specific risks present in Appendix ?

2 - Maintenance worker and full-time employee are exposed to surface soil.

3 - Construction worker is exposed to surface/subsurface soil and groundwater.

4 - Reasonable Maximum Exposures

5 - Central Tendency Exposures

NA - Not applicable, exposure route not evaluated for this receptor.

TABLE 4-20A

QUALITATIVE EVALUATION OF UNFILTERED GROUNDWATER SAMPLES - SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	EPA Drinking Water Standard		EPA Drinking Water Health Advisories	
						MCL	MCLG	Value	Receptor
Semivolatile Organic Compounds (µg/L)									
Bis(2-ethylhexyl)phthalate	1/4	1-3	2.00	4.8	C	6	0	700	DWEL, 70-KG ADULT
Di-n-butyl phthalate	2/4	1	1.00	370	N	NA	NA	4000	DWEL, 70-KG ADULT
Explosives (µg/L)									
1,3,5-Trinitrobenzene	1/4	0.6	0.60	11	N	NA	NA	NA	NA
2,4,6-Trinitrotoluene	1/4	43.75	43.75	**2.2***	C	NA	NA	NA	NA
2-Amino-4,6-dinitrotoluene	2/4	2.8-58.2	30.50	**0.2**	N	NA	NA	NA	NA
4-Nitrotoluene	1/4	1.75	1.75	6.1	N	NA	NA	NA	NA
HMX (5)	1/4	39.75	39.75	180	N	NA	NA	400	LIFETIME, 70-KG ADULT
RDX (5)	1/4	344	344.00	**0.61**	C	NA	NA	2	LIFETIME, 70-KG ADULT
Inorganics (µg/L)									
Antimony	1/4	1.775	1.78	**1.5**	N	6	6	3	LIFETIME, 70-KG ADULT
Arsenic	2/4	3-16.4	9.70	**0.045**	C	50	NA	NA	NA
Barium	4/4	12.1-307	110.13	**260**	N	2000	2000	2000	LIFETIME, 70-KG ADULT
Chromium (6)	3/4	4.8-55.7	27.33	**18**	N	100 (7)	100 (7)	100	LIFETIME, 70-KG ADULT
Cobalt	4/4	1.6-47.8	14.05	220	N	NA	NA	NA	NA
Copper	2/4	12.6-54.5	33.55	150	N	1300	1300	NA	NA
Lead	3/4	1.4-33	14.71	**15 (8)**	N	15	0	NA	NA
Mercury	3/4	0.14-0.23	0.18	1.1	N	2	2	2	LIFETIME, 70-KG ADULT
Nickel	2/4	7.5-28.7	18.10	73	N	100	100	100	LIFETIME, 70-KG ADULT
Selenium	1/4	2.5	2.50	18	N	50	50	NA	NA
Vanadium	3/4	5.2-75.7	37.87	**26**	N	NA	NA	NA	NA
Zinc	3/4	2.7-30.8	12.65	1100	N	5000	NA	2000	LIFETIME, 70-KG ADULT
Miscellaneous (mg/L)									
Total Organic Carbon	1/1	17	17.00	-		NA	NA	NA	NA

* Screening levels exceeded by maximum site concentration have been bolded.
1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine; RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine.
6 Considered as hexavalent chromium.
7 Only value available is for "chromium"
8 Safe Drinking Water Act Action Level

TABLE 4-20B

QUALITATIVE EVALUATION OF FILTERED GROUNDWATER SAMPLES - SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	EPA Drinking Water Standard		EPA Drinking Water Health Advisories	
						MCL	MCLG	Value	Receptor
Inorganics (µg/L)									
Arsenic, Filtered	2/4	2.8-9	5.90	**0.045***	C	50	NA	NA	NA
Barium, Filtered	4/4	5.1-189	66.73	260	N	2000	2000	2000	LIFETIME, 70-KG ADULT
Chromium, Filtered (5)	1/4	4.7	4.70	18	N	100 (6)	100 (6)	100	LIFETIME, 70-KG ADULT
Cobalt, Filtered	4/4	1-33	9.53	220	N	NA	NA	NA	NA
Copper, Filtered	1/4	3.5	3.50	150	N	1300	1300	NA	NA
Mercury, Filtered	2/4	0.14-0.15	0.14	1.1	N	2	2	2	LIFETIME, 70-KG ADULT
Nickel, Filtered	1/4	1.8	1.80	73	N	100	100	100	LIFETIME, 70-KG ADULT
Vanadium, Filtered	1/4	4.7	4.70	26	N	NA	NA	NA	NA
Zinc, Filtered	2/4	4.2-7.6	5.23	1100	N	5000	NA	2000	LIFETIME, 70-KG ADULT

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.

2 Duplicate samples are considered as individual data points.

3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6. Unfiltered data and screening levels presented only for qualitative analysis, not for COPC selection.

4 N = noncarcinogenic basis; C = carcinogenic basis.

5 Considered as hexavalent chromium.

6 Only value available is for "chromium".

TABLE 4-21

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN FOR SWMU 5 - RANGE 6 - SURFACE WATER
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	BTAG Screening Level	EEQ	Retained as PCOC?
		Min.	Max.				
Inorganics (µg/L)							
Barium	4/4	34.4	38.1	RN6SW0030001	1000	0.04	N
Copper	4/4	3.4	5.2	RN6SW0010001	6.5	0.80	N
Vanadium	4/4	2.3	2.7	RN6SW0040001	10000	0.00	N
Zinc	4/4	6.5	8.2	RN6SW0040001	110	0.07	N

EEQ = Ecological Effects Quotient

TABLE 4-22

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN FOR SWMU 5 - RANGE 6 - SEDIMENT
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	BTAG Screening Level	EEQ	Retained as PCOC?
		Min.	Max.				
Inorganics (mg/kg)							
Antimony	1/4	0.29	0.29	RN6SD0010001	150	0.00	N
Arsenic	4/4	0.47	3	RN6SD0010001	0.057	52.63	Y
Barium	4/4	6.5	24.1	RN6SD0010001	NA	NA	Y
Beryllium	1/4	0.31	0.31	RN6SD0010001	NA	NA	Y
Cadmium	4/4	0.22	0.8	RN6SD0010001	1.2	0.67	N
Chromium	4/4	3.6	10.9	RN6SD0010001	260	0.04	N
Cobalt	4/4	0.67	3.3	RN6SD0010001	NA	NA	Y
Copper	4/4	2.2	50.5	RN6SD0010001	34	1.49	Y
Lead	4/4	2.4	28	RN6SD0010001	46.7	0.60	N
Mercury	4/4	0.02	0.13	RN6SD0030001	0.15	0.87	N
Nickel	4/4	2.3	12.8	RN6SD0030001	20.9	0.61	N
Selenium	4/4	0.35	0.96	RN6SD0010001	NA	NA	Y
Vanadium	4/4	3	17.4	RN6SD0010001	NA	NA	Y
Zinc	4/4	7.5	43.5	RN6SD0010001	150	0.29	N
Semivolatile Organic Compounds (µg/kg)							
Benzo(a)anthracene	1/4	71	71	RN6SD0010001	261	0.27	N
Benzo(a)pyrene	1/4	60	60	RN6SD0010001	430	0.14	N
Benzo(b)fluoranthene	1/4	100	100	RN6SD0010001	3200	0.03	N
Chrysene	1/4	56	56	RN6SD0010001	384	0.15	N
Di-n-butyl phthalate	2/4	160	390	RN6SD0040001	1400	0.28	N
Di-n-octyl phthalate	1/4	95	95	RN6SD0020001	6200	0.02	N
Fluoranthene	1/4	77	77	RN6SD0010001	600	0.13	N
Pyrene	1/4	63	63	RN6SD0010001	665	0.09	N

NA = Not Available
EEQ = Ecological Effects Quotient

TABLE 4-23

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN FOR SWMU 5 - RANGE 6 - SURFACE SOIL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	BTAG Screening Level	EEQ	Retained as PCOC?
		Min.	Max.				
Inorganics (mg/kg)							
Aluminum	1/1	5880	6290	S5-MW01-01	1	6290.00	Y
Antimony	18/19	0.23	1.9	RN6SS0020101	0.48	3.96	Y
Arsenic	19/19	1.2	5.6	RN6SS0180101-D	328	0.02	N
Barium	19/19	16.5	111	RN6SS0140101-D	440	0.25	N
Beryllium	18/19	0.19	0.98	RN6SS0080101	0.02	49.00	Y
Cadmium	19/19	0.21	2.1	RN6SS0040101	2.5	0.84	N
Chromium	19/19	5	24.1	RN6SS0180101-D	0.075	321.33	Y
Cobalt	19/19	2.8	10.4	RN6SS0080101	200	0.05	N
Copper	19/19	6.8	217	RN6SS0080101	15	14.47	Y
Iron	1/1	14300	14400	S5-MW01-01-D	12000	1.20	Y
Lead	19/19	5.3	181	RN6SS0070101	0.01	18100.00	Y
Manganese	1/1	82.6	89.9	S5-MW01-01-D	330	0.27	N
Mercury	19/19	0.02	1.6	RN6SS0090101	0.058	27.59	Y
Nickel	19/19	4.2	20.9	RN6SS0080101	2	10.45	Y
Selenium	18/19	0.54	2.3	RN6SS0180101-D	1.8	1.28	Y
Silver	1/19	0.22	0.27	S5-MW01-01	9.80E-06	27551.02	Y
Tin	2/19	6.1	9	RN6SS0140101-D	0.89	10.11	Y
Vanadium	19/19	9.4	30.3	RN6SS0180101-D	58	0.52	N
Zinc	19/19	16.6	446	RN6SS0090101	10	44.60	Y
Semivolatile Organic Compounds (µg/kg)							
Benzo(a)anthracene	2/19	44	97	RN6SS0090101	100	0.97	N
Benzo(a)pyrene	1/19	73	73	RN6SS0090101	100	0.73	N
Benzo(b)fluoranthene	2/19	170	170	RN6SS0090101	100	1.70	Y
Benzo(b)fluoranthene	2/19	170	170	RN6SS0180101-D	100	1.70	Y
Benzo(g,h,i)perylene	1/19	90	90	RN6SS0180101-D	100	0.90	N
Benzo(k)fluoranthene	1/19	110	110	RN6SS0180101-D	100	1.10	Y

TABLE 4-23

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN FOR SWMU 5 - RANGE 6 - SURFACE SOIL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	BTAG Screening Level	EEQ	Retained as PCOC?
		Min.	Max.				
Bis(2-ethylhexyl)phthalate	1/19	72	72	RN6SS0160101	NA	NA	Y
Chrysene	3/19	51	130	RN6SS0090101	100	1.30	Y
Di-n-butyl phthalate	8/19	48	6500	RN6SS0050101	100	65.00	Y
Fluoranthene	1/19	220	220	RN6SS0090101	100	2.20	Y
Indeno(1,2,3-cd)pyrene	1/19	90	90	RN6SS0180101-D	100	0.90	N
N-nitrosodiphenylamine	2/19	90	380	RN6SS0050101	100	3.80	Y
Phenanthrene	1/19	130	130	RN6SS0090101	100	1.30	Y
Pyrene	2/19	63	310	RN6SS0090101	NA	NA	Y
4-Methyl-2-pentanone	1/19	1.5	1.5	S5-MW01-01	NA	NA	Y
Volatile Organic Compounds (µg/kg)							
Acetone	3/19	81	130	RN6SS0070101	NA	NA	Y
Chloroform	1/19	2.5	2.5	S5-MW01-01	300	0.00	N
Ethylbenzene	2/19	1	1	RN6SS0080101	100	0.01	N
Methylene chloride	7/19	19	77	RN6SS0070101	300	0.26	N
Toluene	1/19	0.3	0.3	S5-MW01-01	100	0.00	N
Trichlorofluoromethane	2/19	1	2	RN6SS0090101	NA	NA	Y
Explosives (µg/kg)							
2,4,6-Trinitrotoluene	13/19	139	248000	RN6SS0150101	NA	NA	Y
2-Amino-4,6-dinitrotoluene	11/19	324	16000	RN6SS0070101	NA	NA	Y
HMX	7/19	454	26700	RN6SS0150101	NA	NA	Y
RDX	10/19	243	397000	RN6SS0150101	NA	NA	Y
2,4-Dinitrotoluene	8/37	55	9300	RN6SS0050101	NA	NA	Y
2,6-Dinitrotoluene	3/37	120	500	RN6SS0050101	NA	NA	Y

NA = Not Available
EEQ = Ecological Effects Quotient

TABLE 4-24

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN FOR SWMU 5 - RANGE 6 - GROUNDWATER
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	AWQC	EEQ	Retained as PCOC?
		Min.	Max.				
Inorganics (mg/kg)							
Antimony	1/4	336	352	RN6MW003U001-D	30	11.73	Y
Beryllium	1/4	0.225	0.225	RN6MW003U001-AVG	5.1	0.04	N
Arsenic	2/4	3	16.4	5GW01	8.1	2.02	Y
Barium	4/4	12.1	307	5GW01	3.9	78.72	Y
Chromium	3/4	4.8	55.7	5GW01	10	5.57	Y
Cobalt	4/4	1.6	47.8	5GW01	3	15.93	Y
Copper	2/4	12.6	54.5	5GW01	11	4.95	Y
Lead	3/4	1.4	33	5GW01	2.5	13.20	Y
Mercury	3/4	0.14	0.23	5GW01	0.003	76.67	N
Nickel	2/4	7.5	28.7	5GW01	160	0.18	N
Selenium	1/4	2.5	2.5	RN6MW004U001	5	0.50	N
Vanadium	3/4	5.2	75.7	5GW01	19	3.98	Y
Zinc	3/4	2.7	30.8	RN6MW004U001	100	0.31	N
Semivolatile Organic Compounds (µg/L)							
Bis(2-ethylhexyl)phthalate	1/4	1	3	RN6MW003U001-D	32	0.09	N
Di-n-butyl phthalate	2/4	1	1	RN6MW002U001	33	0.03	N
Explosives (µg/L)							
1,3,5-Trinitrobenzene	2/10	0.6	0.6	RN6MW003U001	NA	NA	Y
2,4,6-Trinitrotoluene	1/4	43.4	44.1	RN6MW003U001-D	NA	NA	Y
2-Amino-4,6-dinitrotoluene	2/4	1.8	1.9	RN6MW003U001	NA	NA	Y
4-Nitrotoluene	1/4	2.8	58.7	RN6MW003U001-D	NA	NA	Y
HMX	1/4	1.7	1.8	RN6MW003U001	NA	NA	Y
RDX	1/4	38.3	41.2	RN6MW003U001-D	NA	NA	Y

NA = Not Available
EEQ = Ecological Effects Quotient

TABLE 4-25

RESULTS OF AQUATIC FOODCHAIN MODELING FOR SWMU 5 - RANGE 6
MAXIMUM AND MEAN CONCENTRATIONS
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Heron - Maximum		Heron - Mean	
	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI
Inorganics (mg/kg)				
Arsenic	2.67	0.27	1.17	0.12
Barium	0.03	0.02	0.02	0.00
Beryllium	NA	NA	NA	NA
Cobalt	0.97	0.10	0.41	0.04
Copper	6.31	0.63	2.09	0.21
Selenium	0.56	0.28	0.32	0.16
Vanadium	0.45	0.04	0.20	0.02

NA = Not Available
EEI = Ecological Effects Index

TABLE 4-26

RESULTS OF TERRESTRIAL FOODCHAIN MODELING FOR SWMU 5 - RANGE 6 MAXIMUM CONCENTRATIONS
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Shrew		Hawk		Fox		Vole		Woodcock	
	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI
Inorganics (mg/kg)										
Aluminum	2230.77	223.08	24.13	2.41	436.02	43.60	1168.05	116.80	31.45	3.14
Antimony	10.40	1.04	NA	NA	2.03	0.20	5.45	0.54	NA	NA
Beryllium	1.24	0.12	NA	NA	0.24	0.02	0.65	0.07	NA	NA
Chromium	97.04	9.70	101.44	10.14	18.97	1.90	50.81	5.08	132.18	1.32
Copper	148.53	14.85	38.87	3.89	29.03	2.90	77.77	7.78	50.65	5.06
Iron	197.13	19.71	60.61	6.06	38.53	3.85	103.22	10.32	78.98	7.90
Lead	825.94	82.59	253.94	25.39	161.44	16.14	432.47	43.25	330.92	33.09
Mercury	21.90	2.19	67.34	6.73	21.41	2.14	11.47	1.15	73.13	7.31
Nickel	0.23	0.02	0.11	0.08	0.04	0.00	0.12	0.01	0.15	0.11
Selenium	62.97	15.74	1.94	0.97	12.31	3.08	32.97	8.24	2.52	1.26
Silver	0.00	0.00	NA	NA	0.00	0.00	0.00	0.00	NA	NA
Tin	0.26	0.18	0.56	0.22	0.05	0.03	0.14	0.09	0.73	0.29
Zinc	12.21	1.22	13.51	1.35	2.39	0.24	6.39	0.64	17.60	1.76
Semivolatile Organic Compounds (µg/kg)										
Benzo(b)fluoranthene	0.09	0.04	0.00	0.00	0.02	0.00	0.05	0.02	0.00	0.00
Benzo(b)fluoranthene	0.09	0.04	0.00	0.00	0.02	0.00	0.05	0.02	0.00	0.00
Benzo(k)fluoranthene	0.06	0.03	0.00	0.00	0.01	0.00	0.03	0.02	0.00	0.00
Bis(2-ethylhexyl)phthalate	0.00	0.00	NA	NA	0.00	0.00	0.00	0.00	NA	NA
Chrysene	0.07	0.03	0.00	0.00	0.01	0.00	0.04	0.02	0.00	0.00
Di-n-butyl phthalate	0.00	0.00	24.87	2.49	0.00	0.00	0.00	0.00	32.41	3.24
Fluoranthene	0.12	0.06	0.00	0.00	0.02	0.01	0.06	0.03	0.01	0.00
N-nitrosodiphenylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	0.07	0.03	0.00	0.00	0.01	0.00	0.04	0.02	0.00	0.00

TABLE 4-26

RESULTS OF TERRESTRIAL FOODCHAIN MODELING FOR SWMU 5 - RANGE 6 MAXIMUM CONCENTRATIONS
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Shrew		Hawk		Fox		Vole		Woodcock	
	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI
Pyrene	0.16	0.08	0.01	0.00	0.03	0.02	0.09	0.04	0.02	0.00
4-Methyl-2-pentanone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds (µg/kg)										
Acetone	0.00	0.00	NA	NA	0.00	0.00	0.00	0.00	NA	NA
Trichlorofluoromethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Explosives (µg/kg)										
2,4,6-Trinitrotoluene	49.9	4.99	34.8	3.48	NA	NA	34.2	3.42	45.3	4.53
2-Amino-4,6-dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
HMX	0.37	0.12	NA	NA	0.07	0.02	0.19	0.06	NA	NA
RDX	38.82	7.76	NA	NA	7.59	1.52	20.33	4.07	NA	NA
2,4-Dinitrotoluene	31.83	4.24	NA	NA	6.22	0.83	16.67	2.22	NA	NA
2,6-Dinitrotoluene	0.10	0.01	NA	NA	0.02	0.00	0.05	0.00	NA	NA

NA = Not Available
EEI = Ecological Effects Index

TABLE 4-27

RESULTS OF TERRESTRIAL FOODCHAIN MODELING FOR SWMU 5 - RANGE 6 MEAN CONCENTRATIONS
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Shrew		Hawk		Fox		Vole		Woodcock	
	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI
Inorganics (mg/kg)										
Aluminum	2158.06	215.81	23.35	2.33	421.81	42.18	1129.98	113.00	30.42	3.04
Antimony	2.78	0.28	NA	NA	0.54	0.05	1.46	0.15	NA	NA
Beryllium	0.49	0.05	NA	NA	0.10	0.00	0.26	0.03	NA	NA
Chromium	50.61	5.06	52.91	5.29	9.89	0.99	26.50	2.65	68.94	0.69
Copper	34.81	3.48	9.11	0.91	6.80	0.68	18.23	1.82	11.87	1.19
Iron	196.45	19.64	60.40	6.04	38.40	3.84	102.86	10.29	78.71	7.87
Lead	180.79	18.08	55.59	5.56	35.34	3.53	94.67	9.47	72.44	7.24
Mercury	4.04	0.40	12.42	1.24	3.95	0.39	2.11	0.21	13.48	1.35
Nickel	0.08	0.00	0.04	0.03	0.02	0.00	0.04	0.00	0.05	0.04
Selenium	22.72	5.68	0.70	0.35	4.44	1.11	11.90	2.97	0.91	0.46
Silver	0.00	0.00	NA	NA	0.00	0.00	0.00	0.00	NA	NA
Tin	0.05	0.04	0.11	0.04	0.01	0.00	0.03	0.02	0.14	0.06
Zinc	1.72	0.17	1.90	0.19	0.34	0.03	0.90	0.09	2.47	0.25
Semivolatile Organic Compounds (µg/kg)										
Benzo(b)fluoranthene	0.09	0.05	0.00	0.00	0.02	0.00	0.05	0.02	0.00	0.00
Benzo(b)fluoranthene	0.09	0.05	0.00	0.00	0.02	0.00	0.05	0.02	0.00	0.00
Benzo(k)fluoranthene	0.09	0.05	0.00	0.00	0.02	0.00	0.05	0.02	0.00	0.00
Bis(2-ethylhexyl)phthalate	0.00	0.00	NA	NA	0.00	0.00	0.00	0.00	NA	NA
Chrysene	0.08	0.04	0.00	0.00	0.02	0.00	0.04	0.02	0.00	0.00
Di-n-butyl phthalate	0.00	0.00	2.48	0.25	0.00	0.00	0.00	0.00	3.24	0.32
Fluoranthene	0.09	0.05	0.00	0.00	0.02	0.00	0.05	0.02	0.00	0.00
N-nitrosodiphenylamine	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Phenanthrene	0.09	0.05	0.00	0.00	0.02	0.00	0.05	0.02	0.00	0.00
Pyrene	0.09	0.05	0.00	0.00	0.02	0.00	0.05	0.02	0.00	0.00
4-Methyl-2-pentanone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 4-27

RESULTS OF TERRESTRIAL FOODCHAIN MODELING FOR SWMU 5 - RANGE 6 MEAN CONCENTRATIONS
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Shrew		Hawk		Fox		Vole		Woodcock	
	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI
Volatile Organic Compounds (µg/kg)										
Acetone	0.00	0.00	NA	NA	0.00	0.00	0.00	0.00	NA	NA
Trichlorofluoromethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Explosives (µg/kg)										
2,4,6-Trinitrotoluene	1.42	0.14	0.99	0.09	NA	NA	0.91	0.09	1.29	0.12
2-Amino-4,6-dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
HMX	0.04	0.01	NA	NA	0.00	0.00	0.02	0.00	NA	NA
RDX	2.67	0.53	NA	NA	0.52	0.10	1.40	0.28	NA	NA
2,4-Dinitrotoluene	1.79	0.24	NA	NA	0.35	0.05	0.94	0.12	NA	NA
2,6-Dinitrotoluene	0.03	0.00	NA	NA	0.00	0.00	0.01	0.00	NA	NA

NA = Not Available
EEI = Ecological Effects Index

TABLE 4-28

RISK MANAGEMENT CONSIDERATIONS FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Frequency of Detection	Range of Detections		Location of Maximum	Mean Concentration	BTAG Screening Level	Alternate Guideline(s)1	Max/Mean Background	Retained as Final PCOC?
		Minimum	Maximum						
Sediment[2]									
Arsenic	4/4	0.47	3	RN6SD001 0001	1.32	0.057	6/33	10.6/3.3	N
Beryllium	1/4	0.31	0.31	RN6SD001 0001	0.12	NA	NA	1/0.52	N
Copper	4/4	2.2	50.5	RN6SD001 0001	16.8	34	16/110	28.3/9.5	N
Surface Soil[3]									
Aluminum	1/1	5880	6290	S5-MW01-01	6107.5	1	NA/600	13400/7874	N
Antimony	18/19	0.23	1.9	RN6SS002 0101	0.47	0.48	NA	ND	N
Beryllium	18/19	0.19	0.98	RN6SS008 0101	0.36	0.02	NA	0.61/0.4	N
Chromium	19/19	5	24.1	RN6SS018 0101-D	12.6	0.075	0.4/10	20.8/12	N
Copper	19/19	6.8	217	RN6SS008 0101	33.1	15	50/100	17.3/5.15	Y
Iron	1/1	14300	14400	S5-MW01-01-D	13625	12000	NA	25300/10290	N
Lead	19/19	5.3	181	RN6SS007 0101	25.82	0.01	500/900	149/20	Y
Mercury	19/19	0.02	1.6	RN6SS009 0101	0.18	0.058	0.1/30	0.08/0.04	Y
Selenium	18/19	0.54	2.3	RN6SS018 0101-D	0.83	1.8	70/100	0.83/0.54	N
Zinc	19/19	16.6	446	RN6SS009 0101	39.6	10	200/100	30.8/18.1	Y
Di-n-butyl phthalate	8/19	48	6500	RN6SS005 0101	392.7	100	NA	ND	Y

TABLE 4-28

RISK MANAGEMENT CONSIDERATIONS FOR SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Frequency of Detection	Range of Detections		Location of Maximum	Mean Concentration	BTAG Screening Level	Alternate Guideline(s)1	Max/Mean Background	Retained as Final PCOC?
		Minimum	Maximum						
N-nitrosodiphenylamine	2/19	90	380	RN6SS005 0101	175.4	100	NA	ND	N
4-Methyl-2-pentanone	1/19	1.5	1.5	S5-MW01-01	2.89	NA	NA	ND	N
Trichlorofluoromethane	2/19	1	2	RN6SS009 0101	2.74	NA	NA	ND	N
2,4,6-Trinitrotoluene	13/19	139	248000	RN6SS015 0101	7063.5	NA	NA	ND	Y
2-Amino-4,6-dinitrotoluene	11/19	324	16000	RN6SS007 0101	1150.5	NA	NA	ND	Y
HMX	7/19	454	26700	RN6SS015 0101	1402.5	NA	NA	ND	Y
RDX	10/19	243	397000	RN6SS015 0101	11678.5	NA	NA	ND	Y
2,4-Dinitrotoluene	8/37	55	9300	RN6SS005 0101	365.4	NA	NA	ND	Y

1 Alternate guidelines are as follows: sediment = MOE LELS and SELs (MOE, 1992); soil = ORNL screening levels for earthworms/soil microbes (when 2 values are present) (Will and Suter, 1995) or Dutch guidelines (when one value is present) (NMHSP&E, 1994)
2 Inorganics = mg/kg, organics = ug/kg
NA = Not Available
ND = Not Detected

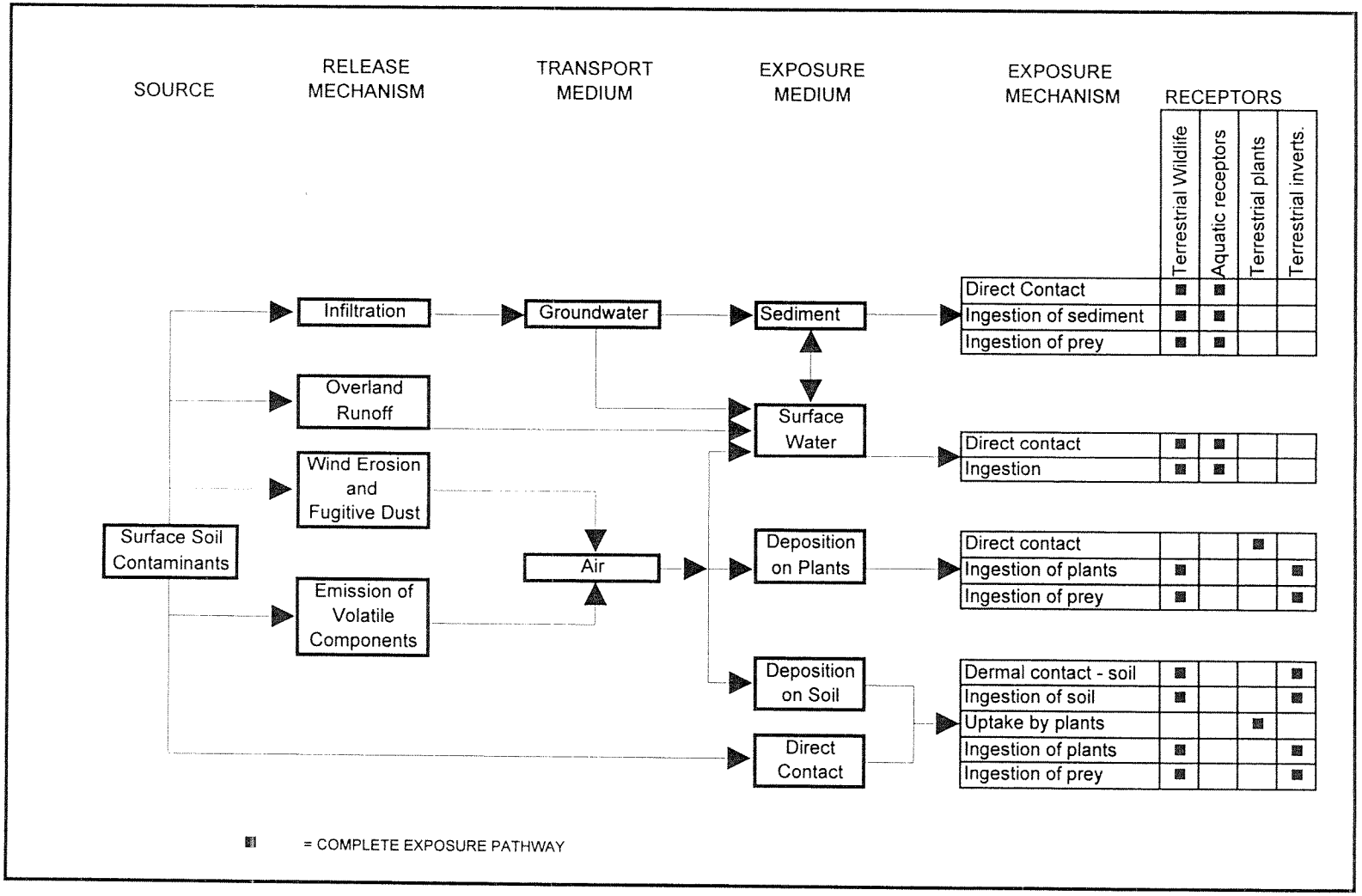
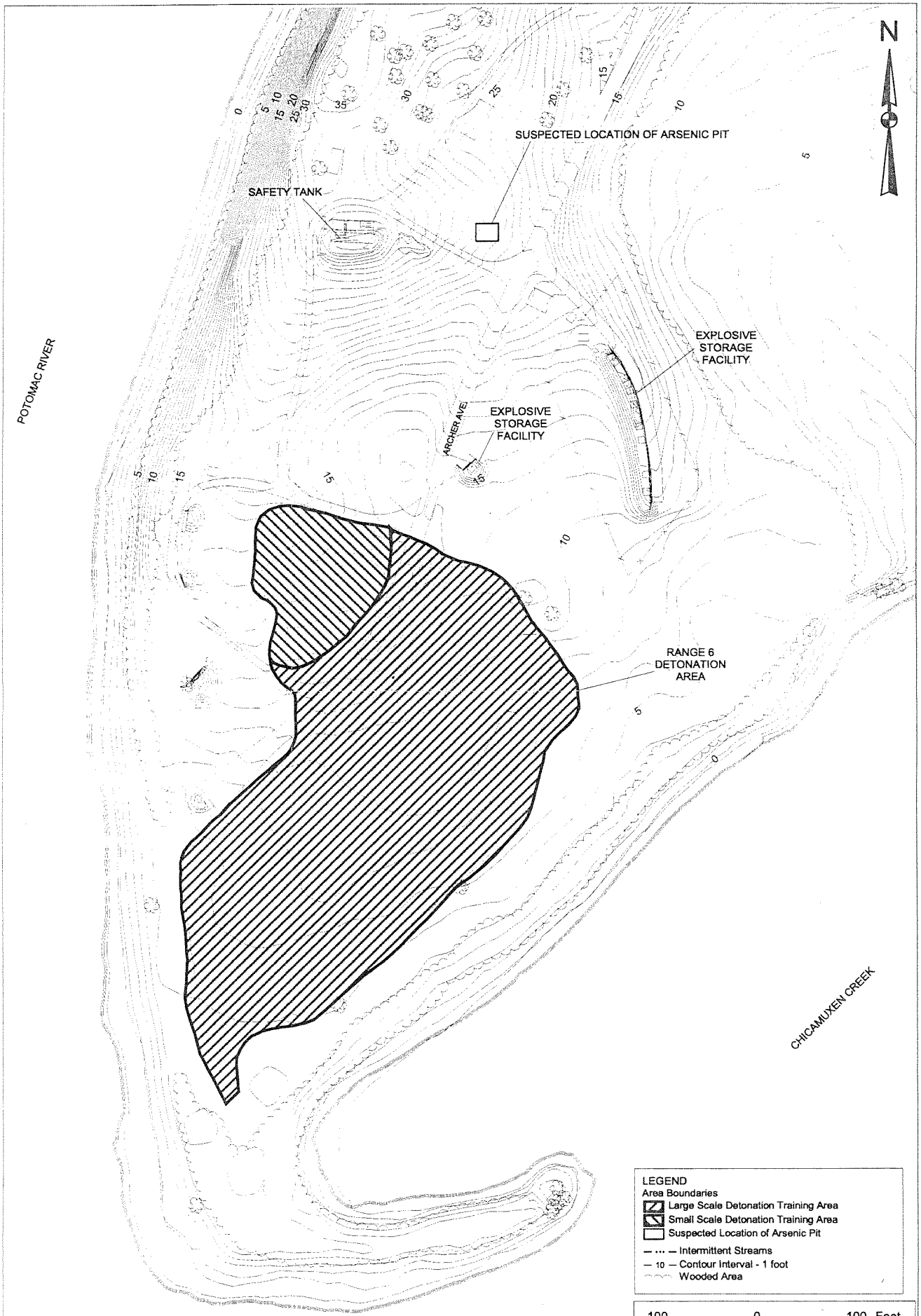


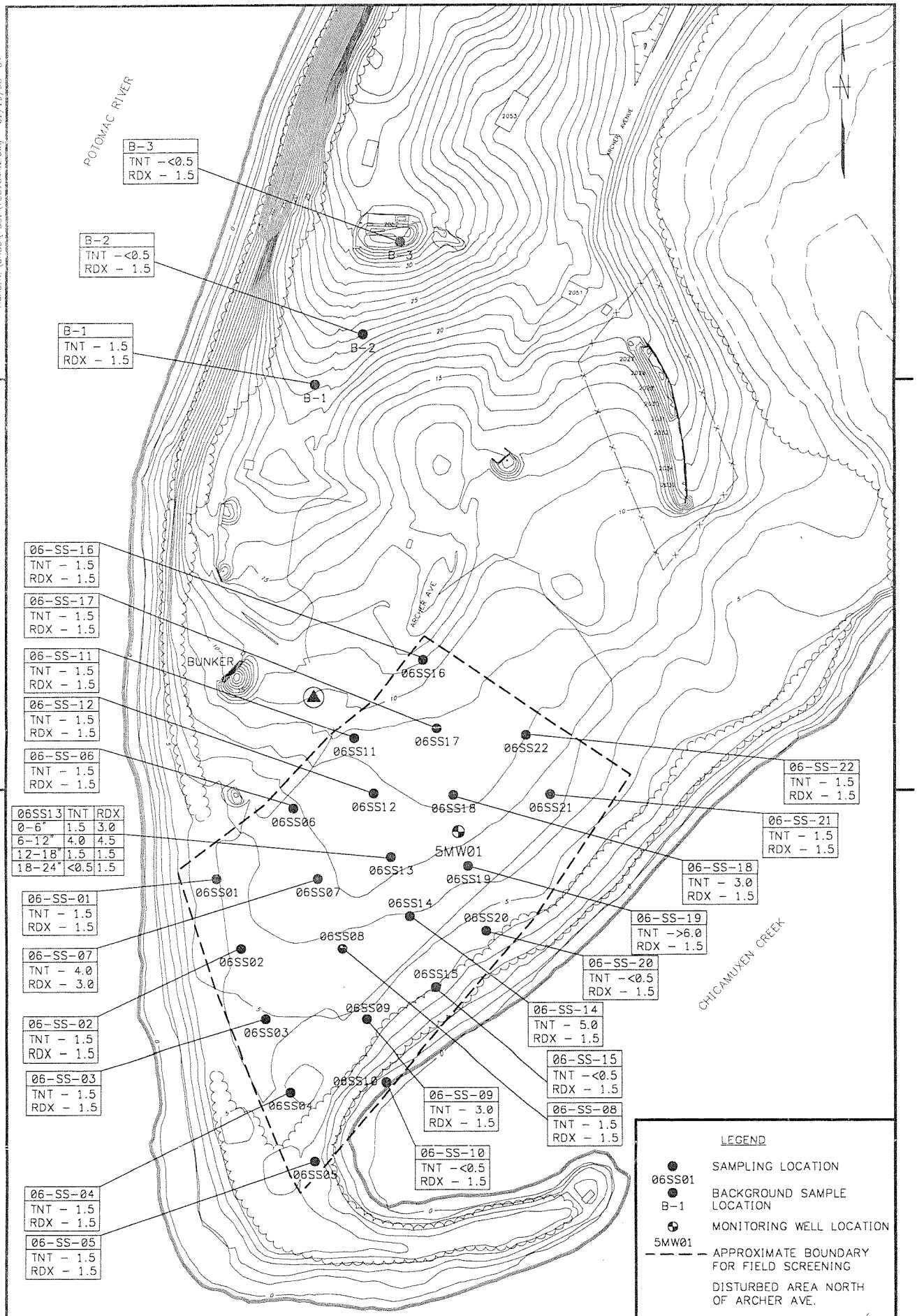
FIGURE 4-13

CONCEPTUAL SITE MODEL - SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

P:\GIS\APR\75810303.APR 19-JAN-98 DNP RANGE 6 SITE COND LAYOUT



NO.	DATE	REVISIONS	DRAWN BY	DATE	Brown & Root Environmental	CONTRACT NO.	OWNER NO.
			D. PERRY	19-JAN-98		7581	
			CHECKED BY	DATE	SITE CONDITION FIGURE SWMU 5 - RANGE 6 RCRA FACILITY INVESTIGATION/ VERIFICATION INVESTIGATION REPORT STUMP NECK ANNEX, INDIAN HEAD DIVISION NSWC INDIAN HEAD, MARYLAND	APPROVED BY	DATE
			COST/SCHED-AREA			APPROVED BY	DATE
			SCALE			DRAWING NO.	REV.
			AS NOTED			FIGURE 4-1	0



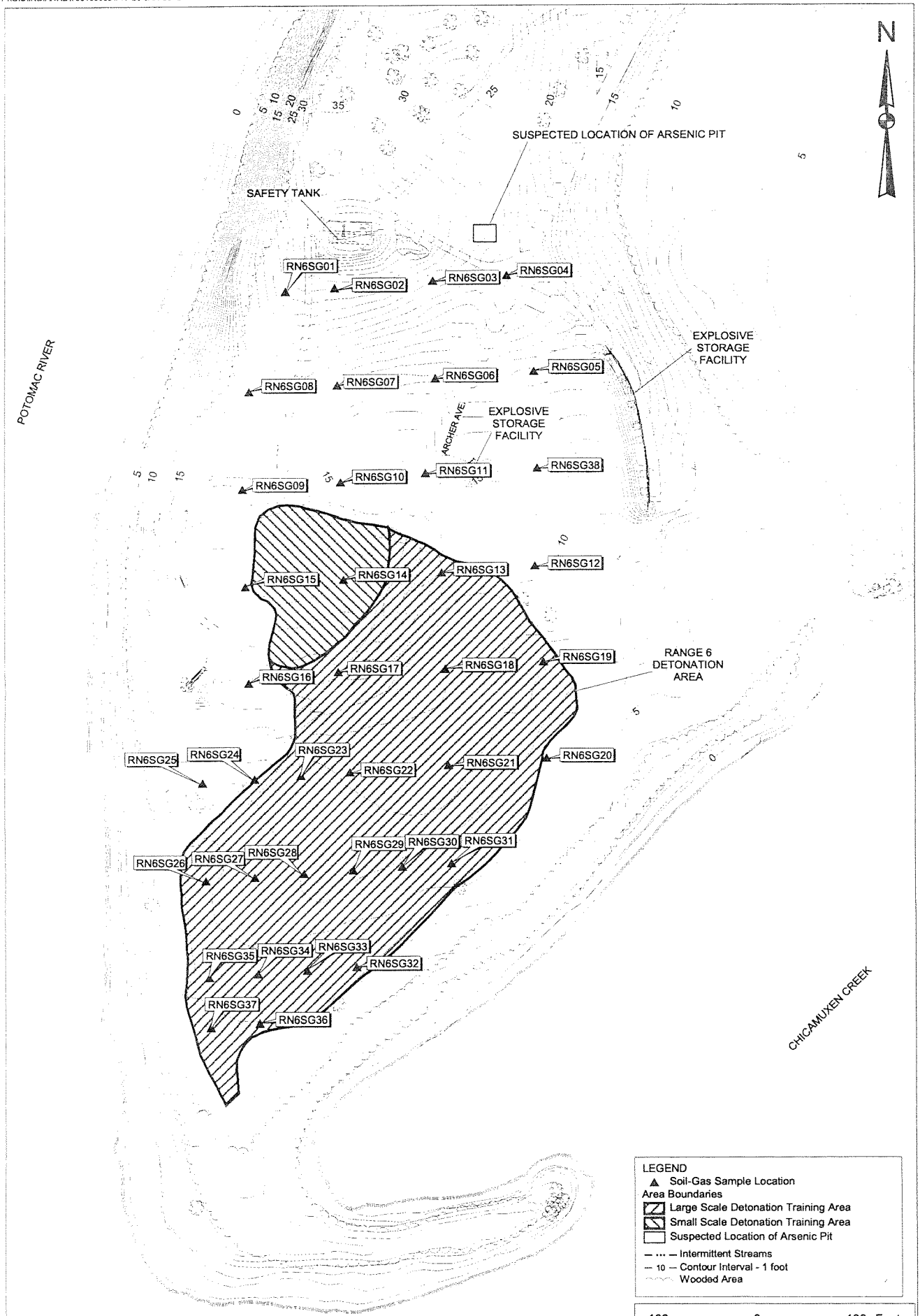
NOTE: THE 2,4,6-TRINITROTOLUENE (TNT) AND HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE (RDX) RESULTS ARE IN PARTS PER MILLION (ppm).

DRAWN BY DLT DATE 1/19/98	Brown & Root Environmental	CONTRACT NO. 7581	OWNER NO. 0222
CHECKED BY DATE	FIELD TEST KIT SAMPLE LOCATIONS AND RESULTS FOR SWMU 5 – RANGE 6 CTO 222 VERIFICATION INVESTIGATION (B & R ENVIRONMENTAL, 1995) STUMP NECK ANNEX, INDIAN HEAD DIVISION NSWC INDIAN HEAD, MARYLAND	APPROVED BY DATE 1-26-98	
COST/SCHED-AREA		APPROVED BY DATE 1-26-98	
SCALE AS NOTED		DRAWING NO. FIGURE 4-2	REV. 0

FORM CADD NO. SOUTH_BV.DWG - REV 0 - 04/16/97

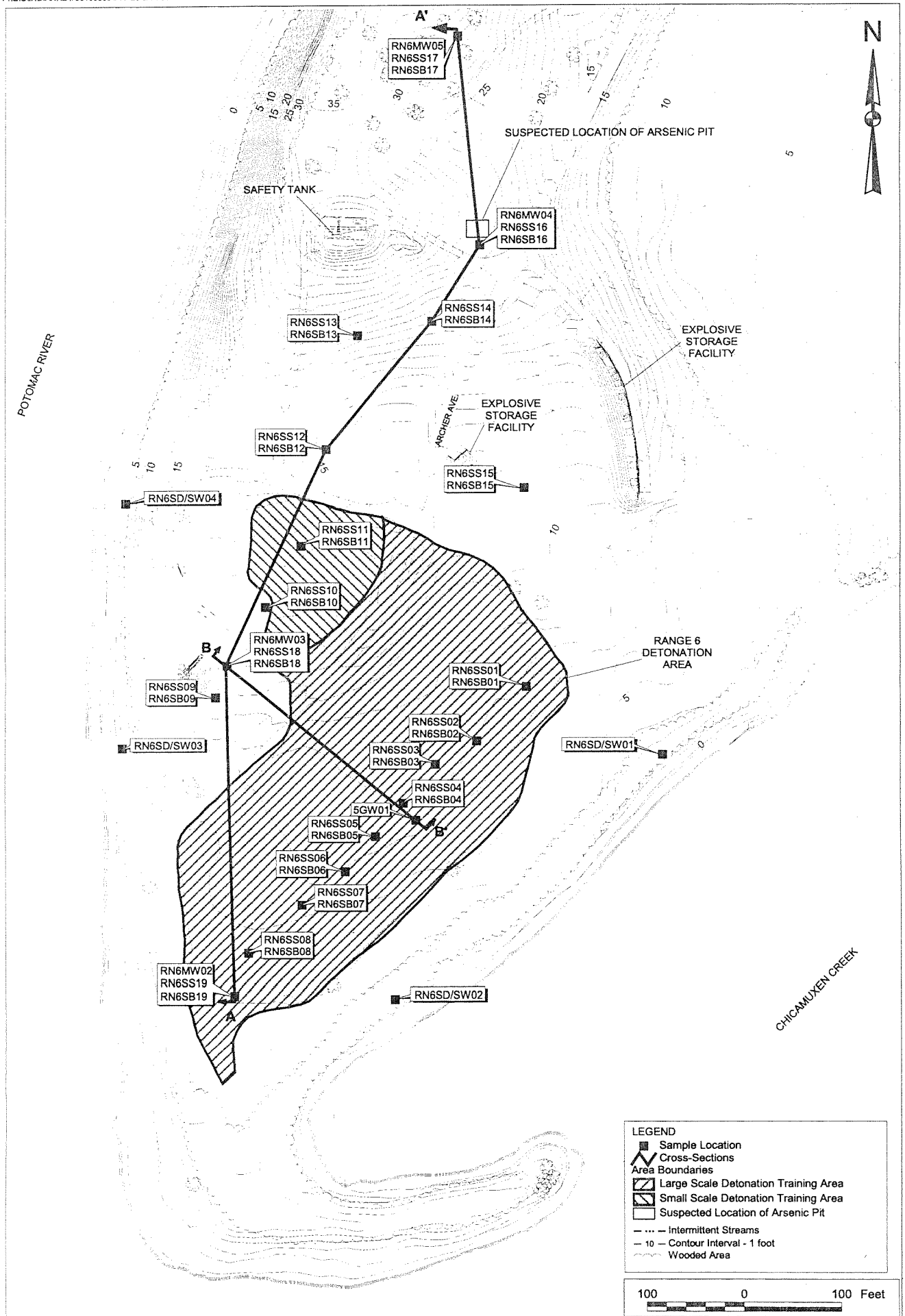
ACAD:K:\CADD\7581\7581GM22.dwg 01/19/98 DT

P:\GIS\INDIANHD\75810303.APR 26-JAN-98 DNP RANGE 6 SOIL GAS LAYOUT



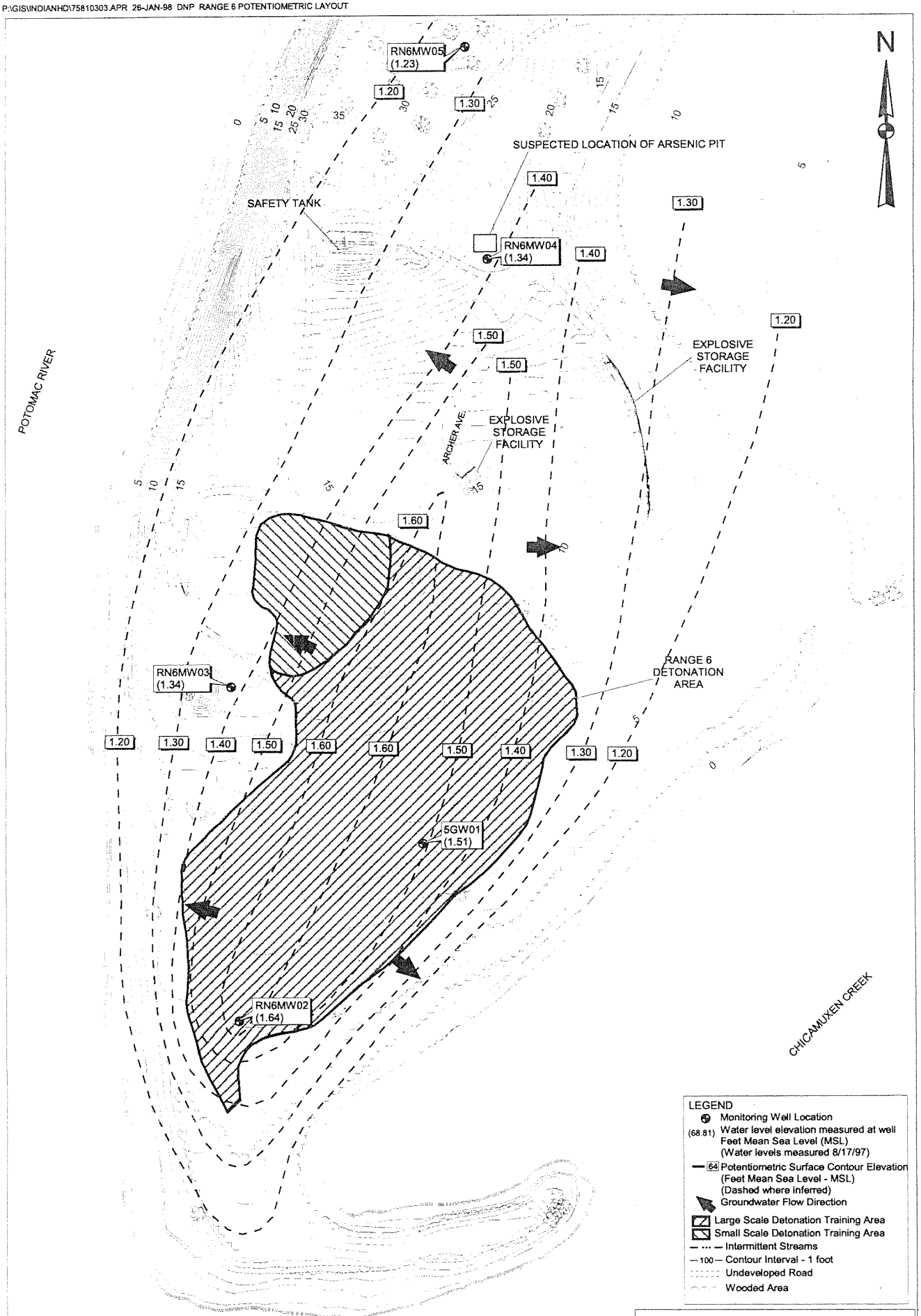
NO.	DATE	REVISIONS	DRAWN BY / DATE	Brown & Root Environmental	CONTRACT NO. / OWNER NO.
			D. PERRY 26-JAN-98		7581
			CHECKED BY / DATE	SOIL-GAS SAMPLE LOCATIONS SWMU 5 - RANGE 6 RCRA FACILITY INVESTIGATION/ VERIFICATION INVESTIGATION REPORT STUMP NECK ANNEX, INDIAN HEAD DIVISION NSWC INDIAN HEAD, MARYLAND	APPROVED BY / DATE 1-26-98
			COST/SCHED-AREA		APPROVED BY / DATE 1-26-98
			SCALE AS NOTED		DRAWING NO. FIGURE 4-3 / REV. 0

P:\GIS\INDIANHD\75810303.APR 26-JAN-98 DNP RANGE 6 XS + SAMPLES LAYOUT



NO.	DATE	REVISIONS	DRAWN BY	DATE	Brown & Root Environmental	CONTRACT NO.	OWNER NO.
			D. PERRY	26-JAN-98		7581	
			CHECKED BY	DATE	CROSS-SECTION AND SAMPLE LOCATIONS SWMU 5 - RANGE 6 RCRA FACILITY INVESTIGATION/ VERIFICATION INVESTIGATION REPORT STUMP NECK ANNEX, INDIAN HEAD DIVISION NSWC INDIAN HEAD, MARYLAND	APPROVED BY JWR	DATE 1-26-98
			COST/SCHED-AREA			APPROVED BY	DATE 1-26-98
			SCALE			DRAWING NO. FIGURE 4-4	REV. 0
			AS NOTED				

P:\GIS\INDIANHD\75810303.APR 26-JAN-98 DNP RANGE 6 POTENTIOMETRIC LAYOUT

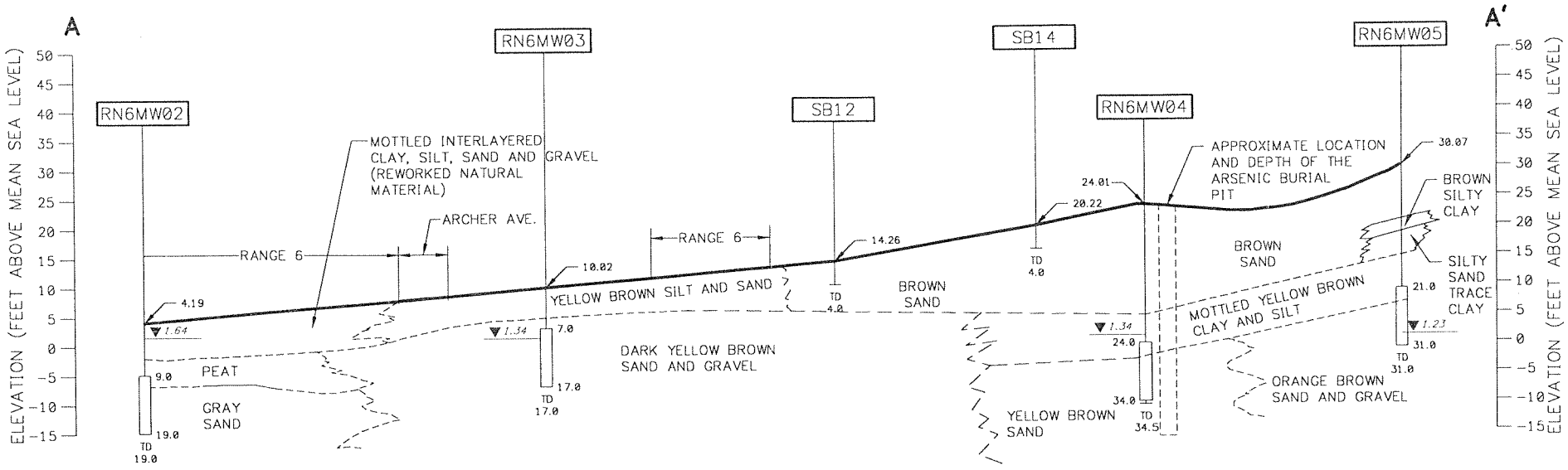


LEGEND

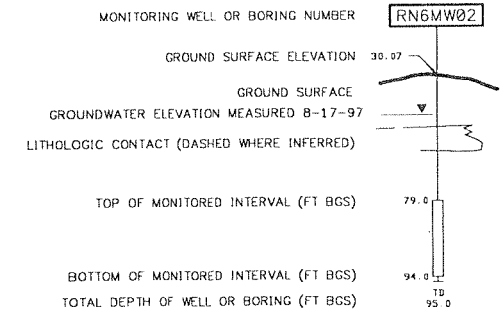
- Monitoring Well Location
- (68.81) Water level elevation measured at well Feet Mean Sea Level (MSL) (Water levels measured 8/17/97)
- 64 Potentiometric Surface Contour Elevation (Feet Mean Sea Level - MSL) (Dashed where inferred)
- Groundwater Flow Direction
- Large Scale Detonation Training Area
- Small Scale Detonation Training Area
- Intermittent Streams
- 100 Contour Interval - 1 foot
- Undeveloped Road
- Wooded Area

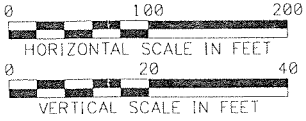
100 0 100 Feet

NO.	DATE	REVISIONS	DRAWN BY	DATE	Brown & Root Environmental	CONTRACT NO.	OWNER NO.
			D. PERRY	26-JAN-98		7581	
			CHECKED BY	DATE	POTENTIOMETRIC SURFACE CONTOUR FIGURE SWMU 5 - RANGE 6 RCRA FACILITY INVESTIGATION/ VERIFICATION INVESTIGATION REPORT STUMP NECK ANNEX, INDIAN HEAD DIVISION NSWC INDIAN HEAD, MARYLAND	APPROVED BY SWR	DATE 1-26-98
			COST/SCHED-AREA			APPROVED BY	DATE 1-26-98
			SCALE			DRAWING NO.	REV.
			AS NOTED			FIGURE 4-5	0



LEGEND





NOTE: ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL (FT AMSL)

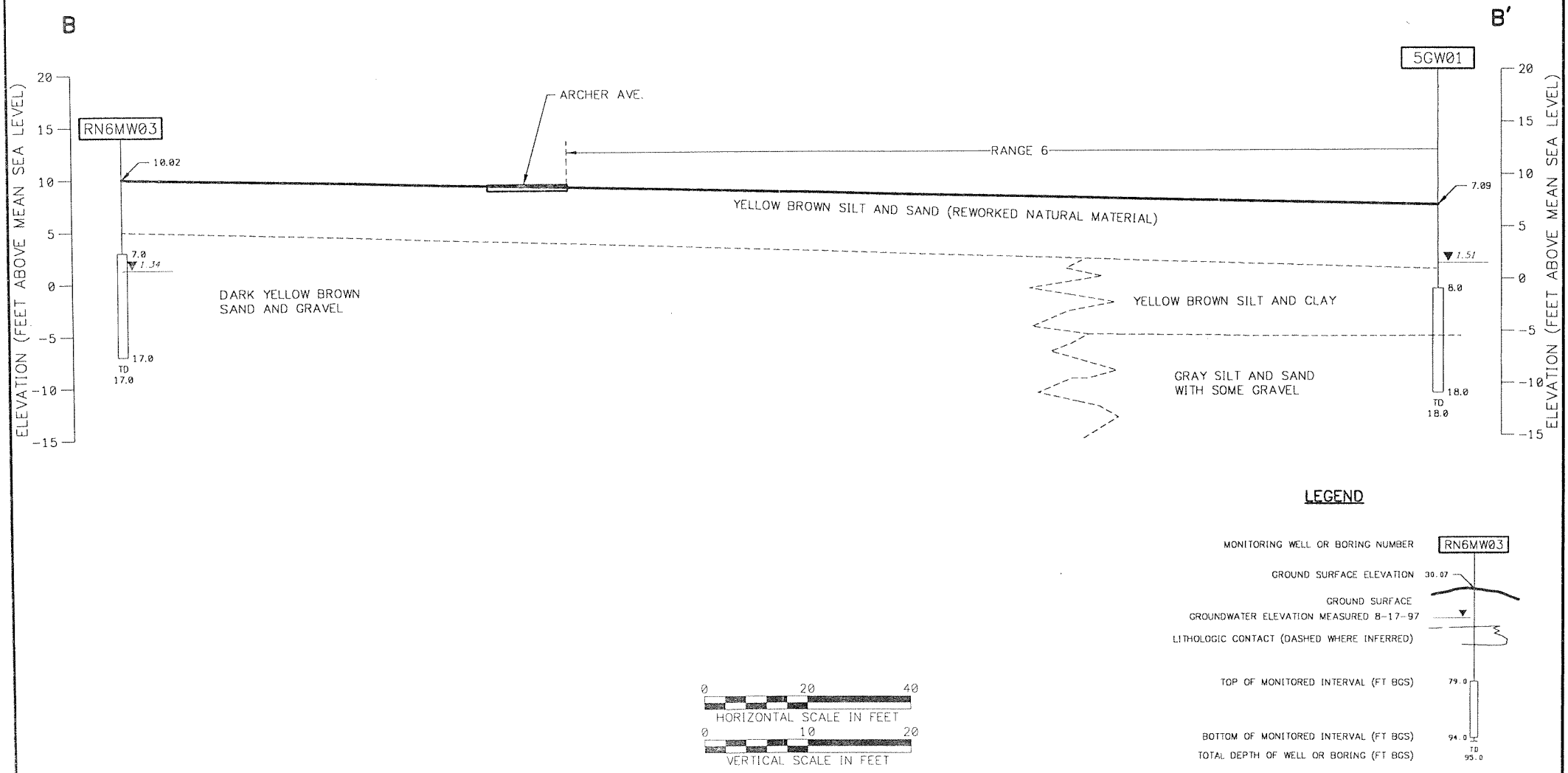
NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 10/30/97
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Brown & Root Environmental

GENERALIZED GEOLOGIC CROSS SECTION A-A'
SWMU 5 - RANGE 6
RFI/VI REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 5781
OWNER NO. 0287
APPROVED BY BUR DATE 1-26-98
APPROVED BY DATE 1-26-98
DRAWING NO. FIGURE 4-6
REV. 0



LEGEND

NOTE: ELEVATIONS IN FEET
ABOVE MEAN SEA LEVEL (FT AMSL)

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

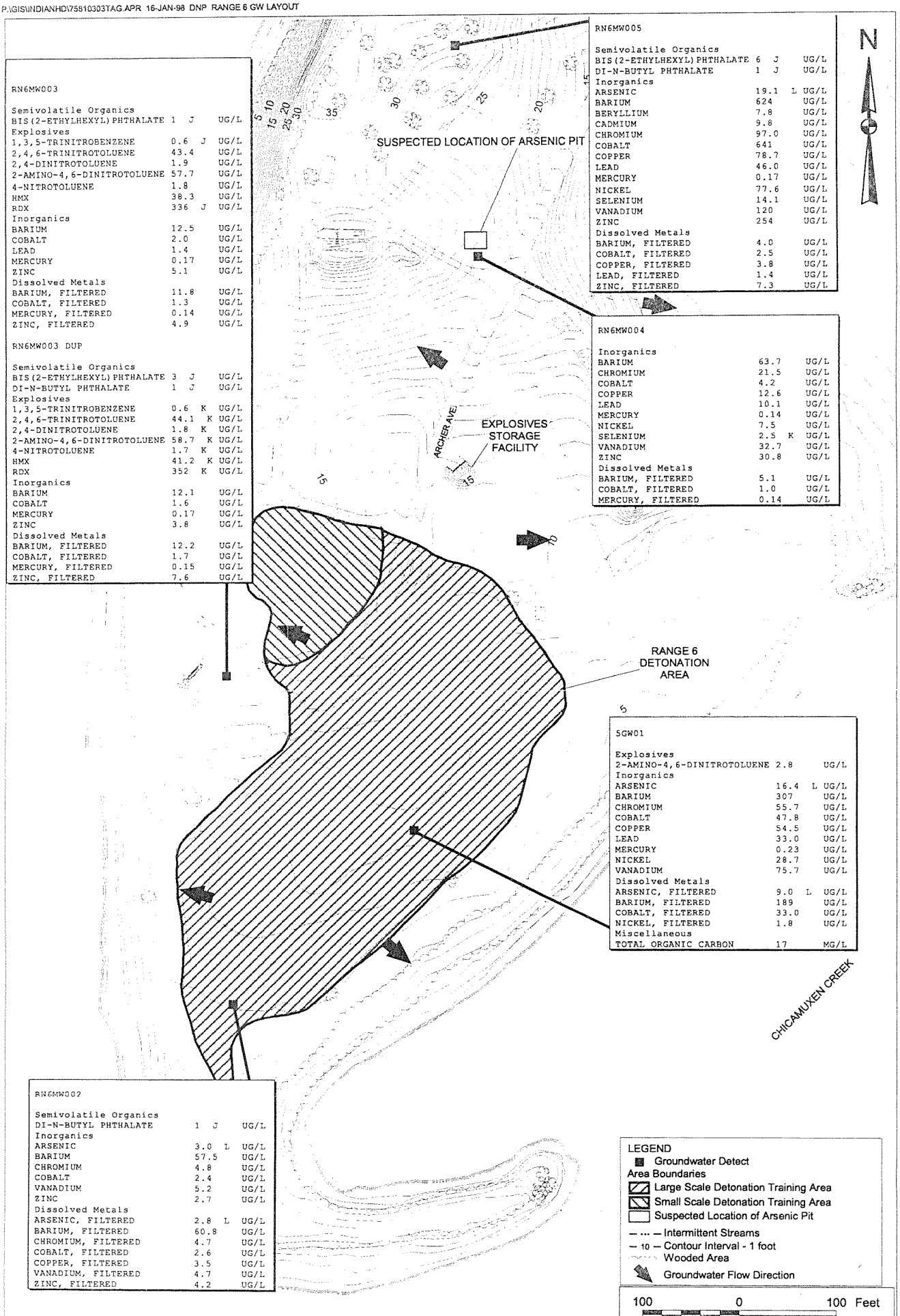
DRAWN BY HJP DATE 10/30/97
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Brown & Root Environmental

GENERALIZED GEOLOGIC CROSS SECTION B-B'
SWMU 5 - RANGE 6
RFI/VI REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581
OWNER NO. 0287
APPROVED BY FUR DATE 1-26-98
APPROVED BY DATE 1-26-98
DRAWING NO. FIGURE 4-7
REV. 0

P:\GIS\INDIANHD\75810303TAG.APR 16-JAN-98 DNP RANGE 6 GW LAYOUT



RN6MW003

Semivolatile Organics			
BIS(2-ETHYLHEXYL) PHTHALATE	1	J	UG/L
Explosives			
1,3,5-TRINITROBENZENE	0.6	J	UG/L
2,4,6-TRINITROTOLUENE	43.4		UG/L
2,4-DINITROTOLUENE	1.9		UG/L
2-AMINO-4,6-DINITROTOLUENE	57.7		UG/L
4-NITROTOLUENE	1.8		UG/L
HMX	38.3		UG/L
RDX	336	J	UG/L
Inorganics			
BARIUM	12.5		UG/L
COBALT	2.0		UG/L
LEAD	1.4		UG/L
MERCURY	0.17		UG/L
ZINC	5.1		UG/L
Dissolved Metals			
BARIUM, FILTERED	11.8		UG/L
COBALT, FILTERED	1.3		UG/L
MERCURY, FILTERED	0.14		UG/L
ZINC, FILTERED	4.9		UG/L

RN6MW003 DUP

Semivolatile Organics			
BIS(2-ETHYLHEXYL) PHTHALATE	3	J	UG/L
DI-N-BUTYL PHTHALATE	1	J	UG/L
Explosives			
1,3,5-TRINITROBENZENE	0.6	K	UG/L
2,4,6-TRINITROTOLUENE	44.1	K	UG/L
2,4-DINITROTOLUENE	1.8	K	UG/L
2-AMINO-4,6-DINITROTOLUENE	58.7	K	UG/L
4-NITROTOLUENE	1.7	K	UG/L
HMX	41.2	K	UG/L
RDX	352	K	UG/L
Inorganics			
BARIUM	12.1		UG/L
COBALT	1.6		UG/L
MERCURY	0.17		UG/L
ZINC	3.8		UG/L
Dissolved Metals			
BARIUM, FILTERED	12.2		UG/L
COBALT, FILTERED	1.7		UG/L
MERCURY, FILTERED	0.15		UG/L
ZINC, FILTERED	7.6		UG/L

RN6MW005

Semivolatile Organics			
BIS(2-ETHYLHEXYL) PHTHALATE	6	J	UG/L
DI-N-BUTYL PHTHALATE	1	J	UG/L
Inorganics			
ARSENIC	19.1	L	UG/L
BARIUM	624		UG/L
BERYLLIUM	7.8		UG/L
CADMIUM	9.8		UG/L
CHROMIUM	97.0		UG/L
COBALT	641		UG/L
COPPER	78.7		UG/L
LEAD	46.0		UG/L
MERCURY	0.17		UG/L
NICKEL	77.6		UG/L
SELENIUM	14.1		UG/L
VANADIUM	120		UG/L
ZINC	254		UG/L
Dissolved Metals			
BARIUM, FILTERED	4.0		UG/L
COBALT, FILTERED	2.5		UG/L
COPPER, FILTERED	3.8		UG/L
LEAD, FILTERED	1.4		UG/L
ZINC, FILTERED	7.3		UG/L

RN6MW004

Inorganics			
BARIUM	63.7		UG/L
CHROMIUM	21.5		UG/L
COBALT	4.2		UG/L
COPPER	12.6		UG/L
LEAD	10.1		UG/L
MERCURY	0.14		UG/L
NICKEL	7.5		UG/L
SELENIUM	2.5	K	UG/L
VANADIUM	32.7		UG/L
ZINC	30.8		UG/L
Dissolved Metals			
BARIUM, FILTERED	5.1		UG/L
COBALT, FILTERED	1.0		UG/L
MERCURY, FILTERED	0.14		UG/L

SGW01

Explosives			
2-AMINO-4,6-DINITROTOLUENE	2.8		UG/L
Inorganics			
ARSENIC	16.4	L	UG/L
BARIUM	307		UG/L
CHROMIUM	55.7		UG/L
COBALT	47.8		UG/L
COPPER	54.5		UG/L
LEAD	33.0		UG/L
MERCURY	0.23		UG/L
NICKEL	28.7		UG/L
VANADIUM	75.7		UG/L
Dissolved Metals			
ARSENIC, FILTERED	9.0	L	UG/L
BARIUM, FILTERED	189		UG/L
COBALT, FILTERED	33.0		UG/L
NICKEL, FILTERED	1.8		UG/L
Miscellaneous			
TOTAL ORGANIC CARBON	17		MG/L

RN6MW002

Semivolatile Organics			
DI-N-BUTYL PHTHALATE	1	J	UG/L
Inorganics			
ARSENIC	3.0	L	UG/L
BARIUM	57.5		UG/L
CHROMIUM	4.8		UG/L
COBALT	2.4		UG/L
VANADIUM	5.2		UG/L
ZINC	2.7		UG/L
Dissolved Metals			
ARSENIC, FILTERED	2.8	L	UG/L
BARIUM, FILTERED	60.8		UG/L
CHROMIUM, FILTERED	4.7		UG/L
COBALT, FILTERED	2.6		UG/L
COPPER, FILTERED	3.5		UG/L
VANADIUM, FILTERED	4.7		UG/L
ZINC, FILTERED	4.2		UG/L

LEGEND
- Groundwater Detect

Area Boundaries
- Large Scale Detonation Training Area
- Small Scale Detonation Training Area
- Suspected Location of Arsenic Pit
- — ··· — Intermittent Streams
- — 10 — Contour Interval - 1 foot
- Wooded Area
- Groundwater Flow Direction

100 0 100 Feet

NO.	DATE	REVISIONS	DRAWN BY	DATE
			D. PERRY	16-JAN-98
			CHECKED BY	DATE
			DEF	1/16/98
			COST/SCHED-AREA	
			SCALE	AS NOTED

Brown & Root Environmental

GROUNDWATER DETECTS
SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581	OWNER NO.
APPROVED BY	DATE
APPROVED BY	DATE 1-16-98
DRAWING NO. FIGURE 4-10	REV. 0

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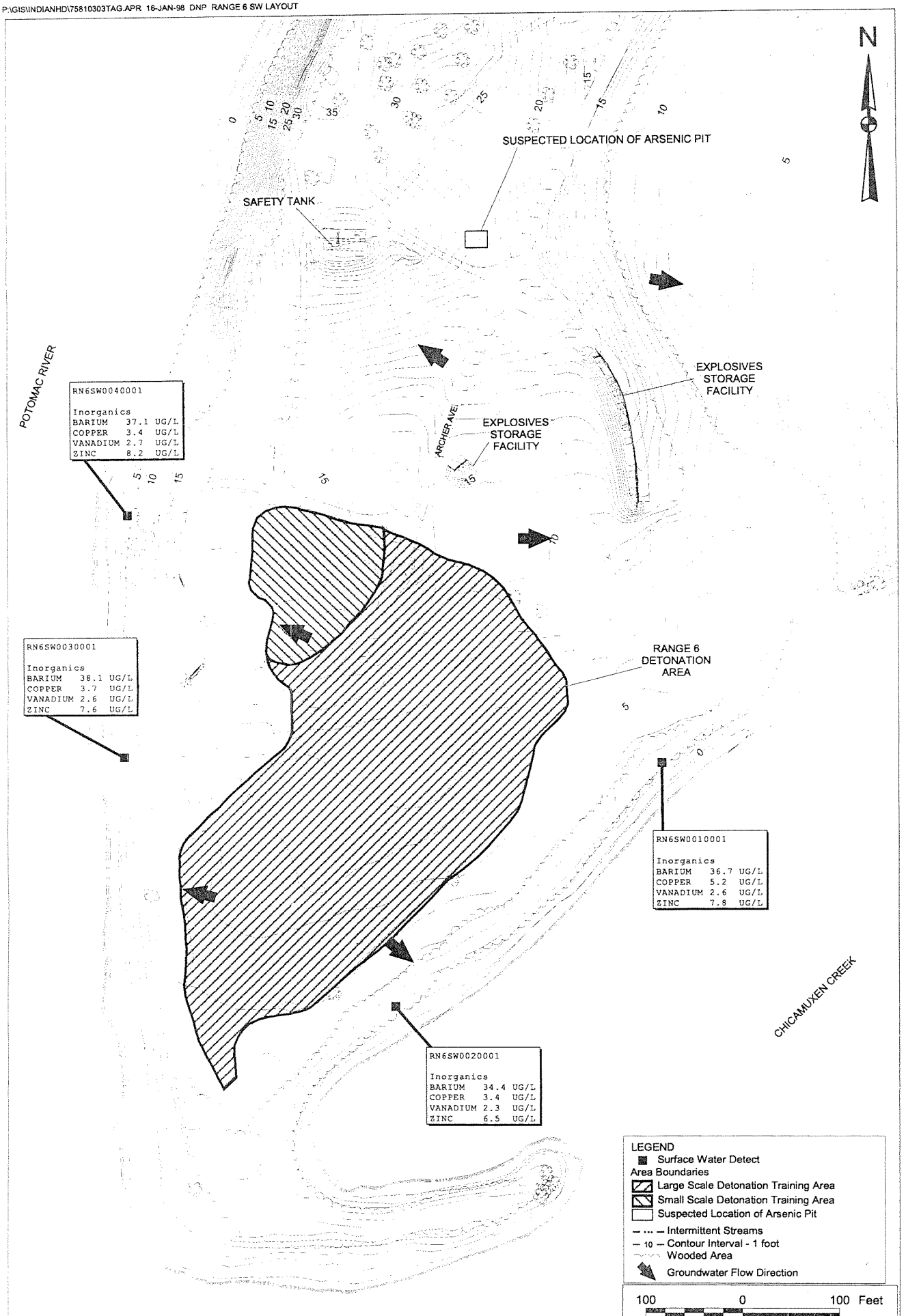

NO.	DATE	REVISIONS

DRAWN BY D. PERRY	DATE 16-JAN-98
CHECKED BY DRT	DATE 1/16/98
COST/SCHED-AREA	
SCALE AS NOTED	

Brown & Root Environmental

SURFACE WATER DETECTS
SWMU 5 - RANGE 6
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581	OWNER NO.
APPROVED BY	DATE
APPROVED BY MF	DATE 1-16-98
DRAWING NO. FIGURE 4-11	REV. 0

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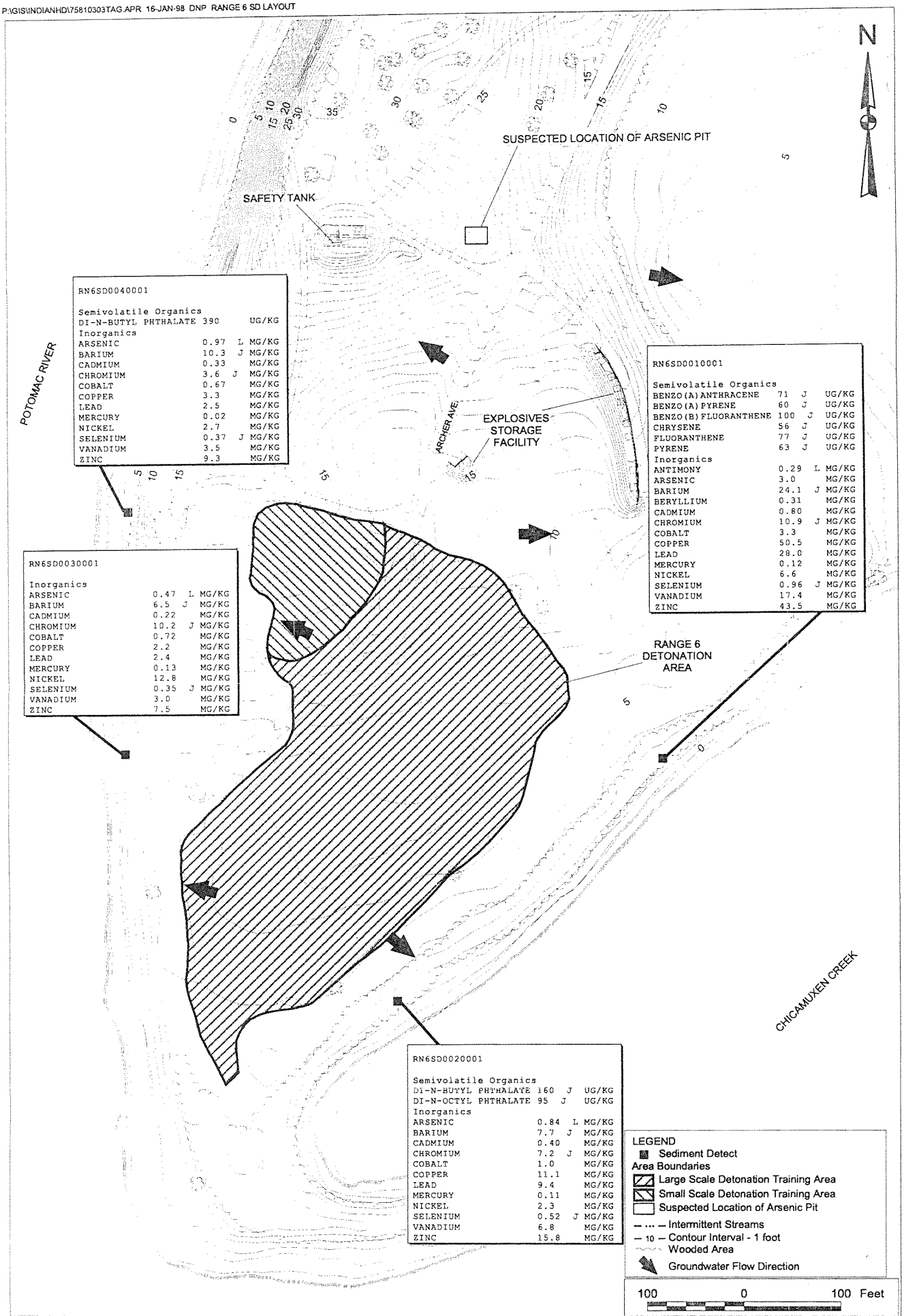


NO.	DATE	REVISIONS	DRAWN BY	DATE	Brown & Root Environmental	CONTRACT NO.	OWNER NO.
			D. PERRY	16-JAN-98		7581	
			CHECKED BY	DATE	SEDIMENT DETECTS SWMU 5 - RANGE 6 RCRA FACILITY INVESTIGATION/ VERIFICATION INVESTIGATION REPORT INDIAN HEAD DIVISION NSWC INDIAN HEAD, MARYLAND	APPROVED BY	DATE
			DCT	4/6/98			
			COST/SCHED-AREA			APPROVED BY	DATE 4-16-98
			SCALE			DRAWING NO.	REV.
			AS NOTED			FIGURE 4-12	0

5.0 SWMU 2/3 - RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A

Section 5 provides a brief description and history of Range 3 (SWMU 2) and Chicamuxen Creek's Edge Dump Site A (SWMU 3) on Stump Neck Annex. The scope and results of the environmental investigations and baseline risk assessments conducted for the RFI/VI are also presented. These two SWMUs are discussed together in this section of the report, because the Range 3 Burn Point completely overlays Chicamuxen Creek's Edge Dump Site A.

5.1 SITE DESCRIPTION AND HISTORY

5.1.1 Site Description

5.1.1.1 SWMU 2 - Range 3 Burn Point

The Range 3 Burn Point occupies approximately two acres of relatively flat, bare soil on the bank of Chicamuxen Creek. This entire unit is a man-made fill area. A two foot man-made rip-rap berm surrounds the unit on three sides. The southern and eastern borders of the site abut on Chicamuxen Creek and a marshy area, respectively. An asphalt road, Archer Avenue, runs perpendicular to the site just north of its northern border. Access to Range 3 Burn Point is controlled by a gate north of the site on Archer Avenue that closes when the range is "hot" or when operations are conducted. The Range 3 Burn Point is within the 100-year flood plain. The location and general features of Range 3 Burn Point are displayed in Figure 5-1.

5.1.1.2 SWMU 3 - Chicamuxen Creek's Edge Dump Site A

Chicamuxen Creek's Edge Dump Site A is located directly underneath Range 3 Burn Point. The boundaries of the dump site are uncertain, and no evidence of its existence is visible from the surface of Range 3. This unit, like Range 3, is a man-made fill area. Chicamuxen Creek's Edge Dump Site A falls within the 100-year flood plain. The location and general features of Chicamuxen Creek's Edge Dump Site A are displayed in Figure 5-1.

5.1.2 Site History

5.1.1.2 SWMU 2 - Range 3 Burn Point

The Range 3 Burn Point has always been active as an explosives burning or detonation area. The Range 3 Burn Pont is still currently used to periodically burn or thermally treat explosive wastes generated at the

facility and is a RCRA-regulated unit. These wastes have been burned on bare soil in the past, but now are usually burned in a thermal treatment tank which rests on bare soil. Additionally, small (2-3 pounds) explosive charges are periodically detonated near the large wood fragmentation barrier on the range. To provide the current land elevation at Range 3, the Chicamuxen Creek's Edge Dump Site A was covered with fill. The date for fill operation is unknown.

5.1.2.2 SWMU 3 - Chicamuxen Creek's Edge Dump Site A

Little is known of the history of Chicamuxen Creek's Edge Dump Site A. Facility representatives are unclear as to the materials dumped in the unit, and its precise boundaries are unknown. The entire unit is covered with fill; the date of the fill operation is unknown.

5.2 RFI FIELD INVESTIGATION

This section discusses the field activities performed at SWMUs 2 and 3 during the RFI. These activities consisted of field screening (field test-kit soil analysis and soil-gas sampling survey), and of sampling of surface soil, subsurface soil, groundwater, sediment, and surface water for fixed base laboratory analysis. Soil-gas data are provided in Appendix A. Sample log sheets are provided in Appendices D through G. Field test-kit results are provided in Appendix C. Table 5-1 provides a summary of the sampling and analytical program for the fixed-base lab samples. Table 5-2 presents a summary of monitoring well construction and groundwater-level data.

5.2.1 Field Screening

A soil-gas survey grid was established at SWMUs 2 and 3. The grid consisted of 50 points positioned on grid nodes spaced at 100-foot centers covering an area of approximately 82,500 sq. feet. Forty-eight soil-gas samples were collected and analyzed for VOCs to assist in locating VOC sources that may be associated with the dump site (SWMU 3) potentially underlying SWMU 2. One location was not sampled due to refusal, and another was omitted because it was located outside of the SWMU 2 boundary. The soil-gas sampling procedures are detailed in Section 2.1.2. The soil-gas target analyte list consisted of the following organic compounds:

- benzene
- toluene
- ethylbenzene
- methylene chloride
- 1,1-dichloroethene
- 1,1-dichloroethane
- 1,2-dichloroethane
- 1,1,1-trichloroethane
- carbon tetrachloride

- xylenes
- total volatile hydrocarbons
- total-1,2-dichloroethene
- chloroform
- trichloroethene
- tetrachloroethene

The soil-gas sampling locations are shown on Figure 5-2, and a summary of the soil-gas positive detections is presented in Table 5-3.

The survey grid that was used for the soil-gas samples was also used to establish field screening locations for samples to be analyzed using test-kits sensitive to 2,4,6-trinitrotoluene (TNT), cyclo-1,3,5-trimethylene-2,4,6-trinitrsamine (RDX), and benzene, toluene, ethylbenzene, and xylenes (BTEX). Fifty (50) near-surface soil samples (one from each grid point) were taken at a depth of 0 to 1 feet bgs, were analyzed in an attempt to locate contaminated soils for sampling and subsequent fixed based laboratory analysis. Additional information on these field test-kits is provided in Section 2.1.4. The field test-kit sample locations are shown on Figure 5-3, and results are summarized in Table 5-4.

5.2.2 Soil Investigation

Fourteen soil borings were drilled at SWMUs 2 and 3 to characterize the soil. The EnSafe Work Plan (EnSafe, Allen, and Hoshall, 1995) specified that four soil borings (RN3SB01 through RN3SB04) were to be converted into monitoring wells. In addition, 10 shallow soil boring locations (RN3SB05 through RN3SB14) were selected based on field screening results. The soil boring locations are shown on Figure 5-4.

Soil borings RN3SB01 through RN3SB04 were completed using hollow-stem auger and split-spoon sampling techniques. One surface soil sample was collected at each soil boring location at a depth of 0 to 1 foot bgs for a total of four samples. Twelve subsurface soil samples were collected from these four soil borings. The samples were obtained over 2-foot intervals ranging from beginning depths of 2 to 22 feet below ground surface (bgs). The samples were analyzed for Appendix IX metals, Appendix IX VOA, Appendix IX SVOA, explosives, TOC, and TOX. Figure 5-9 provides the specific sampling depths and positive detections for each sample collected.

Soil borings RN3SB05 through RN3SB14 were completed using direct-push, large-core sampling tools. One surface soil sample was collected at each soil boring location at a depth of 0 to 1 foot bgs for a total of 10 samples. One shallow subsurface soil sample was also collected at each boring location. These samples were obtained at a depth of 2 to 4 feet bgs. The samples were analyzed for Appendix IX metals, Appendix IX VOA, Appendix IX SVOA, explosives, TOC, and TOX (see summary Table 5-1).

5.2.3 Groundwater Investigation

Four monitoring wells (RN3MW01 through RN3MW04) were installed and sampled to determine whether groundwater contamination was present in the shallow water-table aquifer at SWMUs 2 and 3. The locations are shown on Figure 5-4. The wells were placed at locations proposed in the EnSafe Work Plan (EnSafe, Allen, and Hoshall, 1995). The samples were analyzed for the following parameters: Appendix IX metals, Appendix IX VOA, Appendix IX SVOA, explosives, TOC, TOX, and pH. Table 5-1 provides a summary of the sampling and analytical program. Table 5-2 presents a summary of monitoring well construction and groundwater-level data.

Groundwater level measurements were collected from all the wells at SWMUs 2 and 3. The results are discussed in Section 5.3.2 of this report and presented on a potentiometric surface map (Figure 5-5).

5.2.4 Surface Water and Sediment Investigation

Surface water and sediment samples were collected at two locations in Chicamuxen Creek (RN3SW/SD01 and RN3SW/SD02). A fishing boat was used to reach these sampling locations. The Sweden Point boat ramp was used to enter Chicamuxen Creek via Mattawoman Creek. Sediment samples RN3SD03 and RN3SD04 were collected from drainage ditches west and east of the site, respectively. Both locations were selected from areas receiving sediment deposition as a result of surface water drainage from the detonation area. The samples were analyzed for the following parameters: Appendix IX metals, Appendix IX VOA, Appendix IX SVOA, explosives, TOC, TOX, and pH. Table 5-1 presents a summary of the analytical program for these samples. Sample locations are shown on Figure 5-4.

5.2.5 Summary of Environmental Investigation

The RFI field investigation activities for SWMUs 2 and 3 included a soil-gas survey (48 sampling points) and field screening of soils for TNT, RDX, and BTEX (50 sampling points) to assist in the placement of soil borings. During the primary sampling event, 4 groundwater samples, 14 surface soil samples, 22 subsurface soil samples, 4 sediment, and 2 surface water samples were collected for fixed-base laboratory analyses.

5.3 SITE CHARACTERISTICS

This section discusses the site-specific geology and hydrogeology of SWMUs 2 and 3.

5.3.1 Geology

Subsurface soil conditions at the site were investigated through the drilling and logging of 14 soil borings. Waste material was not encountered at the site during the subsurface investigation. The cross-section locations are shown on Figure 5-4. Cross-section profiles (Figures 5-6 and 5-7) were generated to illustrate the subsurface materials encountered beneath SWMUs 2 and 3.

Cross Section A-A'

Cross section A-A' traverses the site from the south portion of the site (RN3MW03) to the north (RN3MW01) (Figure 5-6). The materials encountered at well RN3MW03 consist of red clay, sand, and gravel (reworked natural material), which are 3 feet thick at the ground surface and are underlain by an approximately 1-foot-thick layer of gray clay. The clay is underlain by a peat bed approximately 6 feet thick. The peat grades downward to gray silt and clay with sand layers to the to the bottom of the boring at a depth of 20.5 feet bgs. The red clay, sand and gravel, and gray clay at the ground surface extends to the RN3MW02 boring location. However, they are underlain at this location by an approximately 4-foot-thick layer of brown sand and gravel and by a 1-foot layer of gray clay. Peat is encountered below the gray clay to the bottom of the boring at a depth of 15.5 feet bgs. Approximately 410 feet to the north, at well RN3MW01, the subsurface material encountered at the ground surface to a depth of approximately 8 feet bgs consisted of brown silt and sand, most likely reworked natural fill grading material for Archer Avenue. The fill material is underlain by brown, interlayered clay, silt, and sand approximately 14 feet thick. Brown sand and gravel was encountered below the interlayered clay, silt, and sand and was present to the bottom of the boring at a depth of 32.5 feet bgs.

Cross Section B-B'

Cross section B-B' traverses west to east across the site from well RN3MW04 to well RN3MW02 (Figure 5-7). The materials encountered at well RN3MW04 consist of red clay, sand, and gravel (reworked natural material) 4-feet thick at the ground surface and are underlain by an approximately 1-foot-thick layer of gray clay. The gray clay is underlain by interbedded peat, clay, silt, sand and gravel mixtures to the bottom of the boring at a depth of 29.5 feet bgs. The red clay, sand and gravel, and gray clay at the ground surface extends to the RN3MW02 boring location. However, it is underlain at this location by an approximately 4-foot-thick layer of brown sand and gravel and by a 1-foot layer of gray clay. Peat is encountered below the gray clay to the bottom of the boring at a depth of 15.5 feet bgs.

Summary

The subsurface materials varied significantly across the study area vertically and horizontally. Reworked natural material was encountered throughout the detonation area at the ground surface to a depth of approximately 4 feet, consisting of red clay, sand, and gravel. The sediments underlying the reworked natural materials generally consisted of fine-grained sand, silt; clay, and peat.

5.3.2 Hydrogeology

Hydrogeological conditions at SWMUs 2 and 3 have been interpreted from data obtained during the field investigation activities. In addition, physical features, such as the ground surface topography (as shown on Figure 5-1), and the proximity to Chicamuxen Creek were considered in making generalized interpretations regarding groundwater flow directions. The groundwater beneath the site occurs primarily under locally semiconfining and unconfined (water table) conditions. The water table aquifer consist primarily of fine-grained sand, silt, clay, and peat. The shallow groundwater is flowing to the south toward and discharging into the Chicamuxen Creek. However, the creek is tidal, and during high tide, losing stream conditions may occur. These conditions may cause the water table to be slightly elevated near the stream (bank storage) and may change the groundwater flow pattern, to one showing groundwater flowing north away from the stream.

The groundwater is probably recharged by downward migration of precipitation through the unsaturated zone to the water table. In addition, the groundwater along the edge of stream is also periodically recharged as a result of the losing stream conditions during high tide.

During the drilling process, groundwater was encountered at varying depths, ranging from approximately 5 feet bgs at well RN3MW02, to 11 feet at RN3MW03, to 19.5 feet at RN3MW04, to 24.5-feet at RN3MW01. However, once the wells were installed and water level stabilized, depth to the groundwater was 7.77 feet bgs and 5.79 feet bgs in the wells RN3MW03 and RN3MW04, respectively. This is an indication that slightly confining aquifer conditions occur around the these wells. The depths to groundwater, groundwater elevations, and well construction summary information, are presented in Table 5-2.

A potentiometric surface map (Figure 5-5) was generated to show the estimated groundwater flow pattern at the site. The groundwater flow pattern is interpreted based on the water-level data collected from the wells and the topographical features at SWMUs 2 and 3. The water levels measured at wells RN3MW03 and RN3MW04 were not included in the data used to generate the potentiometric surface contour figure. The water level in well RN3MW03 was believed to have been measured at an unsteady state, because the well cap was placed on airtight and the well was therefore not allowed to fully recover after it had been

purged and sampled. At well RN3MW04 the water level is unusually high in elevation relative to the other wells and may be a result of the semiconfining conditions around this well. Groundwater at SWMUs 2 and 3 flows to the southeast toward and discharges into Chicamuxen Creek (shown on Figure 5-5). The average horizontal hydraulic gradient across the site is calculated graphically from Figure 5-5 to be .0016.

5.4 NATURE AND EXTENT OF CONTAMINATION

This section presents the results of the sampling and analysis of environmental samples collected at SWMUs 2 and 3 as described in Sections 2.0 and 5.2. The location of SWMUs 2 and 3 is shown on Figure 5-1. Table 5-1 provided a summary of the sampling and analytical program for environmental samples collected by B&RE and analyzed by GP, according to the methods specified in Section 2.0. Analytical results provided by GP are summarized in Tables 5-5 through 5-9 and are presented in detail in Appendix M.

All data generated by GP were validated according to EPA National and Region III guidelines. The data validation was performed by B&RE validation chemists, who routinely validate data from numerous laboratories producing data under the EPA Contract Laboratory Program (CLP). A copy of the validation packages is available to the Navy, the State of Maryland Department of the Environment, and EPA Region III upon request. Additionally, data validation memoranda summarizing the results of the data validation are presented in Appendix N.

The soil gas survey data collected by Tracer was reviewed by a B&RE project chemist familiar with the methodology used to collect conduct the survey. The results of the evaluation are presented in Section 2.0.

5.4.1 Surface and Subsurface Soil

Surface and subsurface soil samples were collected at SWMUs 2 and 3 during the field investigations conducted under CTO 287 and analyzed for the presence of site-related contamination. Summarizing from Section 5.2, the field investigation for CTO 287 included field screening of shallow soil samples from 50 locations for TNT, RDX, and BTEX. The field investigation for CTO 287 also consisted of the collection of soil gas samples at 48 locations, and surface and subsurface samples at 14 locations for fixed-base lab analysis. Analytical results for any parameter detected at least once in surface and subsurface soil samples sent to GP for analysis are presented in Tables 5-5 and 5-6, respectively. Additionally, descriptive statistics (i.e., frequency of detection, range of detection, arithmetic mean of positive detections, locations of maximum positive detection) are summarized in Tables 5-11 through 5-13, the COPC selection tables for SWMUs 2 and 3 soil. The locations of the positive detections are

depicted in Figures 5-8 for surface soil and 5-9 for subsurface soil. Table 5-10 provides a comparison of descriptive statistics for surface and subsurface soil samples.

5.4.1.1 Surface Soil Characterization

In overview, explosives and components of explosives (TNT, HMX, 1,3,5-trinitrobenzene) and degradation by-products of explosives (2-amino-4,6-dinitrotoluene) were detected in less than 21 percent of SWMUs 2 and 3 surface soil samples. Other organics were detected in less than 30 percent of SWMUs 2 and 3 surface soil samples. Most other organics were noted at maximum concentrations 1 or 2 orders of magnitude less than those reported for explosives. Two volatile organic compounds were detected at maximum concentrations ranging from 700 µg/kg (methylene chloride) to 2,600 µg/kg (acetone). Ten semivolatile organic compounds (PAHs and phthalates) were reported at maximum concentrations ranging from 45 µg/kg (benzo(a)anthracene/benzo(a)pyrene) to 780 µg/kg (bis[2-ethylhexyl]phthalate). With a few exceptions, the metals concentrations reported in surface soil samples are within the range of concentrations reported for the background soil samples. The following paragraphs describe the surface soil data in detail.

Field Screening Data

The results of the field screening of shallow soil samples collected at 50 locations for TNT, RDX, and BTEX are summarized in Table 5-4. Sampling locations were displayed on Figure 5-3. Positive detections for TNT and for RDX were reported for locations RN3FT03, RN3FT27, RNFT35, RN3FT37, and RN3FT38. The maximum concentrations detected were 19.4 mg/kg and 6.3 mg/kg for TNT and RDX, respectively. BTEX detections were reported for 18 locations at a concentration range of 10 to 35 mg/kg. It should be noted that the BTEX field screening data have significant limitations as described in Section 2.3.6.2. These positive detections were not confirmed by the fixed-base GC/MS analysis of SWMU 2 and 3 samples.

Explosives

The following explosives compounds, components of explosives compounds, or degradation by-products of explosives were detected in the surface soil samples collected at SWMU 2/3 and analyzed by GP:

Chemical	Maximum Concentration (µg/kg)
TNT	6,570
HMX	355
1,3,5-Trinitrobenezne	420
2-Amino-4,6-dinitrotoluene	525

With the exception of HMX, maximum detected concentrations were reported for the sample collected from location RN3SS05, a location in close proximity to a storage bunker. As will be discussed in the baseline human health risk assessment concentrations of explosives in SWMUs 2 and 3 surface soil samples (Table 5-11) were less than EPA Region III RBCs.

Volatile and Semi-volatile Organic Compounds

The results of the analysis of soil gas survey samples collected at 48 locations are summarized in Table 5-3. The target analyte test was provided in Section 5.2. Total volatile hydrocarbons (C_{max} = 88 µg/L), chloroform (C_{max} = 0.02 µg/L), 1,1,1-trichloroethane (C_{max} = 0.03 µg/L), trichloroethene (C_{max} = 1 µg/L), and tetrachloroethene (C_{max} = 1 µg/L) were detected sporadically.

The following volatile and semi-volatile organic compounds were detected in SWMU 2/3 surface soil samples:

Volatile Organic	Maximum Concentration (µg/kg)
Acetone	2,600
Methylene Chloride	700

Semi-volatile Organic	Maximum Concentration (µg/kg)
Benzo(a)anthracene	45
Benzo(a)pyrene	45
Benzo(b)fluoranthene	85
Bis(2-ethylhexyl)phthalate	780
Chrysene	53
Di-n-butyl phthalate	96
Di-n-octyl phthalate	290
Fluoranthene	88
Phenanthrene	57
Pyrene	81

Several of these compounds (e.g., acetone, methylene chloride, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, and di-n-octyl phthalate) are common laboratory contaminants. However, it should be noted

that the detections were not qualified as possible "blank contamination" during the validation process. The PAH compounds (e.g., benzo(a)pyrene) are by-products of combustion processes. They may not be directly related to the detonation activities at SWMUs 2 and 3; they may be the result, in part, of past and current use of gasoline fueled vehicles in the SWMUs 2 and 3 area. The phthalate compounds are common plasticizers. The concentrations of all volatile and semi-volatile organic compounds are less than the EPA Region III RBCs (Table 5-11). The detected concentrations of methylene chloride, TNT, and 2-amino-4,6-dinitrotoluene exceeded the EPA SSLs for migration of compounds from soil to groundwater (Table 5-13). However, these compounds were not detected in groundwater samples collected at SWMUs 2 and 3.

Metals

Several inorganic compounds were detected in SWMUs 2 and 3 surface soil samples at maximum concentrations exceeding the 95 percent upper tolerance limits ($UTL_{95\%}$) calculated for the background soil dataset:

Metal	Maximum Concentration (mg/kg)	$UTL_{95\%\ BACKGROUND}$ (mg/kg)	Eastern [1] United States Soils (mg/kg)	State of [2] Maryland Soils (mg/kg)
Antimony	0.87	Not detected	<1 - 8.8	NA
Arsenic	6.7	4.25	<0.1 - 73	1.1 - 7.1
Cadmium	0.95	0.26	NA	<0.01 - 5.6
Chromium	35.8	24.2	1 - 1000	15 - 100
Copper	46.7	18.7	<1 - 700	5 - 70
Mercury	0.2	0.087	0.01 - 3.4	0.04 - 0.14
Nickel	26.7	18.2	<5 - 700	ND - 30
Selenium	2.2	1.09	<0.1 - 3.9	<0.1 - 0.5
Silver	0.25	Not detected	NA	NA
Zinc	53.4	38.1	<5 - 2900	8 - 113

1 Shacklette and Boerngen, 1984
2 Dragun, 1991
NA Not available

With the exception of selenium, the positive detections reported are within the available concentration ranges reported in the literature for soils of the Eastern United States and/or the State of Maryland. The maximum concentration of selenium was within the concentration range reported for soils of the Eastern United States, but exceeded the concentration range reported for the State of Maryland. As will be discussed in the human health risk assessment, the maximum arsenic concentration exceeded the EPA

Region III RBCs for industrial exposures (Table 5-11). The maximum concentrations of arsenic and beryllium exceeded the EPA Region III RBCs for residential exposures. The detected concentrations of inorganics were less than the EPA SSLs for migration of compounds from soil to groundwater (Table 5-13).

5.4.1.2 Subsurface Soil Characterization

In overview, the target compounds detected in the subsurface soil are similar to those detected in surface soil. Target compounds were detected in subsurface soil at frequency of detections similar to those in surface soil and at concentrations within one order of magnitude of those detected in surface soil.

Explosives

TNT (C_{max} = 1,180 µg/kg) was detected in two of 22 subsurface soil samples collected. 2-Amino-4,6-dinitrotoluene (405 µg/kg), 2,4-dinitrotoluene (1,600 µg/kg), and 2,6-dinitrotoluene (140 µg/kg), each detected once, were the only other explosives noted in subsurface soil. TNT and 2-amino-4,6-dinitrotoluene were detected at different locations in subsurface soil than in surface soil. 2,4-dinitrotoluene and 2,6-dinitrotoluene were not detected in surface soils. The maximum detected concentrations of explosives in subsurface soil were less than the EPA Region III RBCs (Table 5-12). The maximum detected concentration of 2,6-dinitrotoluene, TNT, and 2-amino-4,6-dinitrotoluene exceeded the EPA SSLs for migration of compounds from soil to groundwater (Table 5-13). However, these explosive compounds were not detected in the groundwater samples collected at SWMUs 2 and 3.

Volatile and Semi-volatile Organic Compounds

The following volatile and semi-volatile organic compounds were detected in SWMUs 2 and 3 subsurface soil samples:

Volatile Organic	Maximum Concentration (µg/kg)
Acetone	4,700
2-Butanone	170
Carbon Disulfide	110
Methylene Chloride	410

Semi-volatile Organic	Maximum Concentration (µg/kg)
Bis(2-ethylhexyl)phthalate	4,000
Chrysene	52
Diethyl phthalate	340
Di-n-butyl phthalate	2,400
Di-n-octyl phthalate	38
Fluoranthene	79
N-nitrosodiphenylamine	300
Pyrene	91
Phenanthrene	88

Carbon disulfide and 2-butanone were not detected in surface soil. Several of these compounds (e.g., acetone, methylene chloride, bis(2-ethylhexyl)phthalate, diethyl phthalate, di-n-butyl phthalate, and di-n-octyl phthalate) are common laboratory contaminants. However, it should be noted that the detections were not qualified as possible "blank contamination" during the validation process. The PAH compounds (e.g., benzo(a)pyrene) are by-products of combustion processes. They may not be directly related to the detonation activities at SWMUs 2 and 3; they may be the result, in part, of past and current use of gasoline fueled vehicles in the SWMUs 2 and 3 area. The concentrations of all volatile and semi-volatile organic compounds are less than the EPA Region III RBCs (Table 5-12). The maximum detected concentration of methylene chloride exceeded the EPA SSLs for migration of compounds from soil to groundwater (Table 5-13). As noted previously, methylene chloride was not detected in groundwater samples collected at SWMUs 2 and 3.

Several inorganic compounds were detected in SWMUs 2 and 3 subsurface soil samples at maximum concentrations exceeding the 95 percent upper tolerance limits ($UTL_{95\%}$) calculated for the basewide background soil dataset:

Metal	Maximum Concentration (mg/kg)	$UTL_{95\%\ BACKGROUND}$ (mg/kg)	Eastern United States Soils (mg/kg)[1]	State of Maryland Soils (mg/kg)[2]
Cadmium	1.8	0.388	NA	<0.01 - 5.6
Copper	66.6	56.5	<1 - 700	5 - 70
Lead	301	37.5	<10 - 300	10 - 50
Mercury	3.5	0.13	0.01 - 3.4	0.04 -0.14
Nickel	25.3	22.1	<5 - 700	ND - 30
Zinc	83.7	79.5	<5 - 2900	8 - 113

1 Shacklette and Boerngen, 1984
2 Dragun, 1991

ND Not detected

The concentrations of metals in subsurface soil were comparable to those detected in surface soil with the exception of lead and mercury which were higher in subsurface soils. Maximum concentrations of cadmium, copper, lead, mercury, nickel, and zinc exceeded their respective $UTLs_{95\%}$ calculated for the basewide background data set. The positive detections reported are within the available concentration ranges reported in literature for soils of the Eastern United States. However, lead and mercury were detected at maximum concentrations exceeding background soils concentrations reported for the State of Maryland. The maximum arsenic concentration exceeded the EPA Region III RBCs for industrial exposures (Table 5-12). The maximum concentrations of arsenic and beryllium exceeded the EPA Region III RBCs for residential exposures. The maximum detected concentration of mercury exceeded the EPA SSLs for migration of compounds from soil to groundwater (Table 5-13). Mercury was not noted in groundwater at concentrations exceeding the federal Safe Drinking Water Act (SDWA) Maximum Contaminant Level (MCL).

5.4.2 Groundwater

Unfiltered and filtered groundwater samples were collected from the following monitoring wells located at SWMUs 2 and 3.

Monitoring Well	Screened Interval (feet below ground surface)	Turbidity Reading Unfiltered Sample
RN3MW001	22 to 32	17
RN3MW002	5 to 15	47
RN3MW003	10 to 20	86
RN3MW004	19 to 29	20

The results of the sampling and analysis of groundwater samples collected during CTO 287 are presented in Table 5-7 and are displayed in Figure 5-10. Additionally, descriptive statistics (i.e., frequency of detection, range of detection, arithmetic mean of positive detections, location of maximum positive detection) are summarized in Table 5-14, the COPC selection table for SWMUs 2 and 3 groundwater.

Explosives

RDX (1.2 µg/L) was the only explosive detected in groundwater. The detection was noted in a sample collected from upgradient well RN3MW01. Explosive compounds were not detected in any of the downgradient monitoring wells. Explosives were not detected in surface or subsurface soil at this location. RDX was not noted in any soil sample collected at SWMUs 2 and 3 and analyzed by GP. RDX was noted

in some samples collected and analyzed using the field screening test kits. However, these RDX field screening test kits are also sensitive to HMX as described in Section 2.3.6.

Volatile and Semi-volatile Organic Compounds

Acetone (C_{max} = 200 µg/L) in two groundwater samples (RN3MW002 and RN3MW003) and chloroform (2 µg/L) in one sample (RN3MW003) were the only volatile organic compounds detected in groundwater samples collected at SWMUs 2 and 3. No semi-volatile organic compounds were detected in the groundwater. Acetone was detected in surface and subsurface soil samples associated with monitoring well RN3MW002 and subsurface soil samples associated with RN3MW003. Chloroform was not detected in surface or subsurface soil samples associated with RN3MW003. Acetone and chloroform are common laboratory or field blank contaminants. However, it should be noted that the detections were not qualified as possible "blank contamination" during the validation process. The maximum concentration of chloroform exceeds the EPA Region III RBC for tap water ingestion (Table 5-14); but was less than the current federal SDWA MCL for trihalomethane compounds

Metals

The following metals were detected in groundwater samples collected at SWMUs 2 and 3:

Metal	Maximum Concentration (µg/L) Unfiltered Samples
Barium	169
Cadmium	1.4
Cobalt	40.4
Mercury	0.19
Nickel	28.3
Silver	0.84
Zinc	6.7

Concentrations of metals in on-site groundwater samples were less than or within 2 times the $UTL_{95\%}$ developed for the basewide background dataset. Concentrations of inorganics in unfiltered groundwater samples were comparable to filtered samples (Table 5-7) and were less than the EPA Region III RBCs for tap water ingestion (Table 5-14).

5.4.3 Surface Water

Two surface water samples were collected from Chicamuxen Creek in the vicinity of SWMUs 2 and 3 as shown on Figure 5-11. No explosives, volatile organic compounds, or semi-volatile organic compounds were detected in the surface water samples. Barium was the only metal detected. The maximum barium concentration (66.5 µg/L) was less than the EPA Region III RBC for tap water (2,600 µg/L) (Table 5-15).

5.4.4 Sediment

Four sediment samples were collected in the vicinity of SWMUs 2 and 3 as shown on Figure 5-12. Two sediment samples were collected from Chicamuxen Creek, one from a drainage ditch on the eastern side of SWMUs 2 and 3, and one from a drainage ditch on the western side of SWMUs 2 and 3.

Explosives

TNT was detected at a concentration of 521 µg/kg in the duplicate of sample (RN3SD0030101) collected from a drainage ditch on the western side of SWMUs 2 and 3. The concentrations of TNT in SWMUs 2 and 3 sediments samples were less than the EPA Region III RBCs for exposure to soil (Table 5-16). No other explosive compounds were detected in the sediments.

Volatile and Semi-volatile Organic Compounds

The following volatile and semi-volatile organic compounds were detected in the SWMUs 2 and 3 sediment samples :

Volatile Organics	Maximum Concentration (µg/kg)
Acetone	1,100
2-Butanone	110
Carbon Disulfide	29

Semi-volatile Organics	Maximum Concentration (µg/kg)
Benzo(a)pyrene	150
Benzo(b)fluoranthene	62
Bis(2-ethylhexyl)phthalate	790
Chrysene	64
Di-n-butyl phthalate	260
Fluoranthene	100
Naphthalene	150
Pyrene	83

No organics were detected in sediment sample RN3SD004 collected from a drainage ditch on the eastern side of SWMUs 2 and 3. Acetone, 2-butanone, and di-N-butyl phthalate are common laboratory contaminants, however, it should be noted that the detections reported were not qualified as possible "blank contamination" during the validation process. The PAH compounds (e.g., benzo(a)pyrene) are by-products of combustion processes. They may not be directly related to the detonation activities at SWMUs 2 and 3; they may be the result, in part, of past and current use of gasoline fueled vehicles in the area. The concentrations of all volatile and semi-volatile organic compounds are less than the EPA Region III RBCs for exposures to soil (Table 5-16).

Metals

Several inorganic compounds were detected in SWMU 2/3 sediment samples:

Metal	Maximum Concentration (mg/kg)	Site-Specific Soil Background Concentration[1]	Literature Background Concentration[2]
Antimony	2.3	ND/3.6	NA
Arsenic	9.9	4.25/24.4	6 - 36.4
Barium	142	144/191	NA
Cadmium	2.7	0.26/0.388	0.4 - 2.01
Chromium	41.2	24.2/101	36 - 66.6
Cobalt	19.7	39.7/133	NA
Copper	305	18.7/56.5	28 - 43.4
Lead	231	149/37.5	20 - 52.8
Mercury	10.4	0.87/0.13	0.08 - 0.74
Nickel	34.2	18.2/22.1	29 - 64.1
Selenium	1.1	1.09/8.93	NA
Silver	0.37	-	NA
Vanadium	56.2	53.5/133	NA
Zinc	178	38.1/79.5	168 - 251

1 Basewide background surface/subsurface soil concentrations (B&R Environmental, December 1997).

2 Data obtained from the Maryland Department of the Environment (B&R Environmental, December 1997)

Overall concentrations of inorganics were lowest in sediment sample RN3SD004 collected from a drainage ditch on the eastern side of SWMUs 2 and 3. With the exception of cadmium, copper, lead, mercury, nickel, and zinc, the reported detections are less than or within the range of the basewide background soils concentrations and sediment concentrations reported for 3 Potomac estuary stations

monitored by the Maryland Department of the Environment. As shown on Table 5-16, maximum concentrations of cadmium, cobalt, copper, and mercury exceeded $UTLs_{95\%}$ calculated for the basewide freshwater sediment background data set. Arsenic is the only metal detected in the SWMUs 2 and 3 sediment at concentrations exceeding EPA Region III RBCs for soils developed assuming an industrial landuse scenario (Table 5-16).

5.5 CONTAMINANT FATE AND TRANSPORT

Explosives were detected in 3 of 14 surface soil samples and 2 of 22 subsurface soil samples at SWMUs 2 and 3. RDX was detected at a low concentration in one upgradient monitoring well (RN3MW001) but not in soil at the same location. No explosives were detected in surface water samples associated with SWMUs 2 and 3. The data suggests that no significant migration of explosives from surface soil to groundwater is occurring at SWMUs 2 and 3.

Volatiles (mainly acetone and methylene chloride) and semi-volatiles (PAHs and phthalates) were detected infrequently in surface and subsurface soil. With the exception of acetone and chloroform, no organics were detected in groundwater at SWMUs 2 and 3. Acetone and methylene chloride are common laboratory contaminants. PAHs and phthalates have low water solubilities and high organic carbon partition coefficients which make them strongly bind to soil. Consequently migration of volatiles and semi-volatiles from soil to groundwater is not expected to occur at SWMUs 2 and 3.

Several metals in surface and subsurface soil, groundwater, and sediment were detected at SWMUs 2 and 3 at concentrations exceeding basewide background concentrations. Mercury was detected at concentrations exceeding basewide background concentrations in all media. Silver was detected at concentrations exceeding basewide background concentrations in surface soil, groundwater, and sediment. Barium and cobalt were detected at concentrations within basewide background levels in soil but exceeding basewide background concentrations in groundwater and sediment. The concentrations of metals in surface soil are lower than those in sediments suggesting that there may be other sources for metals in sediment. The site data suggests that metals may be migrating from soil to groundwater and sediment at SWMUs 2 and 3. However, the pattern of contaminant migration is not clear.

TNT and PAHs were detected in sediment sample RN3SD003 located on the eastern side of SWMUs 2 and 3 area. TNT and PAHs were also detected in SWMUs 2 and 3 surface soil samples located upstream of RN3SD003. TNT and PAHs were not detected in the sediment samples and surface water samples collected downstream of RN3SD003 in Chicamuxen Creek. This suggests that limited migration of TNT and PAHs from SWMUs 2 and 3 soil to off site sediment has occurred.

5.6 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section contains a data evaluation and the site-specific risk assessment for the identified exposure scenarios for SWMUs 2 and 3. The risk assessment methodology was described in Section 2.5, and detailed calculations are contained in Appendix P.

5.6.1 Data Evaluation/Selection of Chemicals of Potential Concern

5.6.1.1 Data Evaluation SWMU 2/3 - Range 3 Burn Point/Chicamuxen Creek's Edge Dump Site A

All field samples collected for fixed-base laboratory analysis for the RFI/VI at NSWC Indian Head underwent the data validation process as described in Section 2.3. This section summarizes the SWMU-specific data validation results for SWMU 2/3 Range 3 Burn Point/Chicamuxen Creek's Edge Dump Site A. Analytical data for samples collected from SWMUs 2 and 3 are contained in SDGs 9707049, 9708099, 9708030, 9708042, 9707039, 9707124, and 9707050.

Some positive analytical results for acetone, methylene chloride, di-n-butyl phthalate, silver, thallium, tin, antimony, beryllium, and copper associated with SWMUs 2 and 3 soils were flagged "B" during data validation indicating that they are false positives attributable to field/laboratory blank contamination. Additionally, all positive analytical results for methylene chloride associated with SWMUs 2 and 3 sediments were flagged "B" during data validation indicating that they are false positives attributable to field/laboratory blank contamination. Finally, some positive results reported for methylene chloride in SWMUs 2 and 3 groundwater samples were flagged B during data validation indicating that they are false positives attributable to field/laboratory blank contamination. Blank contamination was not noted for surface water.

Nondetected results for the organic compounds: 2-butanone, acrolein, acrylonitrile, acetonitrile, propionitrile, isobutyl alcohol, vinyl acetate, 4-nitroquinoline-1-oxide, famphur, and kepone, in most soil, surface water, sediment and groundwater samples were qualified as rejected, "UR", during data validation. Nondetected results for 3-nitroaniline and 1,4-dioxane were qualified as rejected, "UR", in the soil samples RN3SS0100101, RN3SS0130101, RN3SB0130101, RN3SS0140101, and RN3SB0140101. All 2-butanone results were qualified as rejected, "UR", in all soil samples collected, except for sample RN3SB0030101, in which the positive 2-butanone result was qualified as biased low, "L". No other positive results were reported for any of the noted compounds. The rejection of results for the noted compounds were the result of extremely low initial and continuing calibration relative response factors

(RRF) (RRF less than 0.050). These low response factors indicate that the laboratory's instruments could not achieve satisfactory sensitivity for the aforementioned compounds which severely compromises the associated positive and nondetected results.

The method of analysis for the determination of these volatile and semivolatile organic compounds utilizes Gas Chromatography/Mass Spectrometry (GC/MS). Isobutyl alcohol and 2-butanone are soluble in water and are difficult to purge effectively. There are technical adjustments the laboratory could have made that would have improved the responses for isobutyl alcohol and 2-butanone. Vinyl acetate may react under certain chromatographic conditions, thus yielding a poor instrument response. Kepone is best analyzed by GC using an Electron Capture Detector (ECD). Acrolein and Acrylonitrile, chemically, are more suited for analysis by High Performance Liquid Chromatography (HPLC). Acetonitrile may be analyzed using GC with a Nitrogen-Phosphorus Detector (NPD). The chemical properties of propionitrile, 1,4-dioxane, 3-nitroaniline, 4-nitroquinoline-1-oxide, and famphur may restrict these compounds from yielding satisfactory chromatographic response regardless of the analytical method of detection. However, the substitution of alternative analytical methods would be cost prohibitive in comparison to the value they would add to the final data. Therefore, the poor response of the aforementioned compounds is attributable to both the specific chemical properties and the use of GC/MS as an all encompassing method of analysis in an attempt to eliminate a variety of complex alternatives. Furthermore, the rejection of results for these compounds in environmental matrices does not create any significant data gaps that would warrant resampling.

Nondetected results for antimony in soil samples RN3SB0010101 and RN3SB0010201 were qualified as rejected as a result of extremely low matrix spike recovery. These rejections are considered to be insignificant since a total of 36 soil samples were collected and only the antimony results for two samples collected from the same boring (RN3-SB001) were considered unreliable. Antimony was detected in fourteen of the remaining 34 soil samples. No other inorganic analyte results from SWMUs 2 and 3 samples were rejected during the data validation process.

5.6.1.2 Selection of Chemicals of Potential Concern

Chemicals of potential concern at this site were selected using the risk-based COPC screening levels (i.e., the Section 2.0 benchmarks) described in Section 2.5.1. COPC summary screening tables for all media are presented in Tables 5-11 through 5-16. The list of COPCs for SWMUs 2 and 3 is summarized in Table 5-17.

Maximum chemical concentrations in soil were compared to EPA Region III RBCs and site-specific background levels. Additionally, maximum concentrations in soil were compared to EPA SSLs for transfers from soil to air and for migration to groundwater to justify the exclusion of the inhalation pathway and to provide a cursory evaluation of the potential transport of soil chemicals to groundwater. Since the current and expected future site use is nonresidential, only those compounds with concentrations exceeding nonresidential RBCs will be retained as COPCs.

A discussion of the chemicals identified as COPCs and the rationale for their selection is provided in the following subsections.

Surface Soil

Two VOCs, 10 SVOCs (primarily PAHs and phthalates), four explosives, and 15 inorganics were detected in surface soil (0 to 2 feet bgs) at SWMUs 2 and 3. A comparison of the maximum detected soil concentrations to EPA Region III RBCs and EPA SSLs for soil to air is presented in Table 5-11. No VOCs, SVOCs, or explosive chemicals were present in surface soil at concentrations in excess of the RBCs or SSLs. Arsenic was the only inorganic with a maximum detected concentration which exceeded the RBCs for industrial exposures. Arsenic and beryllium were the only inorganics with maximum detected concentrations which exceeded the RBCs for residential exposures. Future site use is anticipated to be nonresidential so only those compounds exceeding nonresidential RBCs were retained as COPCs. Therefore, only arsenic was selected as a COPC.

Maximum surface soil concentrations were also compared to EPA SSLs for migration to groundwater (Table 5-13). Methylene chloride, TNT, and 2-amino-4,6-dinitrotoluene were the only chemicals detected in surface soil at concentrations exceeding the SSLs. Although it should be noted that these compounds were not detected in site groundwater.

Surface/Subsurface Soil

Four VOCs, 14 SVOCs (primarily PAHs and phthalates), four explosives, and 15 inorganics were detected in surface/subsurface soil (0 to >10 feet bgs) at SWMUs 2 and 3. A comparison of the maximum detected soil concentrations to EPA Region III RBCs and EPA SSLs for soil to air is presented in Table 5-12. No VOC or SVOCs were detected in surface/subsurface soil at concentrations in excess of the RBCs or SSLs. Arsenic was the only inorganic with a maximum detected concentration which exceeded the RBCs for industrial exposures. 2-Amino-4,6-dintrotoluene, arsenic and beryllium were the only compounds with maximum detected concentrations which exceeded the RBCs for residential exposures. Future site use is

anticipated to be nonresidential so only those compounds exceeding nonresidential RBCs were retained as COPCs. Therefore, only arsenic was selected as a COPC.

Maximum surface/subsurface soil concentrations were also compared to EPA SSLs for migration to groundwater (Table 5-13). Methylene chloride, TNT, 2,6-dinitrotoluene, and mercury exceeded their respective SSLs. Although it should be noted that methylene chloride, TNT, 2-amino-4,6-dinitrotoluene 2,6-dinitrotoluene were not detected in site groundwater.

Groundwater

Two VOCs and seven inorganics were detected in unfiltered groundwater samples at SWMUs 2 and 3. Eight inorganics were found in the filtered groundwater samples. A comparison of the maximum detected groundwater concentrations to EPA Region III RBCs is presented in Table 5-14. The maximum concentration of all chemicals in unfiltered groundwater samples were less than the RBCs with the exception of chloroform. The maximum concentration of chloroform (2 µg/L) exceeded its RBC (0.15 µg/L) but was equal to the site-specific background concentration (2 µg/L). The maximum concentration of all chemicals in filtered groundwater samples were below the RBCs. No target analytes in groundwater were identified as COPCs.

Surface Water/Fish

Barium was the only chemical detected in surface water samples at SWMUs 2 and 3. The detected concentration of barium in surface water was less than the EPA Region III RBCs for tap water (Table 5-15). In addition, estimated concentrations of barium in fish tissue were less than EPA Region III RBCs for fish ingestion and this exposure scenario was eliminated from further consideration.

Sediment

Three VOCs, eight SVOCs (PAHs and phthalates), one explosive, and 15 inorganics were detected in sediment samples at SWMUs 2 and 3. A comparison of the maximum detected sediment concentrations to EPA Region III RBCs for soil is presented in Table 5-16. The maximum concentrations of benzo(a)pyrene, arsenic, and mercury, exceeded the residential screening levels, but no residential exposures are anticipated for SWMUs 2 and 3. The maximum concentration of arsenic exceeded the nonresidential RBC, but was less than the basewide background arsenic concentration. Consequently arsenic is not considered a COPC at SWMUs 2 and 3.

5.6.2 Exposure Assessment

The location of SWMUs 2 and 3 is shown on Figure 5-1. The area has always been used as an explosives burning or detonation area. Currently it is still used to periodically burn or thermally treat explosive wastes generated at the facility and is a RCRA-regulated unit. In addition, small explosive charges are periodically detonated near the large wood fragmentation barrier on the range. Because of the potential for unexploded ordinance at the site, it is anticipated that future use of the site will remain nonresidential. Potential receptors for SWMUs 2 and 3 include current/future maintenance workers, current/future full-time employees, and future construction workers. Since access to SWMUs 2 and 3 is restricted by a gate north of the site civilian trespassers were not considered as potential human receptors.

Maintenance workers and full-time employees are assumed to enter the site to conduct maintenance (such as mowing) and related activities. The only medium of concern for these workers would be surface soil (0 to 2 feet bgs). Exposure to subsurface soil is expected to be limited to ground-intrusive activities. Although no major construction projects are planned for the site or the surrounding areas, construction workers are evaluated as potential receptors to assess future exposure to subsurface soil (assumed to be exposed to surface and subsurface soil to an estimated maximum depth of 10 feet bgs or greater).

The primary routes of exposure for potential human receptors at SWMUs 2 and 3 are incidental ingestion of soil and dermal contact with soil. Exposure routes associated with soil contact are evaluated for maintenance workers, full-time employees and future construction workers. Other potential exposure routes included incidental dermal contact with groundwater by construction workers.

Ingestion of groundwater, inhalation of volatile emissions, direct contact with surface waters and sediments, and ingestion of wildlife were not considered for the following reasons:

- The shallow aquifer at NSWC is not used as a potable water supply either on base or in surrounding off-base areas. Shallow groundwater at the site is tidally influenced and the source of potable water is the deeper aquifers. The deeper aquifers are not believed to be impacted by the surficial aquifer. Thus, groundwater exposures by base personnel are eliminated.

- Potential exposure to fugitive dust and volatile emissions from SWMUs 2 and 3 is considered to be minimal, thereby eliminating the need for quantitative evaluation of this exposure pathway. As shown in Tables 5-11 and 5-12 all reported surface and subsurface soil concentrations are less than the EPA SSLs for transfers from soil to air (USEPA, 1996a).

- Direct contact with surface water and sediment by potential human receptors was not evaluated, because there were no COPCs identified for these media. Additionally, no COPCs were identified for consumption of fish taken from nearby surface waters.

- Ingestion of wildlife by hunters and their families was eliminated as a significant exposure pathway. The large size of the home ranges for game species at NSWC Stump Neck relative to the size of Range 3 is not expected to result in significant foraging at the site. Moreover, the restrictive nature of the site would limit access both to the game species and to human receptors.

Exposure assumptions for these receptors are presented in Table 2-14. Table 5-17 presents a summary of the COPCs and exposure point concentrations for SWMUs 2 and 3. A summary of the potentially significant exposures identified for quantitative evaluation for SWMUs 2 and 3 is provided in Table 5-18. The dose-response factors (RfDs and CSFs) for COPCs were presented in Tables 2-10 and 2-11. Appendix P contains the toxicological profiles for the COPCs.

5.6.3 Risk Characterization

Potential cancer risks and hazard indices were calculated for maintenance workers, full-time employees and construction workers (future land use) using the methodology presented in Section 2.0. Both RME and CTE exposure scenarios were evaluated. Table 5-19 contains a summary of the estimated risks for SWMUs 2 and 3. All spreadsheets containing the detailed, chemical-specific risks for the site are included in Appendix P. The following text presents a summary of the results of the risk characterization.

5.6.3.1 Carcinogenic Effects

All estimated cancer risks for exposures to soil were within or below EPA's target risk range of 10^{-4} to 10^{-6}. The estimated cancer risk for maintenance workers based on RME and CTE exposures to surface soil were 7.3×10^{-7} and 1.0×10^{-7}, respectively. The estimated cancer risk for full-time employees based on RME and CTE exposures to surface soil were 3.7×10^{-6} and 1.0×10^{-6}, respectively. The estimated cancer risk for construction workers based on RME and CTE exposures to surface and subsurface soil were 2.5×10^{-7} and 1.6×10^{-7}, respectively.

5.6.3.2 Noncarcinogenic Effects

All estimated hazard indices were below 1.0 indicating that no toxic effects are anticipated for these receptors under the defined exposure scenarios. The hazard indices for maintenance workers exposed to

surface soil were 0.0045 for RME exposures and 0.00075 for CTE exposures. The hazard indices for full-time employees exposed to surface soil were 0.023 for RME exposures and 0.0075 for CTE exposures. The hazard indices for construction workers exposed to surface and subsurface soil was 0.039 for RME exposures and 0.013 for CTE exposures.

5.6.3.3 Qualitative Evaluation of Groundwater

Because site groundwater from surficial aquifers is not currently used or expected to be used in the future as a potable water supply and since potential exposure to this medium is not quantitatively addressed in the human health risk assessment (i.e., future residential use is not considered), a brief qualitative assessment of groundwater is included in this section. Table 5-20 contains a summary of the qualitative assessment of this medium.

Maximum detected concentrations in unfiltered and filtered groundwater samples collected at SWMUs 2 and 3 were compared to EPA MCLs, SMCLs, and EPA Region III RBCs for tap water. As previously indicated, the shallow aquifer at the site is not used as a source of drinking water either on- or off-base. Therefore, the comparison of site concentrations to primary MCLs, SMCLs, and RBCs serves as a conservative assessment of potential risks.

Chloroform was the only compound detected in unfiltered groundwater samples at concentrations which exceeded RBCs. Chloroform was detected in only one of three groundwater samples and was not detected in soil at SWMUs 2 and 3. In addition chloroform is a common laboratory contaminant. Consequently the presence of chloroform in one groundwater sample at SWMUs 2 and 3 is not believed to be site related. Concentrations of all compounds in unfiltered groundwater samples were below MCLs and SMCLs. Concentrations of all compounds were below RBCs, MCLs, and SMCLs in filtered groundwater samples.

The qualitative analysis indicates that groundwater is suitable for potable use in its untreated state.

5.6.4 Uncertainty Analysis

A detailed discussion of uncertainties associated with the various aspects of risk assessment in general was provided in Section 2.8. There are no site-specific uncertainties for SWMUs 2 and 3.

5.6.5 Summary of Risk Assessment

The following items summarize the human health risk assessment for SWMUs 2 and 3:

- The human health risk assessment for SWMUs 2 and 3 considered exposures to maintenance workers, full-time employees, and construction workers. Potential exposure pathways for direct contact with soil for all receptors included incidental ingestion and dermal contact with soil. Inhalation of fugitive dust and volatiles from soil were not considered since concentrations of all COPCs in soil were less than the EPA soil to air SSLs.

- Incremental lifetime cancer risks for all receptors exposed to soil were within or below EPA's target risk range of 10^{-4} to 10^{-6}.

- Noncarcinogenic risk estimates (HIs) for all receptors were less than 1.0 indicating that no toxic effects are anticipated for these receptors under the defined exposure scenarios.

5.7 ECOLOGICAL ISSUES

This section presents the ERA, ecological risk management, and ERA/risk management summary for SWMUs 2 and 3 as well as any site-specific uncertainties.

5.7.1 Ecological Risk Assessment

This section presents the results of the ecological risk assessment performed at SWMUs 2 and 3 during the RFI/VI. Included are a discussion of the preliminary problem formulation, effects characterization, exposure assessment, and risk characterization.

5.7.1.1 Preliminary Problem Formulation

This section on preliminary problem formulation includes a discussion of available habitats, ecological receptors, contaminant sources, release mechanisms, migration pathways, exposure routes, selection of preliminary contaminants of potential concern (PCOCs), assessment and measurement endpoints, and the conceptual site model.

Habitat Types and Ecological Receptors

SWMUs 2 and 3 are located along Chicamuxen Creek, approximately 4000 feet from the end of the Stump Neck Annex peninsula (Figure 5-1). Most of the site consists of disturbed, bare soil. A large, slightly curved wall consisting of railroad ties approximately 20 feet high and 100 feet wide is located in the southwest portion of the site, and a few burn pans and other equipment are located on the bare soil areas.

These items are used for ordnance disposal activities. The northern end of the site, near the end of Jager Road, is 10 to 20 feet higher in elevation than the range area. A thick, steep, riprap retaining wall, encased in wire extends the entire perimeter of the site adjacent to Chicamuxen Creek. The wall is approximately 2 feet higher in elevation than the bare soil behind it.

Tidal marsh is located to the northeast and southwest of the riprap, and is dominated by cattail (*Typha* spp.) in the lower elevations and common reed (*Phragmites australis*) closer to the shoreline. The upper portion of the site, along the hill, is covered with grasses, primarily turfgrass. The hillside areas to the east and west of the site are wooded, consisting mainly of maples (*Acer* spp.), tulip poplar (*Liriodendron tulipera*), and oaks (*Quercus* spp.). A thin strip of small trees is located between the bare soil and turfgrass in the northeastern portion of the site. Also, a thin strip (5-8 feet wide) of small brush extends along the landfill side of the rip-rap wall.

Although the grassy area north of the site is located along a small hill, the majority of the site is extremely flat and surrounded by a rip-rap wall. Therefore, most precipitation at the site will tend to pond and infiltrate into the ground surface. No drainage swales or depressions are located on the site proper. However, runoff may enter the marsh areas from two drainage ditches at the extreme ends of the site (where the riprap wall terminates). Communication between shallow groundwater and Chicamuxen Creek probably occurs at the site.

The site itself is mostly disturbed, bare soil with turfgrass at one end. Thus, it provides poor terrestrial habitat. In addition, ongoing activity at the site and related noise probably deters most terrestrial receptors from using the site. The tidal marsh areas to the northeast and southwest, however, provide excellent semiaquatic habitat. The wooded area north of the site is considered part of the Porter Woods Protection Area and provides excellent upland habitat. An active bald eagle's nest is located in this area, approximately 1000 feet from the site. A detailed description of Porter Woods and the bald eagle's nest is presented in the discussion of the Chicamuxen Creek's Edge Dump Site B (SWMU 3) ERA (Section 7.0). Chicamuxen Creek contains an excellent tidal freshwater fishery. Duck hunting is also popular on the Creek.

Contaminant Sources, Release Mechanisms, and Migration Pathways

The potential major contaminant source at SWMUs 2 and 3 is residual soil contamination from historical landfilling activities and from ordnance demilitarization at the site, which is currently active. The contaminant release pathways from this area include overland runoff, infiltration of contaminants, and air transport.

Precipitation runoff can carry contaminants via overland runoff to Chicamuxen Creek and the adjacent marsh areas, mainly along the sides of the peninsula where the riprap ends. Also, infiltrating precipitation can cause the contamination of subsurface soil and groundwater. Such infiltration is probably is a major contaminant transport mechanism, since most of the peninsula is flat and water in low-lying areas from precipitation will tend to pond and infiltrate. Contaminants can be deposited subsequently in sediment or surface water and can potentially accumulate in the tissues of aquatic organisms in Chicamuxen Creek and the marshes.

In addition, contaminated fugitive dust can be generated during ground-disturbing activities on the bare soil areas, such as construction, excavation, or ordnance demilitarization. The contaminants could then be dispersed in the surrounding environment and transported to downwind locations, where they could be entrained in surface soil, surface water, or sediment.

Exposure Routes

Terrestrial animals at SWMUs 2 and 3 can be exposed to soil contaminants through the ingestion of contaminated food items. In addition, animals can incidentally ingest soil while grooming fur, preening feathers, digging, grazing close to the soil, or feeding on items that are covered with soil (such as roots and tubers). Terrestrial vegetation can be exposed to contaminants through direct aerial deposition and root translocation. Terrestrial receptors can also come into contact with contaminants in surface water in Chicamuxen Creek and the marshes by using it for drinking, although this exposure route generally represents a negligible portion of total exposure for most receptors. Aquatic and semiaquatic organisms can be exposed to contaminants through direct contact with surface water and sediments in Chicamuxen Creek and the marshes, incidental ingestion of surface water and sediments in the Chicamuxen Creek and the marshes, and consumption of contaminated food items. Exposure to contaminants in the soil via dermal contact can occur but is unlikely to represent a major exposure pathway because fur, feathers, and chitinous exoskeletons minimize the transfer of contaminants across dermal tissue.

Volatilization and soil-bound contaminant airborne suspension may occur on the bare areas of the site. Yet, inhalation does not represent a significant exposure pathway because this investigation assumes that air contaminant concentrations are quite low, even for burrowing wildlife. Furthermore, inhalation ecotoxicity data for chronic exposure are lacking. Hence, the air pathway was not considered for ecological receptors.

Selection of Preliminary Contaminants of Concern (PCOCs)

The PCOC selection process for this ERA is described in Section 2.6.

Assessment and Measurement Endpoints

A description of assessment and measurement endpoints for this ERA is presented in Section 2.6.

Conceptual Site Model

Figure 5-13 shows the conceptual model for SWMUs 2 and 3.

5.7.1.2 Ecological Effects Characterization

Ecologically based screening levels (concentrations of contaminants in various media protective of ecological receptors) were compared to exposure-point concentrations of detected analytes in surface water, groundwater, sediment, and surface soil to determine whether the analytes should be retained as ecological PCOCs for SWMUs 2 and 3. The thresholds were USEPA Region III BTAG screening levels (EPA, 1995), although AWQC were used for groundwater. The derivation of toxicity reference values (TRVs) for SWMUs 2 and 3 foodchain modeling is described in Section 2.6, as well as the selection of representative receptors. Briefly, the short-tailed shrew, woodcock, red fox, red-tailed hawk, meadow vole, and great blue heron were selected as representative ecological receptors for the foodchain modeling at SWMUs 2 and 3.

5.7.1.3 Exposure Assessment

This section presents the ecological exposure assessment for SWMUs 2 and 3 and includes a discussion of exposure-point contaminant concentrations.

Exposure-Point Contaminant Concentrations

The maximum detected contaminant concentrations in surface water, groundwater, sediment, and soil were used as exposure-point concentrations for screening against USEPA Region III BTAG screening levels (EPA, 1995) and AWQC. The maximum and mean concentrations of contaminants detected in SWMUs 2 and 3 media were used in the foodchain modeling.

5.7.1.4 Risk Characterization

This section presents the results of the ecological risk assessment for SWMUs 2 and 3.

Results - Ecological Screening Assessment

Barium was the only detected analyte in surface water. The concentrations reported did not exceed the BTAG screening level (Table 5-21).

Arsenic, cadmium, copper, lead, mercury, nickel, and zinc had maximum concentrations in sediments that exceeded BTAG screening levels, and thus, were retained as PCOCs (Table 5-22). Antimony, barium, cobalt, selenium, tin, vanadium, two VOCs (2-Butanone and carbon disulfide) and one explosive (TNT) were retained as sediment PCOCs since no BTAG screening levels were available.

Antimony, beryllium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc were retained as inorganic surface soil PCOCs, since their maximum concentrations exceeded BTAG screening levels (Table 5-23). Methylene chloride was retained as a surface soil PCOC because its maximum concentration exceeded its BTAG screening level (Table 5-23). Three phthalates, acetone, and four explosives/energetics were retained as surface soil PCOCs, since no BTAG screening levels were available.

Barium, cadmium, cobalt, mercury, and silver had maximum groundwater concentrations in excess of AWQC and were retained as PCOCs (Table 5-24). Acetone was retained as a groundwater PCOC, since no AWQC were available.

Results - Foodchain Modeling

Arsenic, cadmium, cobalt, copper, lead, mercury, vanadium, and zinc were retained as inorganic PCOCs after the aquatic foodchain modeling since at least one of the EEI values calculated for these inorganic compounds exceeded 1.0 when maximum concentrations were evaluated (Table 5-25). These inorganics except vanadium also had at least one EEI greater than 1.0 when mean concentrations were evaluated (Table 5-25). Antimony, 2-butanone, acetone, and carbon disulfide were retained as PCOCs after the aquatic foodchain modeling, since no toxicity data were available.

Antimony, chromium, copper, lead, mercury, selenium, zinc, and TNT were retained as PCOCs after the terrestrial foodchain modeling, since at least one EEI calculated for the chemicals exceeded 1.0 (Table

5-26). All of these inorganics except zinc and TNT had an least one EEI greater than 1.0 when mean concentrations were evaluated (Table 5-27). Di-n-octylphthalate, methylene chloride, 1,3,5-trinitrobenzene, and 2-amino-4,6-dinitrotoluene were retained as PCOCs after the terrestrial foodchain modeling, since no toxicity data were available.

5.7.2 Risk Management

Risk management considerations for contaminants in SWMUs 2 and 3 sediments and surface soils are discussed below.

5.7.2.1 Sediments

Arsenic, cadmium, copper, lead, mercury, vanadium, and cobalt were all retained as sediment PCOCs after the aquatic foodchain modeling. Antimony was included as a PCOC after the foodchain modeling, since no toxicity were available. The following paragraphs discuss risk management considerations for each of these metals and for the organics initially selected as PCOCs for sediments.

The maximum detected concentration of arsenic in SWMUs 2 and 3 sediments (9.9 mg/kg) was less than the maximum detected concentration in base-wide background freshwater sediment samples (10.6 mg/kg) but higher than the average concentration in background sediments (3.3 mg/kg; Table 5-28). The average concentration of arsenic in sediments (6.2 mg/kg) is approximately equal to the lower alternate guideline presented on Table 5-28 (6.0 mg/kg), which is an MOE LEL, which is indicative of low potential risks. The maximum concentration of arsenic is slightly higher than the LEL and the ER-L of 8.2. The ER-M for arsenic is 70 mg/kg.

Cadmium was detected in two of four sediment samples. The maximum detected concentration of cadmium (2.7 mg/kg) is higher than the average base-wide background concentration and slightly higher than the BTAG screening level (the ER-L) and the alternate screening level presented on Table 5-28 (the LEL). The maximum concentration is less than the SEL of 10 mg/kg.

The maximum detected concentration of copper in sediments (305 mg/kg) was significantly higher than the average base-wide background (9.5 mg/kg; Table 5-28), and both the alternate guidelines (the LEL and SEL). One other reported detection is higher than the SEL, as is the average concentration in sediments (134.7 mg/kg).

The maximum and average concentrations of lead in SWMUs 2 and 3 sediments, 231 and 86.3 mg/kg, respectively, are significantly higher than base-wide background concentrations, and the maximum

concentration is slightly lower than the SEL (Table 5-28). All detections of lead in sediments are between the LEL and the SEL (Section 5.4).

The maximum detected concentration of mercury in sediments (10.4 mg/kg) was significantly higher than base-wide background concentrations (Table 5-28), and the SEL for mercury (2.0 mg/kg). The other two detections of mercury were between the LEL and SEL and below the LEL, respectively.

The maximum concentration of zinc in sediments (178 mg/kg) was higher than the LEL (alternate guideline), but far below the SEL (Table 5-28). The average concentration of zinc (125.5 mg/kg) was less than the BTAG screening level (an ER-L), but higher than the average base-wide background concentration. The maximum base-wide background concentration (158 mg/kg) exceeded the average concentration in SWMUs 2 and 3 sediments (Table 5-28).

The maximum and average concentrations of vanadium and cobalt in sediment were greater than the average base-wide background concentrations (Table 5-28). No BTAG or alternative guidelines were available for vanadium or cobalt, although vanadium is rarely toxic in the environment (Mailman, 1980). The maximum and average concentrations of cobalt, 19.7 and 13.3 mg/kg, respectively, were comparable to the maximum concentration of cobalt in base-wide background sediments (17.6 mg/kg). All of the EEIs calculated for vanadium in the aquatic foodchain modeling were less than 1.0 when mean concentrations were evaluated.

Antimony was detected in what appears qualitatively to be relatively low concentrations (2.3 and 0.94 mg/kg), but the ecotoxicological significance of these concentrations cannot be fully assessed without adequate toxicity data.

In summary, for the inorganics in sediment, maximum concentrations of arsenic, cadmium, and zinc exceeded average base-wide background concentrations for freshwater sediments, but maximum concentrations did not significantly exceed conservative screening levels. Maximum concentrations of these metals were also less than less conservative alternate guidelines. Antimony, cobalt, and vanadium had maximum concentrations that exceeded background, but the reported concentrations do not appear to be significantly elevated. Hence, none of these metals are selected as inorganic PCOCs in sediments. Copper, lead, and mercury had maximum and average concentrations that exceeded background concentrations, BTAG screening levels, and alternate guidelines. Also, the EEIs for the great blue heron were all significantly elevated for these three metals, including the EEIs calculated using means (and NOAELs). Therefore, potential risks may be possible, and copper, lead, and mercury are retained as sediment inorganic PCOCs.

The organics 2-butanone, acetone, and carbon disulfide were retained as sediment PCOCs, since no BTAG or toxicity data (e.g., NOAEL, LOAEL) were available. The concentrations of 2-butanone and carbon disulfide (one of four samples) appear to be relatively low, 100 µg/kg and 29 µg/kg, respectively. However, the toxicological significance of these contaminants cannot be fully assessed without adequate toxicity data. Acetone was detected in three of four sediment samples but is a common laboratory contaminant that is extremely volatile.

5.7.2.2 Surface Soils

Antimony, chromium, copper, lead, mercury, selenium, and zinc were retained as surface soil PCOCs after the terrestrial foodchain modeling for SWMUs 2 and 3. The following paragraphs discuss risk management considerations for each of metals and organics initially selected as PCOCs for soils.

Antimony was not detected in base-wide background (Table 5-28), but the maximum concentration of 0.87 mg/kg was within the range of regional background concentrations, as presented by Boerngen and Shacklette, (1981) of <1-1 mg/kg.

The maximum and average detected concentrations of chromium, 35.8 mg/kg and 18.5 mg/kg, respectively, were greater than the maximum and average base-wide background concentrations, but the average concentration was within the range of regional background concentrations of 15-20 mg/kg (Boerngen and Shacklette, 1981).

The maximum and average concentrations of copper in surface soils, 46.7 and 14.26, respectively, are greater than the average base-wide background concentration (5.15 mg/kg; Table 5-28). The average concentration is less than the maximum concentration in base-wide background and slightly higher than the range of regional background concentrations of 7-10 mg/kg (Boerngen and Shacklette, 1981). The alternate guidelines presented in Table 5-28 (50 and 100 mg/kg), which are Oak Ridge National Laboratory (ORNL) values indicative of toxicity to soil organisms, are greater than the maximum concentration of copper in soil.

The maximum concentration of lead in surface soils (37.2 mg/kg) is less than the maximum concentration in base-wide background (149 mg/kg), and the average concentration of lead (15.6 mg/kg) in surface soil is less than the average concentration calculated for base-wide background surface soil samples (20 mg/kg) (Table 5-28). In addition, the maximum concentration of lead is less than the alternate guidelines, which are ORNL values indicative of toxicity to soil organisms.

The maximum detected concentration of mercury in SWMUs 2 and 3 surface soils (0.2 mg/kg) exceeded the average base-wide background concentration and regional background concentrations (0.04-0.07; Boerngen and Shacklette, (1981) (Table 5-28). The average concentration of mercury calculated for the surface soil samples (0.08 mg/kg) slightly exceeded the average concentration in base-wide background soils (0.04 mg/kg). The maximum and average concentrations of mercury in surface soil samples were comparable to one alternate guideline (for toxicity to earthworms) and much lower than another (for toxicity of soil microbes).

Maximum concentrations of selenium and zinc exceeded average base-wide background concentrations, but were much less than the alternate guidelines presented on Table 5-28, which are ORNL values indicative of toxicity to soil organisms. The average concentration of zinc in surface soils falls within the range of regional background concentrations of 15-26 mg/kg (Boerngen and Shacklette, 1981). All EEI values developed for mean zinc concentrations using the foodchain modeling were less than 1.0.

In summary, the concentrations of chromium, copper, lead, selenium, and zinc in surface soils generally exceed base-wide background concentrations, but not significantly. The average concentrations of chromium, lead, and zinc fall within regional background concentrations, and the average concentration of lead is less than the average concentration in base-wide background. The maximum concentrations of copper, lead, selenium, and zinc are much less than the alternate guidelines presented on Table 5-28.

The maximum and average concentrations of copper, lead, and mercury in surface soils, which were final PCOCs in site sediment, are much lower than in sediment. The maximum concentrations of copper and lead are one order of magnitude lower in surface soils, and the maximum concentration of mercury is two orders of magnitude lower. This suggests that SWMU 2/3 surface soils may not be a current source of these metals to nearby sediments (via overland runoff/erosion).

Although some metals moderately exceed base-wide background concentrations, no inorganic PCOCs are retained as final PCOCs in SWMUs 2 and 3 surface soils. The following items summarize the rationale for not retaining metals as final PCOCs.

- Several different types of terrestrial receptors were included in the terrestrial foodchain modeling for SWMUs 2 and 3. Several elevated EEIs were generated for copper, lead, and mercury (and some other metals). Yet, at present, almost all of SWMUs 2 and 3 is bare soil on which active Navy operations are taking place. Thus the area provides minimal terrestrial habitat for larger mammals.

- Since the riprap wall around the site adjacent to Chicamuxen Creek is steep, the area probably would not attract mammals to the water's edge to drink or forage on aquatic and semi-aquatic organisms.

- Although the red fox may inhabit nearby wooded areas, these areas are located outside the site.

- Since most of the site is covered with bare soil or mowed turfgrass, its use by small mammals that raptors may forage on will be limited.

- Some brushy areas are present on the site that small mammals may utilize; however, these areas constitute only a very small portion of the site.

- The areas surrounding SWMUs 2 and 3 are either heavily wooded or aquatic, which would deter raptors from foraging in the area. Also, ongoing human activity at the site would discourage its use by raptors.

- Although earthworms may be present in site soils, the site does not provide suitable foraging cover for the woodcock. Some brushy areas are present on the site that could attract woodcocks, but these areas constitute only a very small portion of the site. The surrounding wooded areas are off site. The other offsite areas are aquatic, which would deter this species from foraging in the area. Also, present activity at the site would discourage its use by the woodcock and similar species.

- Metals in surface soil on most hazardous waste sites are in poorly available forms (Will and Suter, 1995), although the site-specific bioavailabilty of surface soil inorganics is not known.

It should be noted, however, that if Navy operations cease permanently at the site, native vegetation would probably proliferate and attract wildlife.

Several organics were retained as PCOCs in surface soils after the terrestrial foodchain modeling. All of them were retained because, with the exception of TNT, toxicity data were not available for these compounds. Di-n-octylphthalate had a low frequency of detection (1 of 14 samples), and the one detection (290 µg/kg) was lower than the alternate guideline (3005 µg/kg), a Dutch ecological screening guideline (Table 5-28). Methylene chloride also had a low frequency of detection (1 of 14 samples). No alternate guideline was available, but methylene chloride is a common laboratory solvent.

The explosive 1,3,5-trinitrobenzene had a low frequency of detection (1 of 28 samples). It was not detected in site sediment or groundwater. Two other explosives/energetics (TNT and its breakdown product 2-amino-4,6-dinitrotoluene) were both detected in 3 of 14 surface soil samples. 2-Amino-4,6-dinitrotoluene was not detected in groundwater or sediments.

TNT was not detected in groundwater under SWMUs 2 and 3. The compound was detected in one of four sediment samples, although it was not retained as a sediment PCOC. The maximum detected concentration of TNT in surface soil (sample RN3SS005) was an order of magnitude higher than the other two detections. Therefore, this may be an anomalous, or isolated, detection and widespread terrestrial risks may not be present. EEIs developed for the short-tailed shrew (1.32) and the woodcock (1.2) exceeded 1.0 (using NOAELs) when maximum concentrations were evaluated in the foodchain modeling. There were no EEIs greater than 1.0 when mean concentrations were evaluated in the terrestrial foodchain modeling. RN3SS05 was collected several hundred feet from Chicamuxen Creek (Figure 5-3), and RN3SS08, which had one of the three detections of TNT was collected between RN3SS05 and RN3SD03. However, a distinct pattern of migration to SD03 does not exist. As noted previously, no BTAG screening level was available for TNT; consequently a thorough assessment of the concentrations in surface soil is difficult. Since toxicity data for this compound are scarce and, qualitatively, the maximum concentration appears to be relatively high, TNT will be retained as a final surface soil PCOC. Nonetheless, terrestrial habitat on SWMUs 2 and 3 is of marginal quality. The compound's presence in surface soil would be more of a concern with regard to migration to adjacent Chicamuxen Creek sediments, but TNT was not detected in Chicamuxen Creek sediments or in the drainage ditch along the east side of SWMUs 2 and 3.

5.7.2.3 Groundwater

Copper and lead were not detected in groundwater under SWMUs 2 and 3. Consequently, the data indicates that neither surface soils nor groundwater from SWMUs 2 and 3 are a current source of the elevated copper and lead in sediments. Mercury was detected in two unfiltered and one filtered groundwater sample, and therefore, may be contributing mercury to the sediments. However, mercury concentrations in the groundwater at SWMUs 2 and 3 marginally exceed, if at all, those reported for the background monitoring wells. Subsurface soil sample RN3SB03 contained 3.5 mg/kg mercury, and groundwater sample RN3MW03 contained 0.19 µg/L mercury. These samples were the subsurface soil and groundwater samples collected at the sampling location closest to Chicamuxen Creek (Figure 5-3). The sediment sample collected closest to that location (SD01) contained 0.61 mg/kg mercury, which is between the LEL and SEL for that metal. The highest concentration of mercury in sediments was in

sample SD03 (10.4 mg/kg), which was collected in the drainage ditch west of the site. Mercury was not detected in the monitoring well closest to RN3SD03 (RN3MW04) and subsurface soil at RN3SB04 had a relatively low concentration of mercury (0.14 mg/kg). Mercury was detected at 0.19 µg/L in a filtered groundwater sample (RN3MW02), while the mercury in the subsurface soil sample at that site was relatively low (0.05 mg/kg). Mercury in the nearby sediment drainage ditch sample east of the site (RN3SD04) was low (0.05 mg/kg). Mercury was not detected in SD02, which was collected where the drainage area east of the site discharge to Chicamuxen Creek. It appears that if mercury in SWMUs 2 and 3 groundwater is discharging to adjacent sediments, it is occurring in a south or southwesterly direction.

5.7.3 ERA and Risk Management Summary and Conclusions

The maximum detected concentrations of contaminants detected in SWMUs 2 and 3 surface water, groundwater, sediment, and surface soil were compared to BTAG screening levels (EPA, 1995). All of the contaminants with maximum concentrations that exceeded BTAG screening levels were retained as PCOCs moreover, the PCOCs in sediments and surface soils were included in foodchain modeling at the site for several representative ecological receptors. Contaminants having at leas one HI greater than 1.0 in the foodchain modeling (for all representative receptors) using maximum concentrations were retained as PCOCs. Finally, those PCOCs were assessed using risk management considerations to develop a list of final PCOCs for SWMUs 2 and 3.

As a result of these analyses, the following conclusions are drawn:

- No surface water contaminants exceeded BTAG screening levels.

- Maximum and average concentrations of copper, lead, and mercury in sediments exceed base-wide background concentrations and alternate guidelines and, therefore, were retained as PCOCs.

- Concentrations of metals, including copper, lead, and mercury were not significantly elevated in surface soils, and copper and lead concentrations were not elevated in groundwater, suggesting that neither medium was responsible for elevated copper and lead concentrations in sediments.

- Mercury was elevated in two unfiltered groundwater samples. Therefore, the groundwater may have contributed to the presence of mercury in sediments. Sediment samples SD03 and SD01, collected west and southwest of the site, respectively, contained the elevated detections of mercury.

- TNT was elevated in surface soil sample SS005, and was retained as a PCOC. However, this compound was not elevated in other surface soil samples and was not detected in Chicamuxen Creek sediment samples.

- Since the site is covered with bare soil and Navy activity at the site is ongoing, the use of the site by terrestrial receptors is most likely minimal. The sediments in adjacent Chicamuxen Creek are probably more important ecologically, and hence, off-site migration of contaminants may be more important. However, the source of elevated metals in sediments is unclear.

5.7.4 Site-specific Uncertainties

The following items summarize site-specific uncertainties for the ERA at SWMUs 2 and 3:

- Sample sizes in surface water and sediment collected from SWMUs 2 and 3 were low. This reduces confidence in the use of the average concentration as a representative exposure concentration.

- No BTAG screening levels or alternate guidelines were available for antimony, cobalt, and vanadium, which were all sediment PCOCs after the foodchain modeling. Although these metals are not typically viewed as major environmental contaminants, the general lack of toxicity data for these metals precludes a thorough toxicological evaluation of their presence in site sediments.

- Three VOCs (2-butanone, acetone, and carbon disulfide) were detected in SWMUs 2 and 3 sediments, and no BTAG screening levels or alternate guidelines were available. The concentrations appear to be relatively low, and these volatile organic compounds were not PCOCs in surface soil, However, without adequate toxicity data, the potential risks associated with their concentrations in sediments cannot be fully determined.

- The maximum concentrations of several metals in surface soils at SWMUs 2 and 3 were slightly elevated relative to base-wide and regional background. These concentrations, however, did not appear to be significantly elevated relative to background and were less than alternate guideline levels. As mentioned earlier, metals at hazardous waste sites are usually in poorly available forms (Will and Suter, 1995). However, the lack of site-specific bioavailability data introduces uncertainty into the conclusion of the ERA.

- The maximum concentrations of copper and lead were significantly elevated in SWMUs 2 and 3 sediments, and greater than the concentrations detected in surface soils. These metals were not

detected in groundwater. Hence, it does not appear that SWMUs 2 and 3 are a current source of these metals in sediments, although a possible source is not clear.

5.8 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Section 5.8 summarizes the environmental investigations conducted to date, the nature and extent of the chemicals detected in the environmental media, and the results of the baseline risk assessment. Conclusions and recommendations are provided.

The following items summarize the investigative work conducted to date:

1. The field investigation included the field screening of 50 shallow soil samples for TNT, RDX, and BTEX.

2. The field investigation included the collection of soil gas survey samples at 48 locations. Fourteen aromatic hydrocarbons (e.g., benzene) and chlorinated hydrocarbons (e.g., tetrachloroethene) were the target analytes of concern.

3. Surface and subsurface soil samples were collected from 14 locations and submitted to a fixed base laboratory (GP) for analysis. Fourteen surface and 22 subsurface samples were analyzed.

4. Four monitoring wells (one upgradient; 3 downgradient) were installed. One round of synoptic water level measurements were recorded.

5. Surface water and sediment samples were collected at two locations in Chicamuxen Creek. Additionally, sediment samples were collected from drainage ditches west and east of the site.

6. Environmental samples collected for analysis by the fixed-base laboratory were analyzed for a comprehensive suite of analytes including volatile organic and semivolatile organic compounds, metals, and explosives.

The following items summarized the environmental conditions at SWMUs 2 and 3:

1. The subsurface materials vary significantly across the study area vertically and horizontally. Reworked natural material was encountered throughout the detonation area at the ground surface to a depth of approximately 4 feet, consisting of red clay, sand, and gravel. The sediments

underlying the reworked natural materials generally consist of fine-grained sand, silt, clay, and peat.

2. The groundwater beneath the site occurs primarily under locally semiconfining and unconfined (water table) conditions. The water table aquifer consists primarily of fine-grained sand, silt, clay, and peat. The shallow groundwater is flowing to the south toward and discharging into Chicamuxen Creek. However, the creek is tidal, and during high tide, losing stream conditions may occur. These conditions may cause the water table to be slightly elevated near the stream (bank storage) and may change the groundwater flow pattern, to one showing groundwater flowing north away from the stream.

3. The groundwater resource is probably recharged by downward migration of precipitation through the unsaturated zone to the water table. In addition, groundwater along the edge of the stream is also recharged as a result of the losing stream conditions during high tide.

4. Explosives and components of explosives (TNT, RDX, HMX, 1,3,5-trinitrobenzene), and degradation by-products of explosives (2-amino-4,6-dinitrotoluene) were the predominant site-related organic contaminants detected in SWMUs 2 and 3 soil samples. However, the detection frequency for the explosive compounds in surface and subsurface soils did not exceed 25 percent and maximum concentrations of most explosives were noted at a location outside the main detonation area and in proximity to a storage bunker. One explosive compound (RDX [1.2 µg/L]) was noted in the upgradient monitoring well; none was noted in groundwater samples from actual downgradient monitoring wells or in the surface water samples. TNT was detected in a sediment sample from a drainage ditch to the west of SWMUs 2 and 3.

5. Volatile and semi-volatile organic compounds (other than the explosives) were detected in soils. The organics detected include phthalate compounds (e.g., bis(2-ethylhexyl) phthalate), polyaromatic hydrocarbons (e.g., benzo(a)pyrene) which are by-products of the combustion process, and volatile organic solvents (e.g., acetone). Site-related as well as non-site-related activities may have contributed to the presence of these compounds in the environmental media.

6. Several metals (e.g., lead, cadmium, copper, mercury, selenium, and zinc) were detected in soils at maximum concentrations exceeding basewide background concentrations. However, all positive detections were within the concentration range reported in the literature for soils of the Eastern United States. Few positive detections of selenium, lead, and mercury exceeded background soils concentrations reported for the State of Maryland. Although the maximum

detected concentrations exceed basewide background concentrations, the exceedances were noted at few locations and were often marginal (i.e., similar to or within two times background). Metals concentrations in groundwater were less than or within two times the $UTL_{95\%}$ developed for the background groundwater dataset. Maximum concentrations of several metals were noted in the groundwater sample from the upgradient monitoring well.

7. Metals concentrations detected in surface waters suggest that historic activities at SWMUs 2 and 3 have had minimal impact on surface water quality. The source of the elevated metals concentrations noted in two sediment samples is unclear because the metals concentrations noted in the sediments exceed those noted in soil samples collected at SWMUs 2 and 3. Consequently, the metals concentrations in the sediments may not be site-related.

The following items summarize the baseline human health risk assessment conducted for SWMUs 2 and 3:

1. The human health risk assessment for SWMUs 2 and 3 considered exposures to maintenance workers, full-time employees, and construction workers. Potential exposure pathways for direct contact with soil for all receptors included incidental ingestion and dermal contact with soil. Inhalation of fugitive dust and volatiles from soil were not considered since concentrations of all COPCs in soil were less than the SSLs developed by the EPA for the migration of contaminants form soil to air.

2. Arsenic was the only target analyte selected as a COPC for the evaluation of exposures to soils. No COPCs were selected for groundwater, surface water, or sediments.

3. Incremental lifetime cancer risk estimates developed for the maintenance worker and construction worker hypothetically exposed to arsenic in soil were less than the EPA's target risk range of 10^{-4} to 10^{-6}. Cancer risk estimates developed for the full-time employee were 3.6×10^{-6} and 1×10^{-6} for the RME and CTE cases, respectively. It should be noted that arsenic is not a significant site-related contaminant; the detected concentrations marginally exceeded facility background concentrations (i.e., they are within 2 times the basewide background concentrations).

4. Noncarcinogenic risk estimates (HIs) calculated for all human receptors evaluated were less than unity, indicating that adverse noncarcinogenic health effects are not anticipated under the conditions established in the exposure assessment.

The following items summarize the baseline ecological risk assessment conducted for SWMUs 2 and 3:

1. Metals were not selected as final potential chemicals of concern soils. No target analytes were selected as final potential chemicals of concern for surface water.

2. Copper, lead, and mercury were retained as final potential chemicals of concern for sediments. However, the metals concentrations noted in the sediment samples from a drainage ditch to the west of SWMUs 2 and 3 were greater than those noted in the surface soil samples. The potential contribution of metals in groundwater discharging to the groundwater may also be minimal. Consequently, SWMUs 2 and 3 may not be a current source of these metals to the sediments.

3. TNT was retained as final potential chemical of concern for soil. However, only one detection exceeded the benchmark used to selected the chemical as a final potential chemical of concern. This suggests that widespread terrestrial risk may not be present. It should be noted that the majority of SWMUs 2 and 3 is sparsely vegetated and currently provides limited terrestrial habitat.

It is recommended that the risk managers for NSWC Indian Head consider a "No further action" decision for the soils, groundwater, and surface water at SWMUs 2 and 3. The human health risk assessment indicates that the cancer risk estimates for human receptors evaluated are within the EPA's target risk range of 10^{-4} to 10^{-6}. Arsenic in surface soils was the only COPC contributing to the estimated cancer risk. However, the maximum concentration detected in the surface soils (6.7 mg/kg) is similar to the 95 percent upper tolerance limit value established for the basewide background surface soils (4.25 mg/kg) and background soils concentrations reported for the State of Maryland ([Cmax = 7.1 mg/kg)], and less than the maximum concentration reported for the basewide background subsurface soils (10.4 mg/kg). Adverse noncarcinogenic health effects are not anticipated for the human receptors evaluated. The ecological risk assessment indicates a potential for risks to ecological receptors exposed to metals in sediments in a drainage ditch adjoining the site. However, the sediments and surface waters of the adjacent Chicamuxen Creek are probably the more important ecological resource and SWMUs 2 and 3 may not be a current source of the metals detected in the drainage ditch sediments. Consequently, any further investigation of the sediments at SWMUs 2 and 3 may be ancillary to the actual environmental investigation of SWMUs 2 and 3.

TABLE 5-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE	MEDIA	Explosives SW846 8330	APP IX Metals SW846 6010A/7000	APP IX SVOA SW846 8270B	APP IX VOA SW846 8240B	TOC SW846 9060	TOX SW846 9020B	Miscellaneous
RN3SB0010101	Subsurface Soil	X	X	X	X	X	X	
RN3SB0010201	Subsurface Soil	X	X	X	X	X	X	
RN3SB0010301	Subsurface Soil	X	X	X	X	X	X	
RN3SB0010401	Subsurface Soil	X	X	X	X	X	X	
RN3SB0020101	Subsurface Soil	X	X	X	X	X	X	
RN3SB0020201	Subsurface Soil	X	X	X	X	X	X	
RN3SB0030101	Subsurface Soil	X	X	X	X	X	X	
RN3SB0030201	Subsurface Soil	X	X	X	X	X	X	
RN3SB0040101	Subsurface Soil	X	X	X	X			X
RN3SB0040201	Subsurface Soil	X	X	X	X			X
RN3SB0040301	Subsurface Soil	X	X	X	X	X	X	
RN3SB0040401	Subsurface Soil	X	X	X	X	X	X	
RN3SB0050101	Subsurface Soil	X	X	X	X			X
RN3SB0060101	Subsurface Soil	X	X	X	X			X
RN3SB0070101	Subsurface Soil	X	X	X	X			X
RN3SB0080101	Subsurface Soil	X	X	X	X			X
RN3SB0090101	Subsurface Soil	X	X	X	X			X
RN3SB0100101	Subsurface Soil	X	X	X	X			X
RN3SB0100101-D	Subsurface Soil	X	X	X	X			X
RN3SB0110101	Subsurface Soil	X	X	X	X			X
RN3SB0120101	Subsurface Soil	X	X	X	X			X
RN3SB0130101	Subsurface Soil	X	X	X	X			X
RN3SB0140101	Subsurface Soil	X	X	X	X			X
RN3SD0010101	Sediment	X	X	X	X	X	X	
RN3SD0020101	Sediment	X	X	X	X	X	X	
RN3SD0030101	Sediment	X	X	X	X	X	X	
RN3SD0030101-D	Sediment	X	X	X	X	X	X	
RN3SD0040101	Sediment	X	X	X	X	X	X	
RN3MW002F001	Groundwater		X					
RN3MW002U001	Groundwater	X	X	X	X	X	X	
RN3MW003F001	Groundwater		X					

TABLE 5-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE	MEDIA	Explosives SW846 8330	APP IX Metals SW846 6010A/7000	APP IX SVOA SW846 8270B	APP IX VOA SW846 8240B	TOC SW846 9060	TOX SW846 9020B	Miscellaneous
RN3MW003U001	Groundwater	X	X	X	X	X	X	
RN3MW004F001	Groundwater		X					
RN3MW004U001	Groundwater	X	X	X	X	X	X	
RN3SS0010101	Surface Soil	X	X	X	X	X	X	
RN3SS0020101	Surface Soil	X	X	X	X	X	X	
RN3SS0030101	Surface Soil	X	X	X	X	X	X	
RN3SS0040101	Surface Soil	X	X	X	X	X	X	
RN3SS0050101	Surface Soil	X	X	X	X			X
RN3SS0060101	Surface Soil	X	X	X	X			X
RN3SS0070101	Surface Soil	X	X	X	X			X
RN3SS0070101-D	Surface Soil	X	X	X	X			X
RN3SS0080101	Surface Soil	X	X	X	X			X
RN3SS0090101	Surface Soil	X	X	X	X			X
RN3SS0100101	Surface Soil	X	X	X	X			X
RN3SS0110101	Surface Soil	X	X	X	X			X
RN3SS0120101	Surface Soil	X	X	X	X			X
RN3SS0130101	Surface Soil	X	X	X	X			X
RN3SS0140101	Surface Soil	X	X	X	X			X
RN3SW0010101	Surface Water	X	X	X	X	X	X	
RN3SW0020101	Surface Water	X	X	X	X	X	X	
RN3SW0020101-D	Surface Water					X	X	

APP IX - Appendix IX
VOA - Volatile organic analyte
SVOA - Semi-volatile organic analyte
TOC - Total organic carbon
TOH - Total organic halides
Miscellaneous - Parmeters include ammonia and nitrate/nitrite.

TABLE 5-2

MONITORING WELL CONSTRUCTION SUMMARY
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Well Number	Ground Elevation (Ft. msl)	Top of Riser Elevation (Ft. msl)	Total Well Depth (Ft. bgs)	Monitored Interval (Ft. bgs)	Depth to Groundwater (Ft tor)	Depth to Groundwater (Ft. bgs)	Groundwater Elevation (Ft. msl)
RN3MW01	25.62	27.76	32.5	22-32	26.54	24.40	1.22
RN3MW02	5.49	5.03	15.5	5-15	4.36	4.82	0.67
RN3MW03	5.85	5.56	20.5	10-20	7.48	7.77	-1.92
RN3MW04	7.16	6.74	29.5	19-29	5.37	5.79	1.37

* Water levels measured 8/17/97.
Ft. msl - Feet above mean sea level.
Ft bgs - Feet below ground surface.
Ft tor - Feet below top of riser.

TABLE 5-3

SUMMARY OF SOIL GAS POSITIVE DETECTS
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATIN/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Grid Location Identification	Laboratory Sample Identification	Total Volatile Hydrocarbons (ug/l)	Chloroform (ug/l)	1,1,1-Trichloroethane (ug/l)	Carbon tetrachloride (ug/l)	Trichloroethene (ug/l)	Tetrachloroethene (ug/l)
RN3SG01	RN3SG0010101	3	<0.003	<0.005	<0.001	<0.002	<0.003
RN3SG02	RN3SG0020101	11	<0.003	<0.005	<0.001	<0.002	<0.003
RN3SG03	RN3SG0030101	1	<0.003	<0.005	<0.001	<0.002	<0.003
RN3SG05	RN3SG0050101	8	<0.001	<0.02	<0.005	<0.009	<0.01
RN3SG06	RN3SG0060101	1	<0.001	<0.02	<0.005	<0.009	<0.01
RN3SG07	RN3SG0070101	6	<0.001	<0.02	<0.005	<0.009	<0.01
RN3SG08	RN3SG0080101	0.4	<0.001	<0.02	<0.005	<0.009	<0.01
RN3SG09	RN3SG0090101	3	<0.006	<0.01	<0.002	<0.005	<0.005
RN3SG11	RN3SG0110101	5	<0.006	<0.01	<0.002	<0.005	<0.005
RN3SG12	RN3SG0120101	14	<0.006	<0.01	<0.002	<0.005	<0.005
RN3SG13	RN3SG0130101	7	<0.006	<0.01	<0.002	<0.005	<0.005
RN3SG15	RN3SG0150101	12	<0.006	<0.01	<0.002	<0.005	<0.005
RN3SG26	RN3SG0260101	<4	<0.006	<0.01	<0.002	1	<0.005
RN3SG30	RN3SG0300101	<4	<0.006	0.03	<0.002	<0.005	<0.005
RN3SG31	RN3SG0310101	<4	<0.006	<0.01	<0.002	0.08	<0.005
RN3SG32	RN3SG0320101	<4	<0.006	<0.01	<0.002	0.2	<0.005
RN3SG33	RN3SG0330101	2	<0.006	<0.01	<0.002	<0.005	<0.005
RN3SG34	RN3SG0340101	88	<0.006	<0.01	<0.002	<0.005	<0.005
RN3SG35	RN3SG0350101	<4	<0.006	<0.01	<0.002	<0.005	0.01
RN3SG36	RN3SG0360101	2	<0.006	<0.01	<0.002	<0.005	1
RN3SG37	RN3SG0370101	<4	<0.006	<0.01	<0.002	<0.005	0.1
RN3SG38	RN3SG0380101	4	<0.006	<0.01	<0.002	<0.005	0.1
RN3SG39	RN3SG0390101	<4	<0.006	<0.01	<0.002	<0.005	0.02
RN3SG44	RN3SG0440101	<4	0.01	<0.01	<0.002	<0.005	0.05
RN3SG45	RN3SG0450101	<4	<0.006	<0.01	<0.002	0.1	0.08

TABLE 5-3

SUMMARY OF SOIL GAS POSITIVE DETECTS
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATIN/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Grid Location Identification	Laboratory Sample Identification	Total Volatile Hydrocarbons (ug/l)	Chloroform (ug/l)	1,1,1-Trichloroethane (ug/l)	Carbon tetrachloride (ug/l)	Trichloroethene (ug/l)	Tetrachloroethene (ug/l)
RN3SG46	RN3SG0460101	<4	<0.006	<0.01	<0.002	<0.005	0.05
RN3SG47	RN3SG0470101	<4	0.02	<0.01	<0.002	<0.005	<0.005
RN3SG48	RN3SG0480101	<4	<0.006	<0.01	<0.002	0.02	0.04

TABLE 5-4

FIELD TEST KIT RESULTS
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Grid Location Identification	Laboratory Sample Identification	TNT Result (mg/kg)	RDX Result (mg/kg)	BTEX Result (mg/kg)
RN3FT01	RN3FT0010101	ND	ND	2.5
RN3FT02	RN3FT0020101	ND	ND	35
RN3FT03	RN3FT0030101	0.53*	3.9	2.5
RN3FT04	RN3FT0040101	ND	ND	2.5
RN3FT05	RN3FT0050101	ND	ND	2.5
RN3FT06	RN3FT0060101	ND	ND	2.5
RN3FT07	RN3FT0070101	ND	ND	2.5
RN3FT08	RN3FT0080101	ND	ND	2.5
RN3FT09	RN3FT0090101	ND	ND	2.5
RN3FT10	RN3FT0100101	ND	ND	2.5
RN3FT11	RN3FT0110101	ND	ND	2.5
RN3FT12	RN3FT0120101	ND	ND	10
RN3FT13	RN3FT0130101	ND	ND	2.5
RN3FT14	RN3FT0140101	ND	ND	10
RN3FT15	RN3FT0150101	ND	ND	10
RN3FT16	RN3FT0160101	ND	ND	10
RN3FT17	RN3FT0170101	ND	ND	2.5
RN3FT18	RN3FT0180101	ND	ND	2.5
RN3FT19	RN3FT0190101	ND	ND	2.5
RN3FT20	RN3FT0200101	ND	ND	2.5
RN3FT21	RN3FT0210101	ND	ND	2.5
RN3FT22	RN3FT0220101	ND	ND	20
RN3FT23	RN3FT0230101	ND	ND	20
RN3FT24	RN3FT0240101	ND	ND	10
RN3FT25	RN3FT0250101	ND	ND	10
RN3FT26	RN3FT0260101	ND	ND	20
RN3FT27	RN3FT0270101	ND	6.3	10
RN3FT28	RN3FT0280101	ND	ND	35
RN3FT29	RN3FT0290101	ND	ND	2.5
RN3FT30	RN3FT0300101	ND	ND	2.5
RN3FT31	RN3FT0310101	ND	ND	2.5
RN3FT32	RN3FT0320101	ND	ND	2.5
RN3FT33	RN3FT0330101	ND	ND	2.5
RN3FT34	RN3FT0340101	ND	ND	2.5
RN3FT35	RN3FT0350101	ND	0.8	10
RN3FT36	RN3FT0360101	ND	ND	2.5
RN3FT37	RN3FT0370101	19.4	ND	2.5
RN3FT38	RN3FT0380101	0.9	ND	10
RN3FT39	RN3FT0390101	ND	ND	2.5

TABLE 5-4

FIELD TEST KIT RESULTS
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Grid Location Identification	Laboratory Sample Identification	TNT Result (mg/kg)	RDX Result (mg/kg)	BTEX Result (mg/kg)
RN3FT40	RN3FT0400101	ND	ND	10
RN3FT41	RN3FT0410101	ND	ND	2.5
RN3FT42	RN3FT0420101	ND	ND	2.5
RN3FT43	RN3FT0430101	ND	ND	35
RN3FT44	RN3FT0440101	ND	ND	20
RN3FT45	RN3FT0450101	ND	ND	2.5
RN3FT46	RN3FT0460101	ND	ND	10
RN3FT47	RN3FT0470101	ND	ND	2.5
RN3FT48	RN3FT0480101	ND	ND	2.5
RN3FT49	RN3FT0490101	ND	ND	2.5
RN3FT50	RN3FT0500101	ND	ND	2.5

ND = Not Detected
TNT = 2,4,6-Trinitrotoluene
RDX = Cyclo-1,3,5-trimethylene-2,4,6-trinitramine
BTEX = benzene, toluene, ethylbenzene, xylenes

Note: All BTEX results of 2.5 mg/kg should be considered non-detects with a detection limit of 2.5 mg/kg.
* Published detection limit is 0.7 mg/kg for TNT and 0.8 mg/kg for RDX.

TABLE 5-5
SUMMARY OF POSITIVE DETECTIONS IN SURFACE SOIL FOR SWMU 2/3-RANGE 3 BURN POINT/CHICKAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN3SS0010101	RN3SS0020101	RN3SS0030101	RN3SS0040101	RN3SS0050101	RN3SS0060101	RN3SS0070101
SAMPLE DATE:	07/08/97	07/08/97	07/08/97	07/08/97	07/09/97	07/09/97	07/09/97
LOCATION:	RN3SS0010101	RN3SS0020101	RN3SS0030101	RN3SS0040101	RN3SS0050101	RN3SS0060101	RN3SS0070101
FIELD DUPLICATE OF:							
VOLATILES (µg/kg)							
ACETONE	2300 J	1700 J		96 J			490 J
METHYLENE CHLORIDE	700 J						
SEMIVOLATILES (µg/kg)							
BIS(2-ETHYLHEXYL)PHTHALATE	590	270 K	780	86 J			
DI-N-BUTYL PHTHALATE		68 K		37 J			96 J
DI-N-OCTYL PHTHALATE		290 K					
FLUORANTHENE	59 J						
PHENANTHRENE	53 J						
ENERGETICS (µg/kg)							
1,3,5-TRINITROBENZENE					420		
2,4,6-TRINITROTOLUENE				121	6570		
2-AMINO-4,6-DINITROTOLUENE				211	525		
HMX				355			
METALS (mg/kg)							
ANTIMONY	0.51 L	0.45 L	0.42 L	0.55 L			
ARSENIC	6.7	5.8	4.7	4.4	3.5	3.6	2.9
BARIUM	65.9	35.4	30.7	28.3	94.1	31.8	24.5
BERYLLIUM	0.53	0.21	0.15	0.15	0.72	0.37	0.23
CADMIUM	0.95 K	0.68 K	0.65 K	0.94	0.50 K	0.52 K	0.14 K
CHROMIUM	21.1	23.9	20.2	20.4	16.7	11.5	12.3
COBALT	5.8 J	4.1 J	4.0 J	21.6 J	13.3	11.2	1.2
COPPER	14.5	12.5	13.5	46.7	14.5	15.1	5.5
LEAD	13.5 J	16.7 J	26.3 J	37.2 J	11.4	20.8	4.4

TABLE 5-6
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SWMU 2/3-RANGE 3 BURN POINT/CHICKAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN3SB0010101	RN3SB0010201	RN3SB0010301	RN3SB0010401	RN3SB0020101	RN3SB0020201	RN3SB0030101
SAMPLE DATE:	07/08/97	07/08/97	07/22/97	07/22/97	07/08/97	07/08/97	07/08/97
LOCATION:	RN3SB0010101	RN3SB0010201	RN3SB0010301	RN3SB0010401	RN3SB0020101	RN3SB0020201	RN3SB0030101
FIELD DUPLICATE OF:							
VOLATILES (µg/kg)							
2-BUTANONE							170 J
ACETONE	160 J	190 J			160 J	4700 J	3000 J
SEMIVOLATILES (µg/kg)							
BIS(2-ETHYLHEXYL)PHTHALATE		420	1500 J	400 J		4000	
DI-N-OCTYL PHTHALATE					38 J		
METALS (mg/kg)							
ANTIMONY					0.49 L	0.32 L	0.56 L
ARSENIC	2.7	2.9	5.0	1.9	4.7	4.2	8.4
BARIUM	66.9	9.1	22.6	87.0	25.6	24.9	119
BERYLLIUM	0.82	0.12	0.38 K	0.62 K	0.16	0.14	0.96
CADMIUM	0.43 K	0.22 K	0.15 K	0.24 K	0.56 K	0.48 K	1.4
CHROMIUM	19.2	7.9	7.2	15.1	21.2	18.0	23.6
COBALT	7.7 J	2.1 J	3.8	18.5	3.4 J	3.9 J	11.1 J
COPPER	15.4		10.1	14.3	8.3	7.3	40.1
LEAD	10.5 J	2.4 J	2.5 K	10.0 K	6.8 J	8.0 J	30.7 J
MERCURY	0.02			0.07	0.05	0.05	3.5
NICKEL	13.8	3.8	6.6	16.8	6.4	4.9	20.8
SELENIUM	0.73 K	0.46 K	0.90 L	0.57 L	1.2	1.1	2.6
SILVER							0.16
VANADIUM	29.7	7.2	8.9	15.0	27.0	22.2	51.4
ZINC	44.6 J	10.1 J	23.2	52.3	16.9 J	13.5 J	83.7 J
MISCELLANEOUS PARAMETERS (mg/kg)							
TOTAL ORGANIC CARBON	27800		1010	2610		2960	104000

TABLE 5-6
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SWMU 2/3-RANGE 3 BURN POINT/CHICKAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN3SB0030201	RN3SB0040101	RN3SB0040201	RN3SB0040301	RN3SB0040401	RN3SB0050101	RN3SB0060101
SAMPLE DATE:	07/08/97	07/08/97	07/08/97	07/23/97	07/23/97	07/09/97	07/09/97
LOCATION:	RN3SB0030201	RN3SB0040101	RN3SB0040201	RN3SB0040301	RN3SB0040401	RN3SB0050101	RN3SB0060101
FIELD DUPLICATE OF:							
VOLATILES (µg/kg)							
ACETONE	2800 J	810 J					
CARBON DISULFIDE	110 J						
METHYLENE CHLORIDE	410 J	69 J					
SEMIVOLATILES (µg/kg)							
BIS(2-ETHYLHEXYL)PHTHALATE	160 J	59 J				120 J	
METALS (mg/kg)							
ANTIMONY	0.75 L						
ARSENIC	6.7	2.7	7.9	3.2	9.1	5.7	6.8
BARIUM	116	22.1	27.5	12.0	53.6	77.5	33.9
BERYLLIUM	1.3	0.19	0.59		0.90 K	0.87	0.52
CADMIUM	1.2	0.28 K	0.42 K	0.15 K	0.16 K	0.50 K	0.40 K
CHROMIUM	31.2	10.4	26.6	12.4	31.5	18.9	11.4
COBALT	14.4 J	1.9	2.5	1.9	4.3	19.7	5.4
COPPER	21.7	8.7	7.3	5.1	22.0	16.0	11.2
LEAD	15.1 J	11.3	5.9	16.8 K	12.3 K	22.9	8.9
MERCURY	1.6	0.14		0.03	0.02	0.09	0.03
NICKEL	25.3	2.6	4.9	3.4	10.8	21.2	6.5
SELENIUM	2.7	0.50	2.1	0.50 L	2.1 L	1.6	2.0
VANADIUM	56.2	16.1	25.2	15.9	56.2	29.5	20.3
ZINC	77.9 J	12.5	19.9	9.8	41.3	58.2	29.2
MISCELLANEOUS PARAMETERS (mg/kg)							
TOTAL ORGANIC CARBON	86800	2220	3410	391	5930	8500	5650

TABLE 5-5
SUMMARY OF POSITIVE DETECTIONS IN SURFACE SOIL FOR SWMU 2/3-RANGE 3 BURN POINT/CHICKAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN3SS0010101	RN3SS0020101	RN3SS0030101	RN3SS0040101	RN3SS0050101	RN3SS0060101	RN3SS0070101
SAMPLE DATE:	07/08/97	07/08/97	07/08/97	07/08/97	07/09/97	07/09/97	07/09/97
LOCATION:	RN3SS0010101	RN3SS0020101	RN3SS0030101	RN3SS0040101	RN3SS0050101	RN3SS0060101	RN3SS0070101
FIELD DUPLICATE OF:							
METALS (mg/kg)							
MERCURY	0.09	0.06	0.07	0.06	0.02	0.15	0.02
NICKEL	10.5	7.2	5.9	26.7	18.2	24.9	3.0
SELENIUM	2.2	1.5	1.2	1.1	1.2	0.88	0.53
SILVER				0.25			
VANADIUM	37.6	35.1	31.5	26.0	26.7	18.3	16.6
ZINC	36.9 J	22.8 J	25.0 J	33.4 J	53.4	40.1	10.6
MISCELLANEOUS PARAMETERS (mg/kg)							
TOTAL ORGANIC CARBON	30000	2030		2960	19700	9440	1860

TABLE 5-5
SUMMARY OF POSITIVE DETECTIONS IN SURFACE SOIL FOR SWMU 2/3-RANGE 3 BURN POINT/CHICKAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN3SS0070101-D	RN3SS0080101	RN3SS0090101	RN3SS0100101	RN3SS0110101	RN3SS0120101	RN3SS0130101
SAMPLE DATE:	07/09/97	07/09/97	07/09/97	07/09/97	07/09/97	07/09/97	07/09/97
LOCATION:	RN3DUP005	RN3SS0080101	RN3SS0090101	RN3SS0100101	RN3SS0110101	RN3SS0120101	RN3SS0130101
FIELD DUPLICATE OF:	RN3SS0070101						
VOLATILES (µg/kg)							
ACETONE	250 J	150	930 J		420 J	2600 J	2200 J
SEMIVOLATILES (µg/kg)							
BENZO(A)ANTHRACENE		45 J					
BENZO(A)PYRENE		45 J					
BENZO(B)FLUORANTHENE		85 J					
CHRYSENE		53 J					
DI-N-BUTYL PHTHALATE		61 J					
FLUORANTHENE	57 J	88 J					
PHENANTHRENE	49 J	57 J					
PYRENE	49 J	81 J					
ENERGETICS (µg/kg)							
2,4,6-TRINITROTOLUENE		104					
2-AMINO-4,6-DINITROTOLUENE		127					
METALS (mg/kg)							
ANTIMONY				0.70 L			0.87 L
ARSENIC	2.2	3.4	3.6	4.9	4.5	4.6	4.7
BARIUM	21.7	22.4	18.5	35.5	24.0	23.8	37.9
BERYLLIUM	0.17	0.24	0.18	0.26	0.27	0.19	0.26
CADMIUM	0.16 K	0.23 K	0.24 K	0.33 K	0.28 K	0.23 K	0.44 K
CHROMIUM	9.2	9.7	11.5	22.6 J	35.8	16.5	21.4 J
COBALT	0.94	5.4	1.3	4.1	3.2	2.8	4.9
COPPER		7.1	9.4	10.6	9.7	8.6	12.6
LEAD	3.9	12.2	12.2	9.8	8.9	12.8	15.9

TABLE 5-5
SUMMARY OF POSITIVE DETECTIONS IN SURFACE SOIL FOR SWMU 2/3-RANGE 3 BURN POINT/CHICKAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN3SS0070101-D	RN3SS0080101	RN3SS0090101	RN3SS0100101	RN3SS0110101	RN3SS0120101	RN3SS0130101
SAMPLE DATE:	07/09/97	07/09/97	07/09/97	07/09/97	07/09/97	07/09/97	07/09/97
LOCATION:	RN3DUP005	RN3SS0080101	RN3SS0090101	RN3SS0100101	RN3SS0110101	RN3SS0120101	RN3SS0130101
FIELD DUPLICATE OF:	RN3SS0070101						
METALS (mg/kg)							
MERCURY	0.02	0.19	0.03	0.07	0.05	0.04	0.05
NICKEL	2.1	3.6	2.8	6.7	7.2	4.8	6.6
SELENIUM	0.55	0.45	0.64	1.3 L	1.1	0.96	1.2 L
VANADIUM	13.1	11.4	17.1	32.8	29.4	25.8	33.8
ZINC	8.0	18.1	9.8	20.0	16.3	15.3	22.8
MISCELLANEOUS PARAMETERS (mg/kg)							
TOTAL ORGANIC CARBON	3640	12100	4550	3700	4160	1570	2010

TABLE 5-5
SUMMARY OF POSITIVE DETECTIONS IN SURFACE SOIL FOR SWMU 2/3-RANGE 3 BURN POINT/CHICKAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN3SS0140101						
SAMPLE DATE:	07/08/97	/ /	/ /	/ /	/ /	/ /	/ /
LOCATION:	RN3SS0140101						
FIELD DUPLICATE OF:							
METALS (mg/kg)							
ANTIMONY	0.56 L						
ARSENIC	4.1						
BARIUM	37.7						
BERYLLIUM	0.39						
CADMIUM	0.49 K						
CHROMIUM	17.0 J						
COBALT	5.9						
COPPER	22.2						
LEAD	16.0						
MERCURY	0.20						
NICKEL	8.9						
SELENIUM	1.4 L						
VANADIUM	25.4						
ZINC	32.7						
MISCELLANEOUS PARAMETERS (mg/kg)							
TOTAL ORGANIC CARBON	3680						

TABLE 5-6
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SWMU 2/3-RANGE 3 BURN POINT/CHICKAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN3SB0070101	RN3SB0080101	RN3SB0090101	RN3SB0100101	RN3SB0100101-D	RN3SB0110101	RN3SB0120101
SAMPLE DATE:	07/09/97	07/09/97	07/09/97	07/09/97	07/09/97	07/09/97	07/09/97
LOCATION:	RN3SB0070101	RN3SB0080101	RN3SB0090101	RN3SB0100101	RN3DUP006	RN3SB0110101	RN3SB0120101
FIELD DUPLICATE OF:					RN3SB0100101		
VOLATILES (µg/kg)							
ACETONE			2100 J	460 J			
SEMIVOLATILES (µg/kg)							
2,4-DINITROTOLUENE-OS					1600		
2,6-DINITROTOLUENE					140 J		
BIS(2-ETHYLHEXYL)PHTHALATE					65 J		
CHRYSENE					52 J		
DI-N-BUTYL PHTHALATE			96 J		2400		
DIETHYL PHTHALATE					340 J		
FLUORANTHENE					79 J		
N-NITROSODIPHENYLAMINE					300 J		
PHENANTHRENE					88 J		
PYRENE					91 J		
ENERGETICS (µg/kg)							
2,4,6-TRINITROTOLUENE	497				1180		
2-AMINO-4,6-DINITROTOLUENE	405						
METALS (mg/kg)							
ANTIMONY					2.1 L		
ARSENIC	3.9	2.4	3.1	4.6	3.8	5.7	6.7
BARIUM	41.6	97.0	19.6	23.0	56.2	74.4	43.2
BERYLLIUM	0.34	0.93	0.17	0.17	0.23	0.34	
CADMIUM	0.33 K	0.26 K	0.23 K	0.32 K	1.8	0.90	0.42 K
CHROMIUM	16.2	12.4	13.0	16.1	11.5	17.4	29.4
COBALT	4.2	14.3	1.6	4.5	5.5	8.6	3.3

TABLE 5-6
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SWMU 2/3-RANGE 3 BURN POINT/CHICKAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN3SB0070101	RN3SB0080101	RN3SB0090101	RN3SB0100101	RN3SB0100101-D	RN3SB0110101	RN3SB0120101
SAMPLE DATE:	07/09/97	07/09/97	07/09/97	07/09/97	07/09/97	07/09/97	07/09/97
LOCATION:	RN3SB0070101	RN3SB0080101	RN3SB0090101	RN3SB0100101	RN3DUP006	RN3SB0110101	RN3SB0120101
FIELD DUPLICATE OF:					RN3SB0100101		
METALS (mg/kg)							
COPPER	13.5	12.6	18.1	9.5	66.6	20.4	13.1
LEAD	10.5	17.4	40.4	8.9	301	60.4	16.7
MERCURY	0.05	0.03	0.04	0.05	0.96	1.9	0.08
NICKEL	7.7	10.4	3.7	5.0	22.2	5.7	7.2
SELENIUM	1.0	0.81	0.67	1.3	0.81	1.3	1.7
VANADIUM	23.4	18.7	17.8	27.4	19.1	25.2	43.7
ZINC	25.2	35.8	12.2	12.8	69.6	25.0	24.1
MISCELLANEOUS PARAMETERS (mg/kg)							
TOTAL ORGANIC CARBON	12300	6800	1050	2250	2310	9080	1120

TABLE 5-6
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SWMU 2/3-RANGE 3 BURN POINT/CHICKAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER: SAMPLE DATE: LOCATION: FIELD DUPLICATE OF:	RN3SB0130101 07/09/97 RN3SB0130101	RN3SB0140101 07/08/97 RN3SB0140101	/ /	/ /	/ /	/ /	/ /
VOLATILES (µg/kg)							
ACETONE	2600 J						
SEMIVOLATILES (µg/kg)							
BIS(2-ETHYLHEXYL)PHTHALATE		71 J					
METALS (mg/kg)							
ANTIMONY	1.3 L	0.33 L					
ARSENIC	5.2	1.6					
BARIUM	38.0	108					
BERYLLIUM		0.66					
CADMIUM	0.35 K	0.32 K					
CHROMIUM	20.6 J	5.5 J					
COBALT	6.2	8.5					
COPPER	8.6	8.7					
LEAD	9.9	6.7					
MERCURY	0.11	0.25					
NICKEL	6.3	5.5					
SELENIUM	1.3 L	0.49 L					
VANADIUM	27.2	9.8					
ZINC	16.4	16.3					
MISCELLANEOUS PARAMETERS (mg/kg)							
TOTAL ORGANIC CARBON	650	6060					

TABLE 5-7
SUMMARY OF POSITIVE DETECTIONS IN GROUNDWATER FOR SWMU 2/3-RANGE 3 BURN POINT/CHICKAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN3MW001U001	RN3MW001F001	RN3MW002U001	RN3MW002F001	RN3MW003U001	RN3MW003F001	RN3MW004U001
SAMPLE DATE:	08/03/97	08/03/97	08/05/97	08/05/97	08/04/97	08/04/97	08/03/97
LOCATION:	RN3MW001U001	RN3MW001F001	RN3MW002U001	RN3MW002F001	RN3MW003U001	RN3MW003F001	RN3MW004U001
FIELD DUPLICATE OF:							
VOLATILES (µg/L)							
ACETONE			23 J		200 J		
CHLOROFORM					2 J		
ENERGETICS (µg/L)							
RDX	1.2 J						
METALS (µg/L)							
BARIUM	12.9		112		60.0		169
CADMIUM			1.4				
COBALT	3.8		4.0		2.7		40.4
MERCURY			0.18		0.19		
NICKEL	8.7		2.9				28.3
SILVER					0.84		
ZINC					6.7		
DISSOLVED METALS (µg/L)							
ANTIMONY, FILTERED				3.1			
BARIUM, FILTERED		9.9		122		58.2	
CADMIUM, FILTERED				1.4			
COBALT, FILTERED		3.0		6.2		3.2	
MERCURY, FILTERED				0.19			
NICKEL, FILTERED		7.5		3.8			
SILVER, FILTERED				1.2		1.1	
ZINC, FILTERED						6.1	
MISCELLANEOUS PARAMETERS (mg/L)							
TOTAL ORGANIC CARBON	1.11		37.8		11.4		6.47

TABLE 5-7
SUMMARY OF POSITIVE DETECTIONS IN GROUNDWATER FOR SWMU 2/3-RANGE 3 BURN POINT/CHICKAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN3MW001U001	RN3MW001F001	RN3MW002U001	RN3MW002F001	RN3MW003U001	RN3MW003F001	RN3MW004U001
SAMPLE DATE:	08/03/97	08/03/97	08/05/97	08/05/97	08/04/97	08/04/97	08/03/97
LOCATION:	RN3MW001U001	RN3MW001F001	RN3MW002U001	RN3MW002F001	RN3MW003U001	RN3MW003F001	RN3MW004U001
FIELD DUPLICATE OF:							
MISCELLANEOUS PARAMETERS (µg/L)							
TOTAL ORGANIC HALIDES (ug/L)					52.6		

TABLE 5-7
SUMMARY OF POSITIVE DETECTIONS IN GROUNDWATER FOR SWMU 2/3-RANGE 3 BURN POINT/CHICKAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN3MW004F001						
SAMPLE DATE:	08/03/97	/ /	/ /	/ /	/ /	/ /	/ /
LOCATION:	RN3MW004F001						
FIELD DUPLICATE OF:							
DISSOLVED METALS (µg/L)							
BARIUM, FILTERED	182						
COBALT, FILTERED	39.8						
NICKEL, FILTERED	29.0						

TABLE 5-8
SUMMARY OF POSITIVE DETECTIONS IN SURFACE WATER FOR SWMU 2/3-RANGE 3 BURN POINT/CHICKAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN3SW0010101	RN3SW0020101	RN3SW0020101-D				
SAMPLE DATE:	08/14/97	08/14/97	08/14/97	/ /	/ /	/ /	/ /
LOCATION:	RN3SW0010101	RN3SW0020101	RN3DUP005				
FIELD DUPLICATE OF:			RN3SW0020101				
METALS (µg/L)							
BARIUM	65.2	66.5					
MISCELLANEOUS PARAMETERS (mg/L)							
TOTAL ORGANIC CARBON	9.65	10.1	5.53				
TOTAL ORGANIC HALIDES (ug/L)	20.8	23.8					

TABLE 5-9
SUMMARY OF POSITIVE DETECTIONS IN SEDIMENT FOR SWMU 2/3-RANGE 3 BURN POINT/CHICKAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN3SD0010101	RN3SD0020101	RN3SD0030101	RN3SD0030101-D	RN3SD0040101	/ /	/ /
SAMPLE DATE:	08/14/97	08/14/97	08/15/97	08/15/97	08/14/97		
LOCATION:	RN3SD0010101	RN3SD0020101	RN3SD0030101	RN3DUP017	RN3SD0040101		
FIELD DUPLICATE OF:				RN3SD0030101			
VOLATILES (µg/kg)							
2-BUTANONE		110 L					
ACETONE	1100	800	50	53			
CARBON DISULFIDE		29					
SEMIVOLATILES (µg/kg)							
BENZO(A)PYRENE		150 J					
BENZO(B)FLUORANTHENE				62 J			
BIS(2-ETHYLHEXYL)PHTHALATE	790 J						
CHRYSENE			64 J	63 J			
DI-N-BUTYL PHTHALATE		260 J					
FLUORANTHENE			72 J	100 J			
NAPHTHALENE	150 J						
PYRENE				83 J			
ENERGETICS (µg/kg)							
2,4,6-TRINITROTOLUENE			347	521			
METALS (mg/kg)							
ANTIMONY			2.3 L	2.3 L	0.94 L		
ARSENIC		8.5	9.9	9.9	2.4		
BARIUM	116	142	66.1	66.8	12.6		
CADMIUM			2.7	2.6	0.76		
CHROMIUM	27.5	41.2	20.4	25.9	10.8		
COBALT	15.5	19.7	17.6	15.3	1.6		
COPPER	45.3 J	305 J	169 J	181 J	13.4 J		
LEAD	40.3	46.3	217	231	34.4		

TABLE 5-9
SUMMARY OF POSITIVE DETECTIONS IN SEDIMENT FOR SWMU 2/3-RANGE 3 BURN POINT/CHICKAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RN3SD0010101	RN3SD0020101	RN3SD0030101	RN3SD0030101-D	RN3SD0040101		
SAMPLE DATE:	08/14/97	08/14/97	08/15/97	08/15/97	08/14/97	/ /	/ /
LOCATION:	RN3SD0010101	RN3SD0020101	RN3SD0030101	RN3DUP017	RN3SD0040101		
FIELD DUPLICATE OF:				RN3SD0030101			
METALS (mg/kg)							
MERCURY	0.61		10.4	3.1	0.02		
NICKEL	33.1	34.2	25.4	26.1	4.0		
SELENIUM				1.1 J			
SILVER			0.37	0.29			
TIN	12.2	12.5	7.2	7.3	2.9		
VANADIUM	42.3	56.2	35.9	42.0	10.4		
ZINC	140 J	172 J	178 J	172 J	15.1 J		
MISCELLANEOUS PARAMETERS (mg/kg)							
TOTAL ORGANIC CARBON	40700	30300	17200	8920	2260		

TABLE 5-10

COMPARISON OF SURFACE SOIL AND SUBSURFACE SOIL DATA
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

	SURFACE SOIL				SUBSURFACE SOIL			
Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum
Volatile Organic Compounds (µg/kg)								
2-Butanone	ND	ND	ND	ND	1/1	170	170.00	RN3SB0030101
Acetone	9/14	96-2600	1196.22	RN3SS0120101	9/22	160-4700	1835.56	RN3SB0020201
Carbon disulfide	ND	ND	ND	ND	1/22	110	110.00	RN3SB0030201
Methylene chloride	1/14	700	700.00	RN3SS0010101	3/22	6.25-410	161.75	RN3SB0030201
Semivolatile Organic Compounds (µg/kg)								
2,4-Dinitrotoluene	ND	ND	ND	ND	1/22	1600	892.50	RN3SB0100101-D
2,6-Dinitrotoluene	ND	ND	ND	ND	1/22	140	140.00	RN3SB0100101-D
Benzo(a)anthracene	1/14	45	45.00	RN3SS0080101	ND	ND	ND	ND
Benzo(a)pyrene	1/14	45	45.00	RN3SS0080101	ND	ND	ND	ND
Benzo(b)fluoranthene	1/14	85	85.00	RN3SS0080101	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	4/14	86-780	431.50	RN3SS0030101	9/22	59-4000	755.00	RN3SB0020201
Chrysene	1/14	53	53.00	RN3SS0080101	1/22	52	52.00	RN3SB0100101-D
Di-n-butyl phthalate	4/14	37-96	65.50	RN3SS0070101	2/22	96-2400	694.25	RN3SB0100101-D
Di-n-octyl phthalate	1/14	290	290.00	RN3SS0020101	1/22	38	38.00	RN3SB0020101
Diethyl phthalate	ND	ND	ND	ND	1/22	340	340.00	RN3SB0100101-D
Fluoranthene	3/14	57-88	68.00	RN3SS0080101	1/22	79	79.00	RN3SB0100101-D
N-Nitrosodiphenylamine	ND	ND	ND	ND	1/22	300	300.00	RN3SB0100101-D
Phenanthrene	3/14	49-57	53.00	RN3SS0080101	1/22	88	88.00	RN3SB0100101-D
Pyrene	2/14	49-81	65.00	RN3SS0080101	1/22	91	91.00	RN3SB0100101-D
Explosives (µg/kg)								
1,3,5-Trinitrobenzene	1/14	420	420.00	RN3SS0050101	ND	ND	ND	ND
2,4,6-Trinitrotoluene	3/14	104-6570	2265.00	RN3SS0050101	2/22	497-1180	547.95	RN3SB0100101-D
2-Amino-4,6-dinitrotoluene	3/14	127-525	287.67	RN3SS0050101	1/22	405	405.00	RN3SB0070101
HMX	1/14	355	355.00	RN3SS0040101	ND	ND	ND	ND
Inorganics (mg/kg)								
Antimony	7/14	0.42-0.87	0.58	RN3SS0130101	7/20	0.32-2.1	0.72	RN3SB0100101-D
Arsenic	14/14	2.2-6.7	4.36	RN3SS0010101	22/22	1.6-9.1	4.76	RN3SB0040401
Barium	14/14	18.5-94.1	36.36	RN3SS0050101	22/22	9.1-119	52.69	RN3SB0030101
Beryllium	14/14	0.15-0.72	0.29	RN3SS0050101	19/22	0.12-1.3	0.54	RN3SB0030201
Cadmium	14/14	0.14-0.95	0.47	RN3SS0010101	22/22	0.15-1.8	0.48	RN3SB0100101-D

TABLE 5-10

COMPARISON OF SURFACE SOIL AND SUBSURFACE SOIL DATA
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	SURFACE SOIL				SUBSURFACE SOIL			
	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum
Chromium	14/14	9.2-35.8	18.50	RN3SS0110101	22/22	5.5-31.5	17.40	RN3SB0040401
Cobalt	14/14	0.94-21.6	6.33	RN3SS0040101	22/22	1.6-19.7	6.92	RN3SB0050101
Copper	13/14	5.5-46.7	15.15	RN3SS0040101	21/22	5.1-66.6	15.26	RN3SB0100101-D
Lead	14/14	3.9-37.2	15.56	RN3SS0040101	22/22	2.4-301	21.87	RN3SB0100101-D
Mercury	14/14	0.02-0.2	0.08	RN3SS0140101	19/22	0.02-3.5	0.45	RN3SB0030101
Nickel	14/14	2.1-26.7	9.75	RN3SS0040101	22/22	2.6-25.3	9.45	RN3SB0030201
Selenium	14/14	0.45-2.2	1.12	RN3SS0010101	22/22	0.46-2.7	1.24	RN3SB0030201
Silver	1/22	0.25	0.25	RN3SS0040101	1/22	0.16	0.16	RN3SB0030101
Vanadium	14/14	11.4-37.6	26.13	RN3SS0010101	22/22	7.2-56.2	25.90	RN3SB0030201/ RN3SB0040401
Zinc	14/14	8-53.4	25.42	RN3SS0050101	22/22	9.8-83.7	31.33	RN3SB0030101
Miscellaneous (mg/kg)								
Total Organic Carbon	13/14	1570-30000	7588.46	RN3SS0010101	20/22	391-104000	14531.00	RN3SB0030101

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.

TABLE 5-11

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT SURFACE SOIL (0 TO 2 FEET)
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tol. Limit for Background	Greater Than Background?	SSL Transfer from Soil to Air (5)	Selected as COPC?
					Industrial	Residential					
Volatile Organic Compounds (µg/kg)											
Acetone	9/14	96-2600	1196.22	RN3SS0120101	20000000	780000	N	13000	No	100000000	No
Methylene chloride	1/14	700	700.00	RN3SS0010101	760000	85000	C	ND (6)	Yes (7)	13000	No
Semivolatile Organic Compounds (µg/Kg)											
Benzo(a)anthracene	1/14	45	45.00	RN3SS0080101	7800	880	C	ND	Yes (7)	(8)	No
Benzo(a)pyrene	1/14	45	45.00	RN3SS0080101	780	88	C	ND	Yes (7)	-	No
Benzo(b)fluoranthene	1/14	85	85.00	RN3SS0080101	7800	880	C	ND	Yes (7)	-	No
Bis(2-ethylhexyl)phthalate	4/14	86-780	431.50	RN3SS0030101	410000	46000	C	640	Yes	31000000	No
Chrysene	1/14	53	53.00	RN3SS0080101	780000	88000	C	ND	Yes (7)	-	No
Di-n-butyl phthalate	4/14	37-96	65.50	RN3SS0070101	20000000	780000	N	ND	Yes (7)	2300000	No
Di-n-octyl phthalate	1/14	290	290.00	RN3SS0020101	4100000	160000	N	ND	Yes (7)	10000000	No
Fluoranthene	3/14	57-88	68.00	RN3SS0080101	8200000	310000	N	ND	Yes (7)	-	No
Phenanthrene	3/14	49-57	53.00	RN3SS0080101	-	-	-	ND	Yes (7)	-	No (9)
Pyrene	2/14	49-81	65.00	RN3SS0080101	6100000	230000	N	ND	Yes (7)	-	No
Explosives (µg/kg)											
1,3,5-Trinitrobenzene	1/14	420	420.00	RN3SS0050101	6100000	230000	N	ND	Yes (7)	-	No
2,4,6-Trinitrotoluene	3/14	104-6570	2265.00	RN3SS0050101	190000	21000	C	ND	Yes (7)	-	No
2-Amino-4,6-dinitrotoluene	3/14	127-525	287.67	RN3SS0050101	12000	470	N	ND	Yes (7)	-	No
HMX (10)	1/14	355	355.00	RN3SS0040101	10000000	390000	N	ND	Yes (7)	-	No
Inorganics (mg/kg)											
Antimony	7/14	0.42-0.87	0.58	RN3SS0130101	82	3.1	N	ND	Yes (7)	-	No
Arsenic	14/14	2.2-6.7	4.36	RN3SS0010101	3.8*	0.43	C	4.2547	Yes	750	Yes
Barium	14/14	18.5-94.1	36.36	RN3SS0050101	14000	550	N	143.9192	No	690000	No
Beryllium	14/14	0.15-0.72	0.29	RN3SS0050101	1.3	0.15	C	0.905	No	1300	No
Cadmium	14/14	0.14-0.95	0.47	RN3SS0010101	100	3.9	N	0.26	Yes	1800	No
Chromium (11)	14/14	9.2-35.8	18.50	RN3SS0110101	1000	39	N	24.2185	Yes	270	No
Cobalt	14/14	0.94-21.6	6.33	RN3SS0040101	12000	470	N	39.7328	No	-	No
Copper	13/14	5.5-46.7	15.15	RN3SS0040101	8200	310	N	18.6594	Yes	-	No
Lead	14/14	3.9-37.2	15.56	RN3SS0040101	2000 (12)	400 (12)	N	149	No	-	No
Mercury	14/14	0.02-0.2	0.08	RN3SS0140101	61	2.3	N	0.087	Yes	10	No
Nickel	14/14	2.1-26.7	9.75	RN3SS0040101	4100	160	N	18.2456	Yes	13000	No
Selenium	14/14	0.45-2.2	1.12	RN3SS0010101	1000	39	N	1.0916	Yes	-	No
Silver	1/14	0.25	0.25	RN3SS0040101	1000	39	N	ND	Yes (7)	-	No
Vanadium	14/14	11.4-37.6	26.13	RN3SS0010101	1400	55	N	53.4527	No	-	No
Zinc	14/14	8-53.4	25.42	RN3SS0050101	61000	2300	N	38.1078	No	-	No

TABLE 5-11

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT SURFACE SOIL (0 TO 2 FEET)
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tol. Limit for Background	Greater Than Background?	SSL Transfer from Soil to Air (5)	Selected as COPC?
					Industrial	Residential					
Miscellaneous (mg/kg)											
Total Organic Carbon	13/14	1570-30000	7588.46	RN3SS0010101	-	-	-	30695	No	-	No

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 Soil Screening Levels (SSLs) for transfers from soil to air (USEPA, 1996) included for qualitative evaluation only.
6 ND = not detected; NA = not applicable.
7 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
8 Data not available.
9 Sufficient toxicity criteria not available; maximum concentration below screening levels of related chemicals (naphthalene, fluoranthene,fluorene).
10 HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
11 Considered as hexavalent chromium.
12 OSWER screening level for lead in soil (USEPA, 1993).

TABLE 5-12

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT FOR ALL SOIL
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tolerance Limit for Background		Greater Than Background?	SSL Transfer from Soil to Air (5)	Selected as COPC?
					Industrial	Residential		Surface	Subsurface			
Volatile Organic Compounds (µg/kg)												
2-Butanone	1/2	170	170.00	RN3SB0030101	100000000	4700000	N	ND (6)	ND	Yes (7)	(8)	No
Acetone	18/36	96-4700	1515.89	RN3SB0020201	20000000	780000	N	13000	1800	Yes	100000000	No
Carbon disulfide	1/36	110	110.00	RN3SB0030201	20000000	780000	N	ND	ND	Yes (7)	720000	No
Methylene chloride	4/36	69-700	296.31	RN3SS0010101	760000	85000	C	ND	ND	Yes (7)	13000	No
Semivolatile Organic Compounds (µg/kg)												
2,4-Dinitrotoluene	1/36	1600	892.50	RN3SB0100101-D	410000	16000	N	ND	ND	Yes (7)	-	No
2,6-Dinitrotoluene	1/36	140	140.00	RN3SB0100101-D	200000	7800	N	ND	ND	Yes (7)	-	No
Benzo(a)anthracene	1/36	45	45.00	RN3SS0080101	7800	880	C	ND	ND	Yes (7)	-	No
Benzo(a)pyrene	1/36	45	45.00	RN3SS0080101	780	88	C	ND	ND	Yes (7)	-	No
Benzo(b)fluoranthene	1/36	85	85.00	RN3SS0080101	7800	880	C	ND	ND	Yes (7)	-	No
Bis(2-ethylhexyl)phthalate	13/36	59-4000	655.46	RN3SB0020201	410000	46000	C	640	ND	Yes	-	No
Chrysene	2/36	52-53	52.50	RN3SS0080101	780000	88000	C	ND	ND	Yes (7)	-	No
Di-n-butyl phthalate	6/36	37-2400	275.08	RN3SB0100101-D	20000000	780000	N	ND	ND	Yes (7)	720000	No
Di-n-octyl phthalate	2/36	38-290	164.00	RN3SS0020101	4100000	160000	N	ND	ND	Yes (7)	10000000	No
Diethyl phthalate	1/36	340	340.00	RN3SB0100101-D	100000000	6300000	N	ND	ND	Yes (7)	-	No
Fluoranthene	4/36	57-88	70.75	RN3SS0080101	8200000	310000	N	ND	ND	Yes (7)	-	No
N-Nitrosodiphenylamine	1/36	300	300.00	RN3SB0100101-D	1200000	130000	C	ND	ND	Yes (7)	-	No
Phenanthrene	4/36	49-88	61.75	RN3SB0100101-D	-	-	-	ND	ND	Yes (7)	-	No (9)
Pyrene	3/36	49-91	73.67	RN3SB0100101-D	6100000	230000	N	ND	ND	Yes (7)	-	No
Explosives (µg/kg)												
1,3,5-Trinitrobenzene	1/36	420	420.00	RN3SS0050101	6100000	230000	N	ND	ND	Yes (7)	-	No
2,4,6-Trinitrotoluene	5/36	104-6570	1578.18	RN3SS0050101	190000	21000	C	ND	ND	Yes (7)	-	No
2-Amino-4,6-dinitrotoluene	4/36	127-525	317.00	RN3SS0050101	12000	**470**	N	ND	ND	Yes (7)	-	No
HMX (10)	1/36	355	355.00	RN3SS0040101	10000000	390000	N	ND	ND	Yes (7)	-	No
Inorganics (mg/kg)												
Antimony	14/34	0.32-2.1	0.65	RN3SB0100101-D	82	3.1	N	ND	3.6	No	-	No
Arsenic	36/36	1.6-9.1	4.60	RN3SB0040401	**3.8***	**0.43**	C	4.25	24.4	Yes	750	Yes
Barium	36/36	9.1-119	46.34	RN3SB0030101	1400	550	N	144	191	No	690000	No
Beryllium	33/36	0.12-1.3	0.43	RN3SB0030201	1.3	**0.15**	C	0.905	2.46	Yes	1300	No
Cadmium	36/36	0.14-1.8	0.47	RN3SB0100101-D	100	3.9	N	0.26	0.388	Yes	1800	No
Chromium (11)	36/36	5.5-35.8	17.83	RN3SS0110101	1000	39	N	24.2	101	Yes	270	No
Cobalt	36/36	0.94-21.6	6.69	RN3SS0040101	12000	470	N	39.7	133	No	-	No
Copper	34/36	5.1-66.6	15.22	RN3SB0100101-D	100000	27000	N	18.7	56.5	Yes	-	No
Lead	36/36	2.4-301	19.41	RN3SB0100101-D	2000 (11)	400 (11)	N	149	37.5	Yes	-	No
Mercury	33/36	0.02-3.5	0.29	RN3SB0030101	61	**2.3**	N	0.087	0.13	Yes	10	No
Nickel	36/36	2.1-26.7	9.57	RN3SS0040101	4100	160	N	18.2	22.1	Yes	13000	No
Selenium	36/36	0.45-2.7	1.20	RN3SB0030201	1000	39	N	1.09	8.93	Yes	-	No
Silver	2/36	0.16-0.25	0.21	RN3SS0040101	1000	39	N	ND	0.63	No	-	No
Vanadium	36/36	7.2-56.2	25.99	RN3SB0030201, RN3SB0040401	1400	**55**	N	53.5	133	No	-	No
Zinc	36/36	8-83.7	29.03	RN3SB0030101	61000	2300	N	38.1	79.5	Yes	-	No

TABLE 5-12

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT FOR ALL SOIL
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tolerance Limit for Background		Greater Than Background?	SSL Transfer from Soil to Air (5)	Selected as COPC?
					Industrial	Residential		Surface	Subsurface			
Miscellaneous (mg/kg)												
Total Organic Carbon	33/36	391-104000	11796.09	RN3SB0030101	-	-	-	30695	4243	Yes	-	No

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 Soil Screening Levels (SSLs) for transfers from soil to air (USEPA, 1996) included for qualitative evaluation only.
6 ND = not detected; NA = not applicable.
7 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
8 Data not available.
9 Sufficient toxicity criteria not available; maximum concentration below screening levels of related chemicals.
10 HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine
11 Considered as hexavalent chromium.
12 OSWER screening level for lead in soil (USEPA, 1993)

TABLE 5-13

SOIL CONCENTRATION VERSUS SOIL SCREENING LEVELS (SSLs) FOR PROTECTION OF GROUNDWATER FOR ALL SOIL
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Upper Tolerance Limit for Background		Greater Than Background?	SSL Transfer from Soil to GW-20DAF(3)
					Surface	Subsurface		
Volatile Organic Compounds (µg/kg)								
2-Butanone	1/2	170	170.00	RN3SB0030101	ND (4)	ND	Yes (5)	(6)
Acetone	18/36	96-4700	1515.89	RN3SB0020201	13000	1800	Yes	16000
Carbon disulfide	1/36	110	110.00	RN3SB0030201	ND	ND	Yes (5)	32000
Methylene chloride	4/36	69-700	296.31	RN3SS0010101	ND	ND	Yes (5)	**20***
Semivolatile Organic Compounds (µg/kg)								
2,4-Dinitrotoluene	1/36	1600	892.50	RN3SB0100101-D	ND	ND	Yes (5)	1025
2,6-Dinitrotoluene	1/36	140	140.00	RN3SB0100101-D	ND	ND	Yes (5)	**0.71**
Benzo(a)anthracene	1/36	45	45.00	RN3SS0080101	ND	ND	Yes (5)	2000
Benzo(a)pyrene	1/36	45	45.00	RN3SS0080101	ND	ND	Yes (5)	8000
Benzo(b)fluoranthene	1/36	85	85.00	RN3SS0080101	ND	ND	Yes (5)	5000
Bis(2-ethylhexyl)phthalate	13/36	59-4000	655.46	RN3SB0020201	640	ND	Yes	3600000
Chrysene	2/36	52-53	52.50	RN3SS0080101	ND	ND	Yes (5)	160000
Di-n-butyl phthalate	6/36	37-2400	275.08	RN3SB0100101-D	ND	ND	Yes (5)	2300000
Di-n-octyl phthalate	2/36	38-290	164.00	RN3SS0020101	ND	ND	Yes (5)	10000000
Diethyl phthalate	1/36	340	340.00	RN3SB0100101-D	ND	ND	Yes (5)	470000
Fluoranthene	4/36	57-88	70.75	RN3SS0080101	ND	ND	Yes (5)	4300000
N-Nitrosodiphenylamine	1/36	300	300.00	RN3SB0100101-D	ND	ND	Yes (5)	1000
Phenanthrene	4/36	49-88	61.75	RN3SB0100101-D	ND	ND	Yes (5)	-
Pyrene	3/36	49-91	73.67	RN3SB0100101-D	ND	ND	Yes (5)	4200000
Explosives (µg/kg)								
1,3,5-Trinitrobenzene	1/36	420	420.00	RN3SS0050101	ND	ND	Yes (5)	528
2,4,6-Trinitrotoluene	5/36	104-6570	1578.18	RN3SS0050101	ND	ND	Yes (5)	55.0
2-Amino-4,6-dinitrotoluene	4/36	127-525	317.00	RN3SS0050101	ND	ND	Yes (5)	14.2
HMX (7)	1/36	355	355.00	RN3SS0040101	ND	ND	Yes (5)	7450
Inorganics (mg/kg)								
Antimony	14/34	0.32-2.1	0.65	RN3SB0100101-D	ND	3.6	No	5
Arsenic	36/36	1.6-9.1	4.60	RN3SB0040401	4.25	24.4	No	29
Barium	36/36	9.1-119	46.34	RN3SB0030101	144	191	No	1600
Beryllium	33/36	0.12-1.3	0.43	RN3SB0030201	0.905	2.46	Yes	63
Cadmium	36/36	0.14-1.8	0.47	RN3SB0100101-D	0.26	0.388	Yes	8
Chromium (8)	36/36	5.5-35.8	17.83	RN3SS0110101	24.2	101	Yes	38
Cobalt	36/36	0.94-21.6	6.69	RN3SS0040101	39.7	133	No	-

TABLE 5-13

SOIL CONCENTRATION VERSUS SOIL SCREENING LEVELS (SSLs) FOR PROTECTION OF GROUNDWATER FOR ALL SOIL
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Upper Tolerance Limit for Background		Greater Than Background?	SSL Transfer from Soil to GW-20DAF(3)
					Surface	Subsurface		
Copper	34/36	5.1-66.6	15.22	RN3SB0100101-D	18.7	56.5	Yes	-
Lead	36/36	2.4-301	19.41	RN3SB0100101-D	149	37.5	Yes	-
Mercury	33/36	0.02-3.5	0.29	RN3SB0030101	0.087	0.13	Yes	2
Nickel	36/36	2.1-26.7	9.57	RN3SS0040101	18.2	22.1	Yes	130
Selenium	36/36	0.45-2.7	1.20	RN3SB0030201	1.09	8.93	Yes	5
Silver	2/36	0.16-0.25	0.21	RN3SS0040101	ND	0.63	No	34
Vanadium	36/36	7.2-56.2	25.99	N3SB0030201, RN3SB004040	53.5	133	No	6000
Zinc	36/36	8-83.7	29.03	RN3SB0030101	38.1	79.5	Yes	12000
Miscellaneous (mg/kg)								
Total Organic Carbon	33/36	391-104000	11796.09	RN3SB0030101	30695	4243	Yes	-

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Soil Screening Levels (SSLs) for migration from soil to groundwater (USEPA, 1996) corresponding to a dilution and attenuation factor (DAF) of 20.
4 ND = not detected; NA = not applicable.
5 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
6 Data not available.
7 HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine.
8 Considered as hexavalent chromium.

TABLE 5-14A

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR UNFILTERED GROUNDWATER
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	UTL for Background (5)	Greater Than Background?	Selected as COPC?
Semivolatile Organic Compounds (µg/L)									
Acetone	2/3	23-200	111.50	RN3MW003U001	370	N	ND (6)	Yes (7)	No
Chloroform	1/3	2	2.00	RN3MW003U001	**0.15***	C	2	No	No
Inorganics (µg/L)									
Barium	3/3	60-169	113.67	RN3MW004U001	260	N	253.52	No	No
Cadmium	1/3	1.4	1.40	RN3MW002U001	1.8	N	2.8	No	No
Cobalt	3/3	2.7-40.4	15.70	RN3MW004U001	220	N	39.574	Yes	No
Mercury	2/3	0.18-0.19	0.19	RN3MW003U001	1.1	N	0.13	Yes	No
Nickel	2/3	2.9-28.3	15.60	RN3MW004U001	73	N	39.0087	No	No
Silver	1/3	0.84	0.84	RN3MW003U001	18	N	ND	Yes (7)	No
Zinc	1/3	6.7	6.70	RN3MW003U001	1100	N	45.2	No	No
Miscellaneous (mg/L)									
Total Organic Carbon	3/3	6.47-37.8	18.56	RN3MW002U001	-	-	45.0467	No	No
Total Organic Halides	1/3	52.6	52.60	RN3MW003U001	-	-	ND	Yes (7)	No

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 Only nonturbid background samples included.
6 ND = not detected; NA = not applicable.
7 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.

TABLE 5-14B

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR FILTERED GROUNDWATER
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	Upper Tol. Limit for Background	Greater Than Background?
Inorganics (µg/L)								
Antimony, Filtered	1/3	3.1	3.10	RN3MW002F001	1.5	N	ND (5)	Yes (6)
Barium, Filtered	3/3	58.2-182	120.73	RN3MW004F001	260	N	114.03	Yes
Cadmium, Filtered	1/3	1.4	1.40	RN3MW002F001	1.8	N	2.90	No
Cobalt, Filtered	3/3	3.2-39.8	16.40	RN3MW004F001	220	N	12.97	Yes
Mercury, Filtered	1/3	0.19	0.19	RN3MW002F001	1.1	N	0.16	Yes
Nickel, Filtered	2/3	3.8-29	16.40	RN3MW004F001	73	N	41.36	No
Silver, Filtered	2/3	1.1-1.2	1.15	RN3MW002F001	18	N	ND	Yes (6)
Zinc, Filtered	1/3	6.1	6.10	RN3MW003F001	1100	N	10.26	No

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6. or a target cancer risk of 1E-6. Unfiltered data and screening levels presented only for qualitative analysis, not for COPC selection.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 ND = not detected; NA = not applicable.
6 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.

TABLE 5-15

SELECTION OF CHEMCIALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT FOR SURFACE WATER
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	Biocon-centration Factor (5)	Estimated Maximum Fish Conc. (6)	Risk-Based Screening Level, Fish (3)	Selected as COPC?
Inorganics (µg/L)										
Barium	2/2	65.2-66.5	65.20	RN3SW0020101	2600	N	10	665	95000	No
Miscellaneous (mg/L)										
Total Organic Carbon	2/2	5.53-10.1	8.73	RN3SW0020101	13000	N	-	-	-	No
Total Organic Halides	2/2	20.8-23.8	17.60	RN3SW0020101	11000	N	-	-	-	No

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 Factor assumed, because no value is available.
6 Estimated by multiplying Bioconcentration Factor times maximum site concentration.

TABLE 5-16

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT FOR SEDIMENT
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND
PAGE 1 OF 2

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tol. Limit for Background	Greater Than Background?	Selected as COPC?
					Industrial	Residential				
Volatile Organic Compounds (µg/kg)										
2-Butanone	1/1	110	110.00	RN3SD0020101	100000000	4700000	N	ND (5)	Yes (6)	No
Acetone	3/4	50-1100	650.50	RN3SD0010101	20000000	780000	N	ND	Yes (6)	No
Carbon disulfide	1/4	29	29.00	RN3SD0020101	20000000	780000	N	ND	Yes (6)	No
Semivolatile Organic Compounds (µg/kg)										
Benzo(a)pyrene	1/4	150	150.00	RN3SD0020101	780	**88***	C	ND	Yes (6)	No
Benzo(b)fluoranthene	1/4	62	62.00	RN3SD0030101-D	7800	880	C	ND	Yes (6)	No
Bis(2-ethylhexyl)phthalate	1/4	790	790.00	RN3SD0010101	410000	46000	C	ND	Yes (6)	No
Chrysene	1/4	63-64	63.50	RN3SD0030101	780000	88000	C	ND	Yes (6)	No
Di-n-butyl phthalate	1/4	260	260.00	RN3SD0020101	20000000	780000	N	ND	Yes (6)	No
Fluoranthene	1/4	72-100	86.00	RN3SD0030101-D	8200000	310000	N	ND	Yes (6)	No
Naphthalene	1/4	150	150.00	RN3SD0010101	8200000	310000	N	ND	Yes (6)	No
Pyrene	1/4	83	83.00	RN3SD0030101-D	6100000	230000	N	ND	Yes (6)	No
Explosives (µg/kg)										
2,4,6-Trinitrotoluene	1/4	347-521	434.00	RN3SD0030101-D	190000	21000	C	ND	Yes (6)	No
Inorganics (mg/kg)										
Antimony	2/4	0.94-2.3	1.62	3SD0030101, RN3SD0030101	82	3.1	N	ND	Yes (6)	No
Arsenic	3/4	2.4-9.9	6.93	3SD0030101, RN3SD0030101	**3.8**	**0.43**	C	62.96	No	No
Barium	4/4	12.6-142	84.26	RN3SD0020101	14000	550	N	577.19	No	No
Cadmium	2/4	0.76-2.7	1.71	RN3SD0030101	100	**3.9**	N	1.85	Yes	No
Chromium (7)	4/4	10.8-41.2	25.66	RN3SD0020101	1000	39	N	79.16	No	No
Cobalt	4/4	1.6-19.7	13.31	RN3SD0020101	12000	470	N	118.38	No	No
Copper	4/4	13.4-305	134.68	RN3SD0020101	8200	310	N	296.57	Yes	No
Lead	4/4	34.4-231	86.25	RN3SD0030101-D	2000 (8)	400 (8)	N	475.52	No	No
Mercury	3/4	0.02-10.4	2.46	RN3SD0030101	61	**2.3**	N	0.78	Yes	No
Nickel	4/4	4-34.2	24.26	RN3SD0020101	4100	160	N	382.01	No	No
Selenium	1/4	1.1	0.78	RN3SD0030101-D	1000	39	N	6.45	No	No
Silver	1/4	0.29-0.37	0.33	RN3SD0030101	1000	39	N	0.92	No	No
Tin	4/4	2.9-12.5	8.71	RN3SD0020101	1400	55	N	ND	Yes (6)	No
Vanadium	4/4	10.4-56.2	36.96	RN3SD0020101	1400	**55**	N	196.46	No	No
Zinc	4/4	15.1-178	125.53	RN3SD0030101	61000	2300	N	1659.58	No	No

TABLE 5-16

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT FOR SEDIMENT
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tol. Limit for Background	Greater Than Background?	Selected as COPC?
					Industrial	Residential				
Miscellaneous (mg/kg)										
Total Organic Carbon	4/4	260-4070	21580.00	RN3SD0010101	(9)	-	-	41450	No	No

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 ND = not detected; NA = not applicable.
6 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
7 Considered as hexavalent chromium.
8 OSWER screening level for lead in soil (USEPA, 1993).
9 Data not available.

TABLE 5-17

CHEMICALS OF POTENTIAL CONCERN AND EXPOSURE CONCENTRATIONS
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Medium	Organics		Inorganics	
	Chemical	Exposure Point Concentration[1]	Chemical	Exposure Point Concentration[1]
Surface Soil	None[2]	-	Arsenic	4.95 mg/kg
All Soil (Surface/ Subsurface Soil)	None[2]	-	Arsenic	5.26 mg/kg
Sediments	None[2]	-	Arsenic	9.90 mg/kg (max.) 6.93 mg/kg (ave.)
Groundwater (Unfiltered)	None[2]	-	None[2]	-
Surface Water/Fish Tissue	None[2]	-	None[2]	-

1 95 Percent UCLs of the arithmetic mean were used as exposure point concentrations for RME and CTE, unless they exceeded the maximum concentration or fewer than 10 sample were analyzed. In these instances, the maximum concentrations were used for the RME. The mean of positive detects for data sets with fewer than 10 samples (if less than the maximum) were used for the CTE. Statistics for distribution of data sets and 95 percent UCLs are presented in Appendix I.

2 No maximum analyte concentrations exceeded screening levels and\or background concentrations.

TABLE 5-18

SUMMARY OF EXPOSURE SCENARIOS
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Medium	Receptor	Exposure Route
Current Scenario		
Surface Soil[1]	Maintenance Worker/ Full-Time Employee	Incidental Ingestion Dermal Contact
Future Scenario		
Surface Soil	Maintenance Worker/ Full-Time Employee	Incidental Ingestion Dermal Contact
Surface/Subsurface Soil[2]	Construction Worker	Incidental Ingestion Dermal Contact

1 Surface soil is defined as soil collected from depths of 0 to 2 feet bgs.

2 Surface soil/subsurface soil is defined as soil collected from depths of 0 to >10 feet bgs.

TABLE 5-19

SUMMARY OF CANCER RISKS AND HAZARD INDICES [1]

SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A

RCRA FACILITY INVESTIGATION REPORT

STUMP NECK ANNEX, INDIAN HEAD DIVISION

NSWC INDIAN HEAD, MD

EXPOSURE ROUTE	MAINTENANCE WORKER [2]		FULL-TIME EMPLOYEE [2]		CONSTRUCTION WORKER [3]	
	RME [4]	CTE [5]	RME	CTE	RME	CTE
INCREMENTAL CANCER RISK						
Soil						
Incidental Ingestion of Soil	3.1E-07	2.8E-08	1.6E-06	2.8E-07	1.6E-07	6.6E-08
Dermal Contact with Soil	4.2E-07	7.6E-08	2.1E-06	7.6E-07	8.9E-08	8.9E-08
Cumulative Risk	**7.3E-07**	**1.0E-07**	**3.7E-06**	**1.0E-06**	**2.5E-07**	**1.6E-07**
HAZARD INDEX						
Soil						
Incidental Ingestion of Soil	0.0019	0.00048	0.0097	0.0048	0.025	0.01
Dermal Contact with Soil	0.0026	0.00026	0.013	0.0026	0.014	0.0028
Total Hazard Index	**0.0045**	**0.00075**	**0.023**	**0.0075**	**0.039**	**0.013**

Notes:

1 - Chemical specific risks present in Appendix ?

2 - Maintenance worker and full-time employee are exposed to surface soil.

3 - Construction worker is exposed to surface/subsurface soil.

4 - Reasonable Maximum Exposures

5 - Central Tendency Exposures

NA - Not applicable, exposure route not evaluated for this receptor.

TABLE 5-20A

QUALITATIVE EVALUATION OF UNFILTERED GROUNDWATER SAMPLES
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	EPA Drinking Water Standard		EPA Drinking Water Health Advisories	
						MCL	MCLG	Value	Receptor
Semivolatile Organic Compounds (ug/L)									
Acetone	2/3	23-200	111.50	370	N	NA	NA	NA	NA
Chloroform	1/3	2	2.00	**0.15***	C	100/80	0	100	LONG-TERM 10-KG CHILD
Inorganics (µg/L)									
Barium	3/3	60-169	113.67	260	N	2000	2000	2000	LIFETIME, 70-KG ADULT
Cadmium	1/3	1.4	1.40	1.8	N	5	5	5	LIFETIME, 70-KG ADULT
Cobalt	3/3	2.7-40.4	15.70	220	N	NA	NA	NA	NA
Mercury	2/3	0.18-0.19	0.19	1.1	N	2	2	2	LIFETIME, 70-KG ADULT
Nickel	2/3	2.9-28.3	15.60	73	N	100	100	100	LIFETIME, 70-KG ADULT
Silver	1/3	0.84	0.84	18	N	100	NA	100	LIFETIME, 70-KG ADULT
Zinc	1/3	6.7	6.70	1100	N	5000	NA	2000	LIFETIME, 70-KG ADULT
Miscellaneous (mg/L)									
Total Organic Carbon	3/3	6.47-37.8	18.56	NA	-	NA	NA	NA	NA
Total Organic Halides	1/3	52.6	52.60	NA	-	NA	NA	NA	NA

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
NA Data not available

TABLE 5-20B

QUALITATIVE EVALUATION OF FILTERED GROUNDWATER SAMPLES
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	EPA Drinking Water Standard		EPA Drinking Water Health Advisories	
						MCL	MCLG	Value	Receptor
Inorganics (µg/L)									
Antimony, Filtered	1/3	3.1	3.10	**1.5**	N	6	6	3	LIFETIME, 70-KG ADULT
Barium, Filtered	3/3	58.2-182	120.73	260	N	2000	2000	2000	LIFETIME, 70-KG ADULT
Cadmium, Filtered	1/3	1.4	1.40	1.8	N	5	5	5	LIFETIME, 70-KG ADULT
Cobalt, Filtered	3/3	3.2-39.8	16.40	220	N	NA	NA	NA	NA
Mercury, Filtered	1/3	0.19	0.19	1.1	N	2	2	2	LIFETIME, 70-KG ADULT
Nickel, Filtered	2/3	3.8-29	16.40	73	N	100	100	100	LIFETIME, 70-KG ADULT
Silver, Filtered	2/3	1.1-1.2	1.15	18	N	100	NA	100	LIFETIME, 70-KG ADULT
Zinc, Filtered	1/3	6.1	6.10	1100	N	5000	NA	2000	LIFETIME, 70-KG ADULT

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6. Unfiltered data and screening levels presented only for qualitative analysis, not for COPC selection.
4 N = noncarcinogenic basis; C = carcinogenic basis.
NA Data not available.

TABLE 5-21

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A - SURFACE WATER
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	BTAG Screening Level	EEQ	Retained as PCOC?
		Min.	Max.				
Inorganics (µg/L)							
Barium	1/1	65.2	66.5	RN3SW0020101	1000	0.07	N

EEQ = Ecological Effects Quotient

TABLE 5-22

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A - SEDIMENT
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	BTAG Screening Level	EEQ	Retained as PCOC?
		Min.	Max.				
Inorganics (mg/kg)							
Antimony	2/4	0.94	2.3	RN3SD0030101-D	NA	NA	Y
Arsenic	3/4	2.4	9.9	RN3SD0030101	0.057	173.68	Y
Barium	4/4	12.6	142	RN3SD0020101	NA	NA	Y
Cadmium	2/4	0.76	2.7	RN3SD0030101	1.2	2.25	Y
Chromium	4/4	10.8	41.2	RN3SD0020101	260	0.16	N
Cobalt	4/4	1.6	19.7	RN3SD0020101	NA	NA	Y
Copper	4/4	13.4	305	RN3SD0020101	34	8.97	Y
Lead	4/4	34.4	231	RN3SD0030101-D	46.7	4.95	Y
Mercury	3/4	0.02	10.4	RN3SD0030101	0.15	69.33	Y
Nickel	4/4	4	34.2	RN3SD0020101	20.9	1.64	Y
Selenium	1/4	1.1	1.1	RN3SD0030101-D	NA	NA	Y
Silver	1/4	0.29	0.37	RN3SD0030101	1	0.37	N
Tin	4/4	2.9	12.5	RN3SD0020101	NA	NA	Y
Vanadium	4/4	10.4	56.2	RN3SD0020101	NA	NA	Y
Zinc	4/4	15.1	178	RN3SD0030101	150	1.19	Y
Semivolatile Organic Compounds (µg/kg)							
Benzo(a)pyrene	1/4	150	150	RN3SD0020101	430	0.35	N
Benzo(b)fluoranthene	1/4	62	62	RN3SD0030101-D	3200	0.02	N
Bis(2-ethylhexyl)phthalate	1/4	790	790	RN3SD0010101	1300	0.61	N
Chrysene	1/4	63	64	RN3SD0030101	384	0.17	N
Di-n-butyl phthalate	1/4	260	260	RN3SD0020101	1400	0.19	N
Fluoranthene	1/4	72	100	RN3SD0030101-D	600	0.17	N
Naphthalene	1/4	150	150	RN3SD0010101	160	0.94	N
Pyrene	1/4	83	83	RN3SD0030101-D	665	0.12	N

TABLE 5-22

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A - SEDIMENT
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	BTAG Screening Level	EEQ	Retained as PCOC?
		Min.	Max.				
Volatile Organic Compounds (µg/kg)							
2-Butanone	1/1	110	110	RN3SD0020101	NA	NA	Y
Acetone	3/4	50	1100	RN3SD0010101	NA	NA	Y
Carbon disulfide	1/4	29	29	RN3SD0020101	NA	NA	Y
Explosives(µg/kg)							
2,4,6-trinitrotoluene	1/4	347	521	RN3SD0030101-D	NA	NA	Y

NA = Not Available
EEQ = Ecological Effects Quotient

TABLE 5-23

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A - SURFACE SOIL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	BTAG Screening Level	Hazard Quotient	Retained as PCOC?
		Min.	Max.				
Inorganics (mg/kg)							
Antimony	7/14	0.42	0.87	RN3SS0130101	0.48	1.81	Y
Arsenic	14/14	2.2	6.7	RN3SS0010101	328	0.02	N
Barium	14/14	18.5	94.1	RN3SS0050101	440	0.21	N
Beryllium	14/14	0.15	0.72	RN3SS0050101	0.02	36.00	Y
Cadmium	14/14	0.14	0.95	RN3SS0010101	2.5	0.38	N
Chromium	14/14	9.2	35.8	RN3SS0110101	0.0075	4773.33	Y
Cobalt	14/14	0.94	21.6	RN3SS0040101	200	0.11	N
Copper	13/14	5.5	46.7	RN3SS0040101	15	3.11	Y
Lead	14/14	3.9	37.2	RN3SS0040101	0.01	3720.00	Y
Mercury	14/14	0.02	0.2	RN3SS0140101	0.058	3.45	Y
Nickel	14/14	2.1	26.7	RN3SS0040101	2	13.35	Y
Selenium	14/14	0.45	2.2	RN3SS0010101	1.8	1.22	Y
Silver	1/14	0.25	0.25	RN3SS0040101	9.80E-06	25510.20	Y
Vanadium	14/14	11.4	37.6	RN3SS0010101	58	0.65	N
Zinc	14/14	8	53.4	RN3SS0050101	10	5.34	Y
Semivolatile Organic Compounds (µg/kg)							
Benzo(a)anthracene	1/14	45	45	RN3SS0080101	100	0.45	N
Benzo(a)pyrene	1/14	45	45	RN3SS0080101	100	0.45	N
Benzo(b)fluoranthene	1/14	85	85	RN3SS0080101	100	0.85	N
Bis(2-ethylhexyl)phthalate	4/14	86	780	RN3SS0030101	NA	NA	Y
Chrysene	1/14	53	53	RN3SS0080101	100	0.53	N
Di-n-butyl phthalate	4/14	37	96	RN3SS0070101	NA	NA	Y
Di-n-octyl phthalate	1/14	290	290	RN3SS0020101	NA	NA	Y

TABLE 5-23

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A - SURFACE SOIL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	BTAG Screening Level	Hazard Quotient	Retained as PCOC?
		Min.	Max.				
Fluoranthene	3/14	57	88	RN3SS0080101	100	0.88	N
Phenanthrene	3/14	49	57	RN3SS0080101	100	0.57	N
Pyrene	2/14	49	81	RN3SS0080101	100	0.81	N
Volatile Organic Compounds (μg/kg)							
Acetone	9/14	96	2600	RN3SS0120101	NA	NA	Y
Methylene Chloride	1/14	700	700	RN3SS0010101	300	2.33	Y
Explosives (μg/kg)							
1,3,5-Trinitrobenzene	1/28	420	420	RN3SS0050101	NA	NA	Y
2,4,6-Trinitrotoluene	3/14	104	6570	RN3SS0050101	NA	NA	Y
2-Amino-4,6-dinitrotoluene	3/14	127	525	RN3SS0050101	NA	NA	Y
HMX	1/14	355	355	RN3SS0040101	NA	NA	Y

NA = Not Available
EEQ = Ecological Effects Quotient

TABLE 5-24

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A - GROUNDWATER
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	AWQC	EEQ	Retained as PCOC?
		Min.	Max.				
Inorganics (mg/kg)							
Barium	3/3	60	169	RN3MW004U001	3.9	43.33	Y
Cadmium	1/3	1.4	1.4	RN3MW002U001	1	1.40	Y
Cobalt	3/3	2.7	40.4	RN3MW004U001	3	13.47	Y
Mercury	2/3	0.18	0.19	RN3MW003U001	0.003	63.33	Y
Nickel	2/3	2.9	28.3	RN3MW004U001	160	0.18	N
Silver	1/3	0.84	0.84	RN3MW003U001	0.12	7.00	Y
Zinc	1/3	6.7	6.7	RN3MW003U001	100	0.07	N
Volatile Organic Compounds (µg/L)							
Acetone	2/3	23	200	RN3MW003U001	NA	NA	Y
Chloroform	1/3	2	2	RN3MW003U001	1240	0.00	N

NA = Not Available
EEQ = Ecological Effects Quotient

TABLE 5-25

RESULTS OF AQUATIC FOODCHAIN MODELING
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
MAXIMUM AND MEAN CONCENTRATIONS
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Heron - Maximum		Heron - Mean	
	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI
Inorganics (mg/kg)				
Antimony	NA	NA	NA	NA
Arsenic	8.80	0.88	5.49	0.55
Barium	0.20	0.10	0.12	0.06
Cadmium	26.41	2.64	10.95	1.10
Cobalt	5.78	0.58	3.91	0.39
Copper	38.08	3.81	16.81	1.68
Lead	225.92	22.59	84.35	8.44
Mercury	305.14	30.51	54.28	5.43
Nickel	0.13	0.09	0.09	0.07
Selenium	0.65	0.32	0.45	0.23
Tin	0.54	0.22	0.38	0.15
Vanadium	1.45	0.14	0.95	0.10
Zinc	3.76	0.38	2.65	0.26
Volatile Organic Compounds (μg/kg)				
2-Butanone	NA	NA	NA	NA
Acetone	NA	NA	NA	NA
Carbon Disulfide	NA	NA	NA	NA
Explosives (μg/kg)				
2,4,6-Trinitrotoluene	0.13	0.01	0.02	0.00

NA = Not Available
EEI = Ecological Effects Index

TABLE 5-26

RESULTS OF TERRESTRIAL FOODCHAIN MODELING
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
MAXIMUM CONCENTRATIONS
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Potential Concern	Shrew		Hawk		Fox		Vole		Woodcock	
	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI
Inorganics (mg/kg)										
Antimony	4.76	0.48	NA	NA	0.93	0.09	2.49	0.25	NA	NA
Beryllium	0.91	0.09	NA	NA	0.18	0.02	0.48	0.05	NA	NA
Chromium	144.14	14.41	150.68	15.07	28.17	2.82	75.47	7.55	196.36	1.96
Copper	31.97	3.20	8.36	0.84	6.25	0.62	16.74	1.67	10.90	1.09
Lead	169.75	16.98	52.19	5.22	33.18	3.32	88.88	8.89	68.01	6.80
Mercury	2.74	0.27	8.42	0.84	2.68	0.27	1.43	0.14	9.14	0.91
Nickel	0.29	0.03	0.15	0.11	0.06	0.00	0.15	0.02	0.19	0.14
Selenium	60.23	15.06	1.85	0.93	11.77	2.94	31.54	7.88	2.41	1.21
Silver	0.00	0.00	NA	NA	0.00	0.00	0.00	0.00	NA	NA
Zinc	1.46	0.15	1.62	0.16	0.29	0.03	0.77	0.08	2.11	0.21
Semivolatile Organic Compounds (µg/kg)										
Bis(2-ethylhexyl)phthalate	0.03	0.00	NA	NA	0.00	0.00	0.02	0.00	NA	NA
Di-n-butyl phthalate	0.00	0.00	0.37	0.04	0.00	0.00	0.00	0.00	0.48	0.05
Di-n-octyl phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds (µg/kg)										
Acetone	0.18	0.04	NA	NA	0.03	0.00	0.09	0.02	NA	NA
Methylene chloride	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Explosives (µg/kg)										
1,3,5-Trinitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trinitrotoluene	1.32	0.13	0.92	0.09	NA	NA	0.91	0.09	1.2	0.12
2-Amino-4,6-dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
HMX	0.00	0.00	NA	NA	0.00	0.00	0.00	0.00	NA	NA

NA = Not Available
EEI = Ecological Effects Index

TABLE 5-27

RESULTS OF TERRESTRIAL FOODCHAIN MODELING
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
MEAN CONCENTRATIONS
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Potential Concern	Shrew		Hawk		Fox		Vole		Woodcock	
	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI
Inorganics (mg/kg)										
Antimony	2.17	0.22	NA	NA	0.42	0.04	1.14	0.11	NA	NA
Beryllium	0.37	0.04	NA	NA	0.07	0.00	0.19	0.02	NA	NA
Chromium	74.49	7.45	77.87	7.79	14.56	1.46	39.00	3.90	101.47	1.01
Copper	9.76	0.98	2.55	0.26	1.91	0.19	5.11	0.51	3.33	0.33
Lead	70.73	7.07	21.75	2.17	13.82	1.38	37.03	3.70	28.34	2.83
Mercury	1.07	0.11	3.28	0.33	1.04	0.10	0.56	0.06	3.57	0.36
Nickel	0.11	0.01	0.05	0.04	0.02	0.00	0.06	0.00	0.07	0.05
Selenium	30.39	7.60	0.93	0.47	5.94	1.49	15.91	3.98	1.22	0.61
Silver	0.00	0.00	NA	NA	0.00	0.00	0.00	0.00	NA	NA
Zinc	0.70	0.07	0.77	0.08	0.14	0.01	0.36	0.04	1.00	0.10
Semivolatile Organic Compounds (µg/kg)										
Bis(2-ethylhexyl)phthalate	0.00	0.00	NA	NA	0.00	0.00	0.00	0.00	NA	NA
Di-n-butyl phthalate	0.00	0.00	0.53	0.05	0.00	0.00	0.00	0.00	0.69	0.07
Di-n-octyl phthalate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds (µg/kg)										
Acetone	0.05	0.01	NA	NA	0.01	0.00	0.03	0.00	NA	NA
Methylene chloride	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Explosives (µg/kg)										
1,3,5-Trinitrobenzene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2,4,6-Trinitrotoluene	0.10	0.01	0.7	0.07	NA	NA	0.69	0.07	0.09	0.01
2-Amino-4,6-dinitrotoluene	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
HMX	0.00	0.00	NA	NA	0.00	0.00	0.00	0.00	NA	NA

NA = Not Available
EEI = Ecological Effects Index

TABLE 5-28

RISK MANAGEMENT CONSIDERATIONS
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Frequency of Detection	Range of Detections		Location of Maximum	Mean Concentration	BTAG Screening Level	Alternate Guideline(s)1	Max/Mean Background	Retained as Final PCOC?
		Minimum	Maximum						
Sediment2									
Antimony	2/4	0.94	2.3	RN3SD0030101-D	1.29	NA	NA	ND	N
Arsenic	3/4	2.4	9.9	RN3SD0030101	6.2	0.057	6/33	10.6/3.3	N
Cadmium	2/4	0.76	2.7	RN3SD0030101	1.1	1.2	0.6/10	0.86/0.35	N
Cobalt	4/4	1.6	19.7	RN3SD0020101	13.3	NA	NA	17.6/5.97	N
Copper	4/4	13.4	305	RN3SD0020101	134.7	34	16/110	28.3/9.5	Y
Lead	4/4	34.4	231	RN3SD0030101-D	86.3	46.7	31/250	79.3/23.1	Y
Mercury	3/4	0.02	10.4	RN3SD0030101	1.85	0.15	0.2/2	0.25/0.07	Y
Vanadium	4/4	10.4	56.2	RN3SD0020101	36.96	NA	NA	46.3/18.6	N
Zinc	4/4	15.1	178	RN3SD0030101	125.5	150	120/820	158/41.2	N
2-Butanone	1/1	110	110	RN3SD0020101	110	NA	NA	ND	N
Acetone	3/4	50	1100	RN3SD0010101	489	NA	NA	ND	N
Carbon disulfide	1/4	29	29	RN3SD0020101	11.7	NA	NA	ND	N
2,4,6-Trinitrotoluene	1/4	347	521	RN3SD0030101-D	121.9	NA	NA	ND	Y
Surface Soil2									
Antimony	7/14	0.42	0.87	RN3SS0130101	0.4	0.48	NA	ND	N
Chromium	14/14	9.2	35.8	RN3SS0110101	18.5	0.0075	0.4/10	20.8/12	N
Copper	13/14	5.5	46.7	RN3SS0040101	14.26	15	50/100	17..3/5.15	N
Lead	14/14	3.9	37.2	RN3SS0040101	15.6	0.01	500/900	149/20	N
Mercury	14/14	0.02	0.2	RN3SS0140101	0.08	0.058	0.1/30	0.08/0.04	N
Selenium	14/14	0.45	2.2	RN3SS0010101	1.12	1.8	70/100	0.83/0.54	N
Zinc	14/14	8	53.4	RN3SS0050101	25.4	10	200/100	30.8/18.1	N
Di-n-octyl phthalate	1/14	290	290	RN3SS0020101	191.8	NA	3005	ND	N

TABLE 5-28

RISK MANAGEMENT CONSIDERATIONS
SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Frequency of Detection	Range of Detections		Location of Maximum	Mean Concentration	BTAG Screening Level	Alternate Guideline(s)1	Max/Mean Background	Retained as Final PCOC?
		Minimum	Maximum						
Methylene chloride	1/14	700	700	RN3SS0010101	54.8	300	NA	ND	N
1,3,5-Trinitrobenzene	1/28	420	420	RN3SS0050101	116.5	NA	NA	ND	N
2,4,6-Trinitrotoluene	3/14	104	6570	RN3SS0050101	499.3	NA	NA	ND	N
2-Amino-4,6-Dinitrotoluene	3/14	127	525	RN3SS0050101	79.99	NA	NA	ND	N

1 Alternate guidelines are as follows: sediment = MOE LELS and SELs (MOE, 1992); soil = ORNL screening levels for earthworms/soil microbes (when 2 values are present) (Will and Suter, 1995) or Dutch guidelines (when one value is present) (NMHSP&E, 1994)

2 Inorganics = mg/kg, organics = ug/kg

NA = Not Available

ND = Not Detected

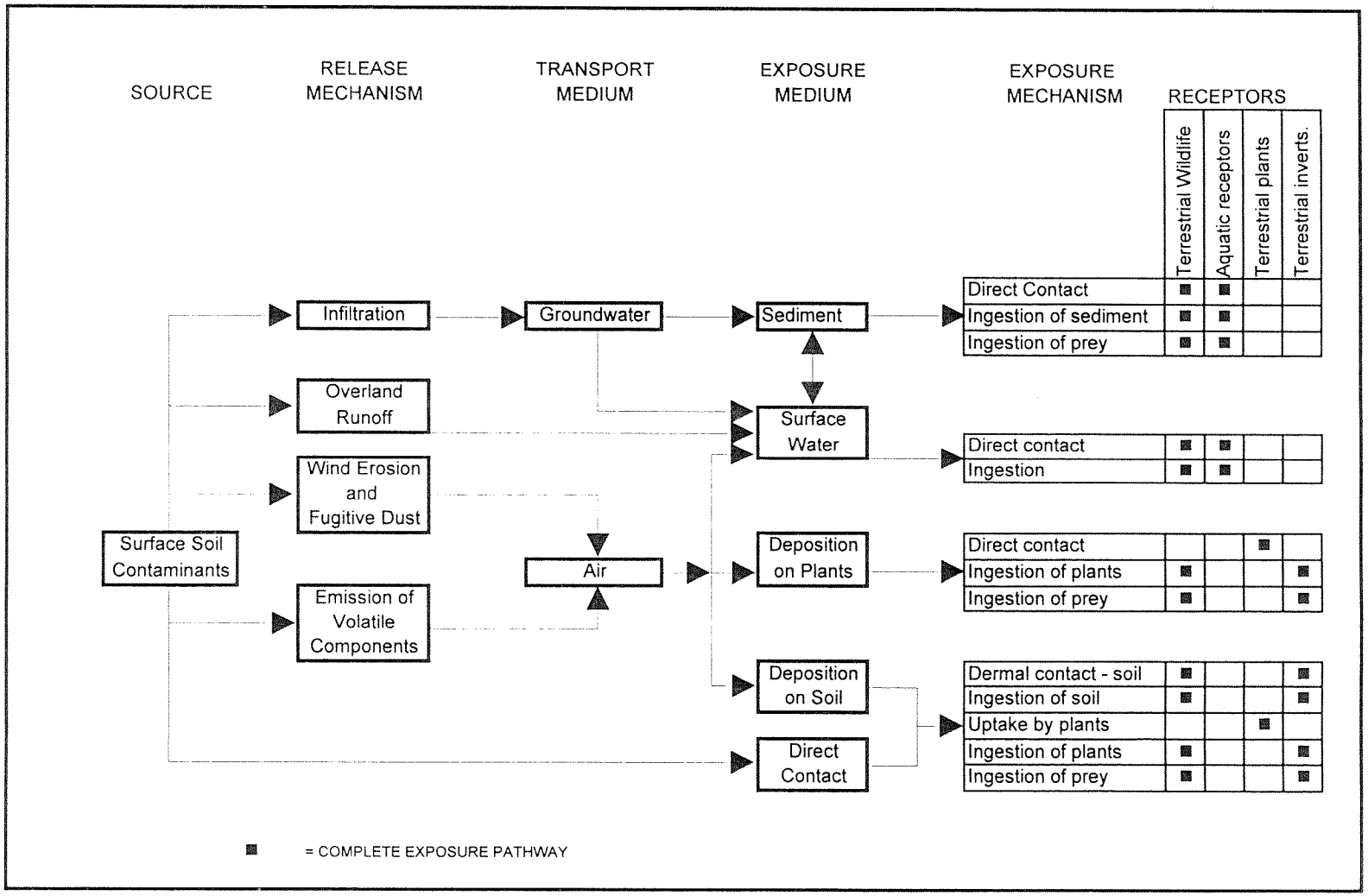


FIGURE 5-13

CONCEPTUAL SITE MODEL - SWMU 2/3 RANGE 3 BURN POINT/CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

P:\GIS\APR\75810303.APR 19-JAN-98 DNP RANGE 3 SITE COND LAYOUT

LEGEND

- Site Boundary
- Intermittent Streams
- 10 — Contour Interval - 1 foot
- Wooded Area
- Marsh/Wetlands

100 0 100 Feet

NO.	DATE	REVISIONS

DRAWN BY: D. PERRY — DATE: 19-JAN-98

CHECKED BY — DATE

COST/SCHED-AREA

SCALE: AS NOTED

Brown & Root Environmental

SITE CONDITIONS FIGURE
SWMU 2/3 - RANGE 3 BURN POINT/
CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

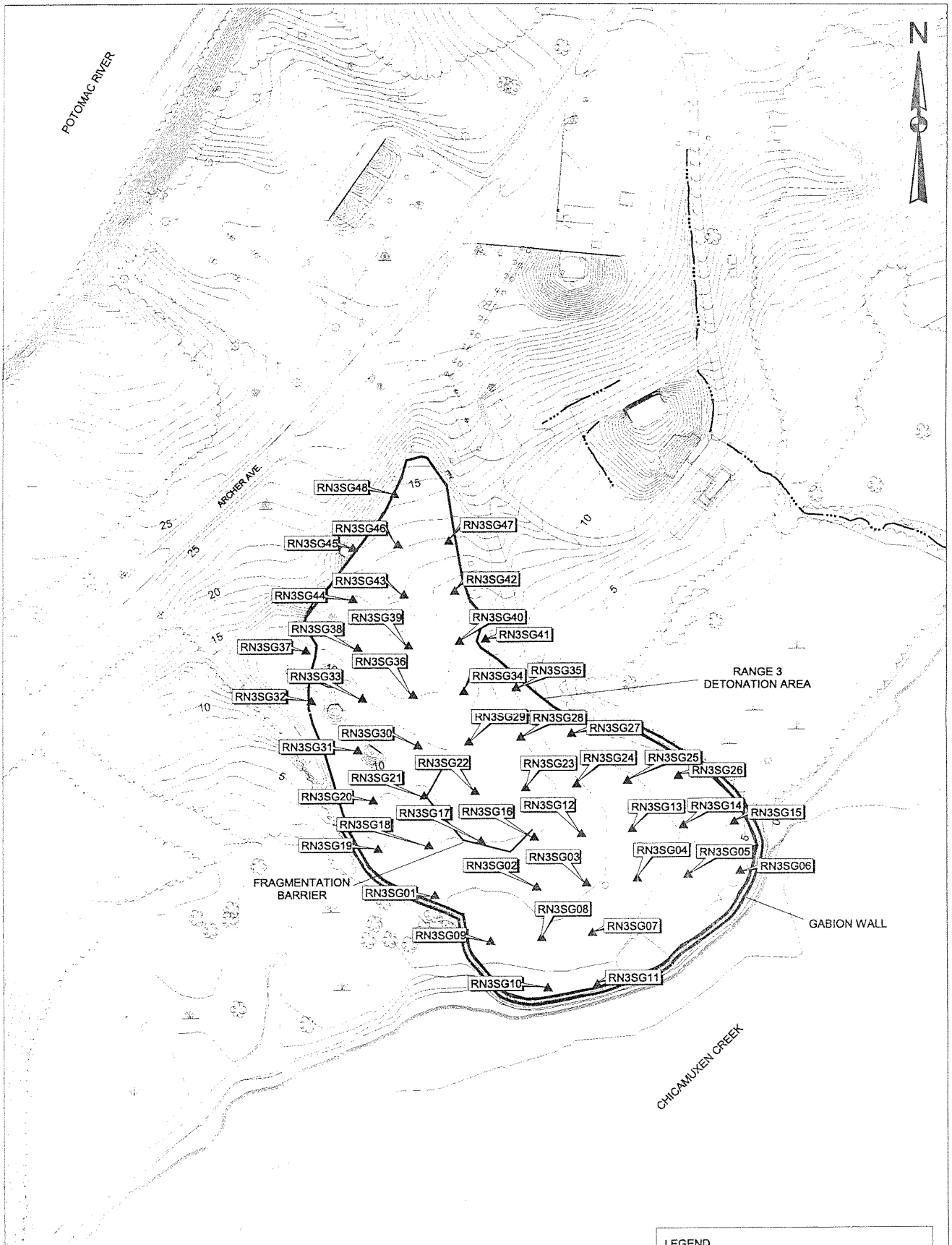
CONTRACT NO.: 7581 — OWNER NO.:

APPROVED BY: [signature] — DATE: 1-19-98

APPROVED BY: [signature] — DATE: 1-20-98

DRAWING NO.: FIGURE 5-1 — REV.: 0

P:\GIS\APR\75810303.APR 19-JAN-98 DNP RANGE 3 SOIL GAS LAYOUT



NO.	DATE	REVISIONS

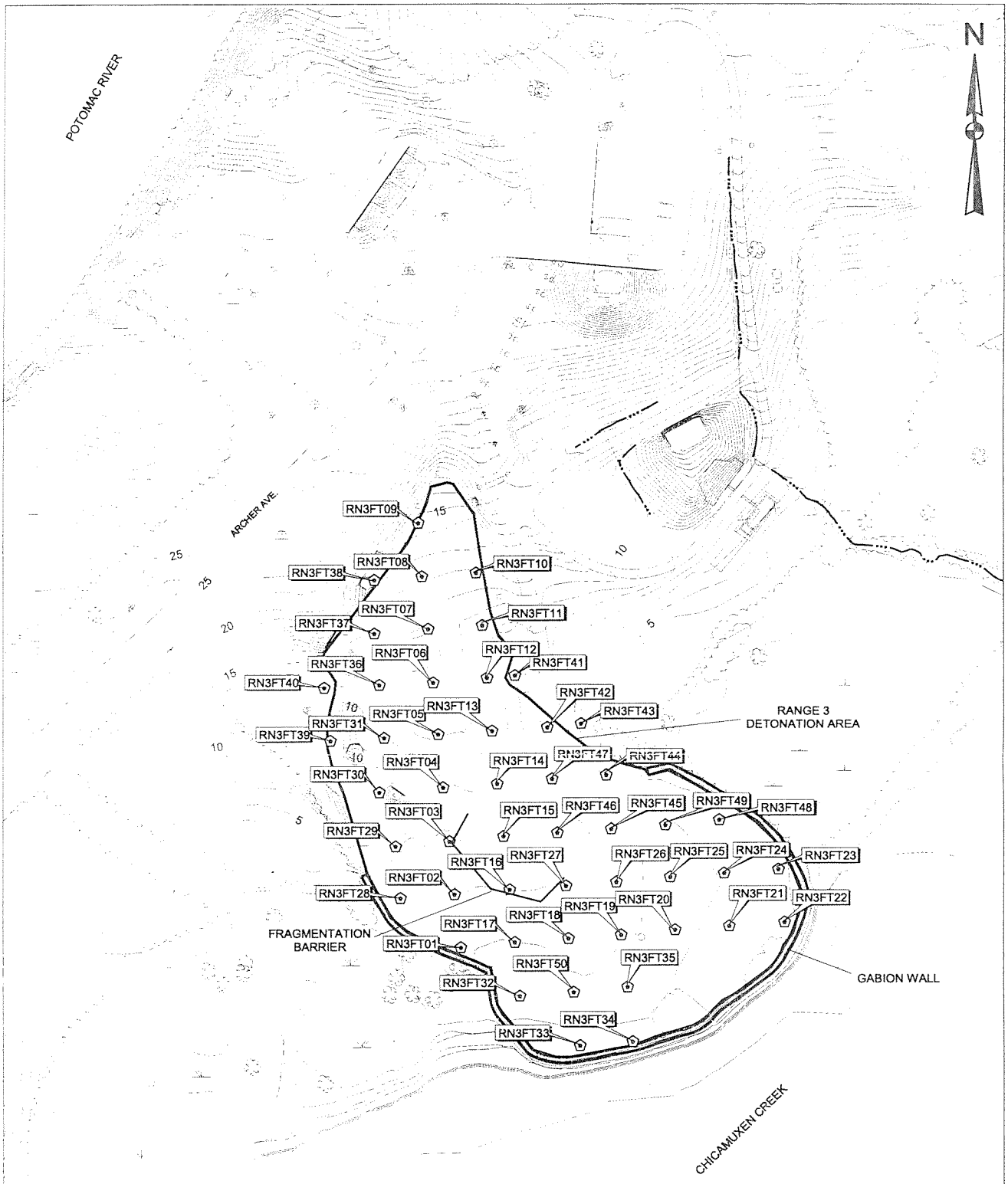
DRAWN BY: D. PERRY — DATE: 19-JAN-98
CHECKED BY: — DATE: —
COST/SCHED-AREA: —
SCALE: AS NOTED

Brown & Root Environmental

SOIL-GAS SAMPLE LOCATIONS
SWMU 2/3 - RANGE 3 BURN POINT/
CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO.: 7581
OWNER NO.: —
APPROVED BY: [signature] DATE: 1-19-98
APPROVED BY: [signature] DATE: 1-29-98
DRAWING NO.: FIGURE 5-2
REV.: 0

P:\GIS\APR\75810303.APR 19-JAN-98 DNP RANGE 3 FTK LAYOUT



LEGEND
- Field Test-Kit Sample Location
- Site Boundary
- — ··· — Intermittent Streams
- — 10 — Contour Interval - 1 foot
- Wooded Area
- Marsh/Wetlands

100 0 100 Feet

NO.	DATE	REVISIONS

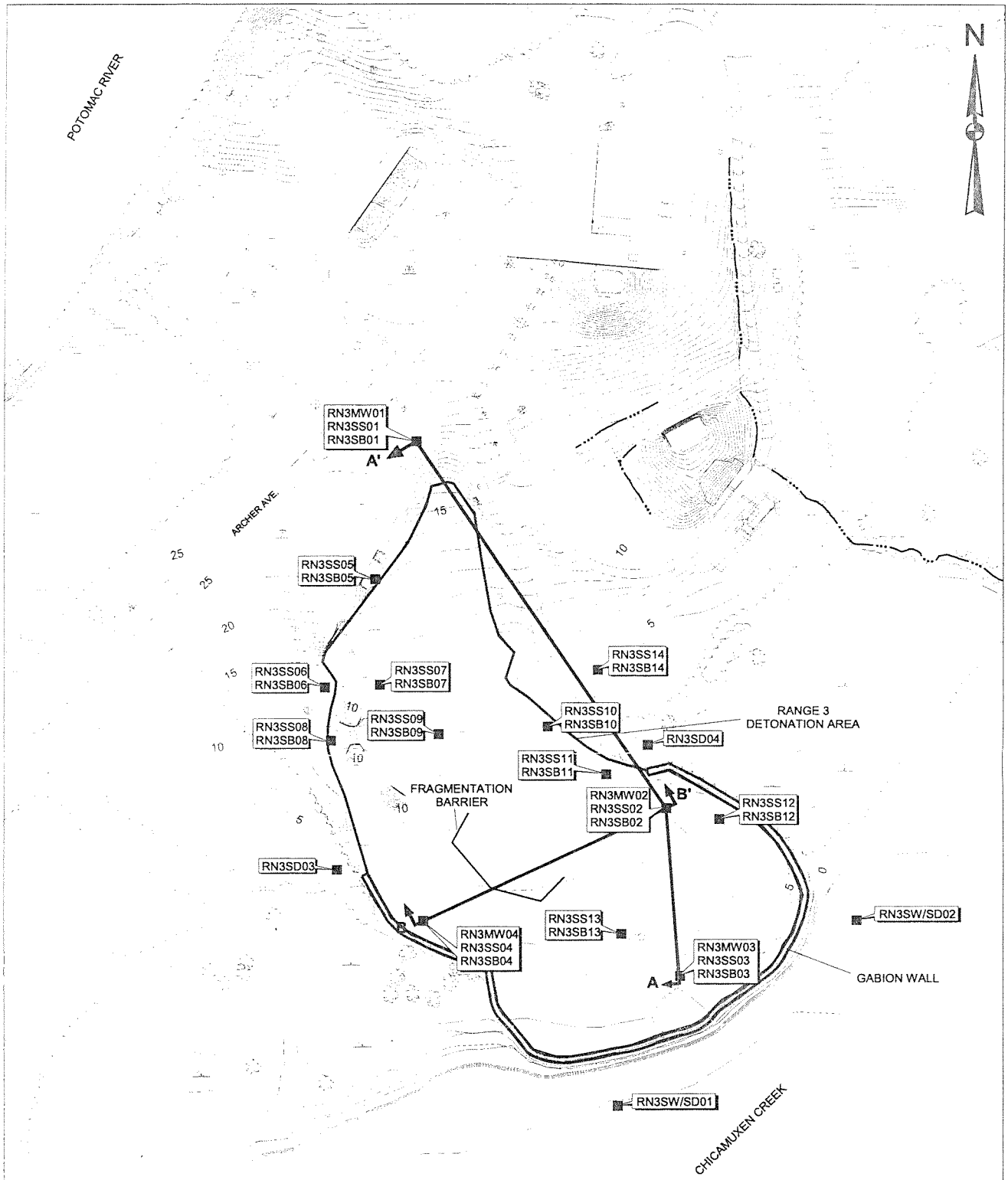
DRAWN BY: D. PERRY — DATE: 19-JAN-98
CHECKED BY: — DATE:
COST/SCHED-AREA:
SCALE: AS NOTED

Brown & Root Environmental

FIELD TEST-KIT SAMPLE LOCATION
SWMU 2/3 - RANGE 3 BURN POINT/
CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO.: 7581 — OWNER NO.:
APPROVED BY: — DATE: 1-19-98
APPROVED BY: — DATE: 1-20-98
DRAWING NO.: FIGURE 5-3 — REV.: 0

P:\GIS\APR\75810303.APR 19-JAN-98 DNP RANGE 3 XS + SAMPLE LAYOUT

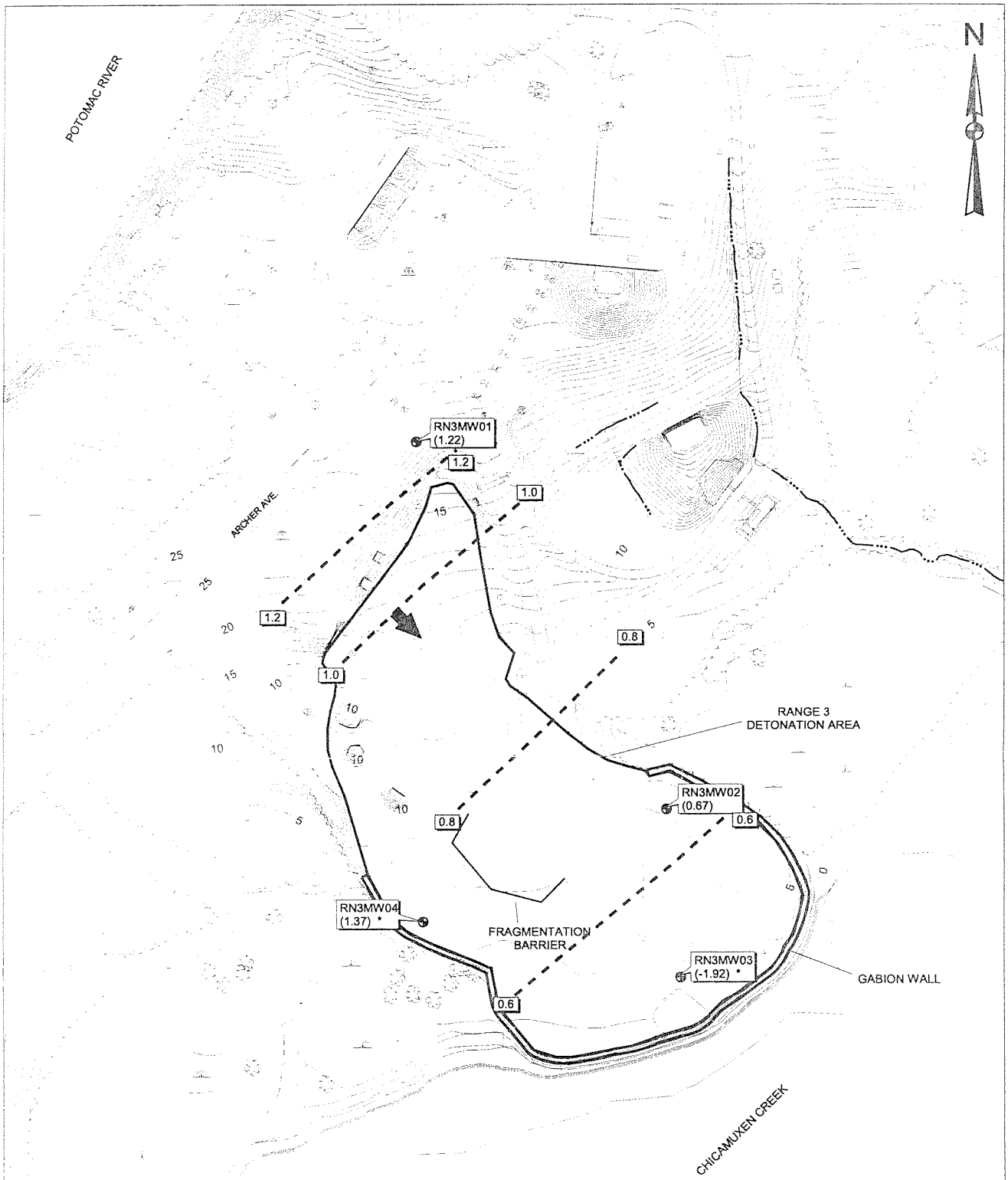


LEGEND
- Sample Location
- Cross-Section Location
- Site Boundary
- Intermittent Streams
- 10 — Contour Interval - 1 foot
- Wooded Area
- Marsh/Wetlands

100 0 100 Feet

NO.	DATE	REVISIONS	DRAWN BY / DATE	Brown & Root Environmental	CONTRACT NO. / OWNER NO.
			D. PERRY 19-JAN-98		7581
			CHECKED BY / DATE	CROSS-SECTION AND SAMPLE LOCATION FIGURE SWMU 2/3 - RANGE 3 BURN POINT/ CHICAMUXEN CREEK'S EDGE DUMP SITE A RCRA FACILITY INVESTIGATION/ VERIFICATION INVESTIGATION REPORT STUMP NECK ANNEX, INDIAN HEAD DIVISION NSWC INDIAN HEAD, MARYLAND	APPROVED BY / DATE 1-20-98
			COST/SCHED-AREA		APPROVED BY / DATE 1-20-98
			SCALE: AS NOTED		DRAWING NO.: FIGURE 5-4 / REV.: 0

P:\GIS\INDIANHD\75810303.APR 19-JAN-98 DNP RANGE 3 POTENTIOMETRIC LAYOUT



LEGEND

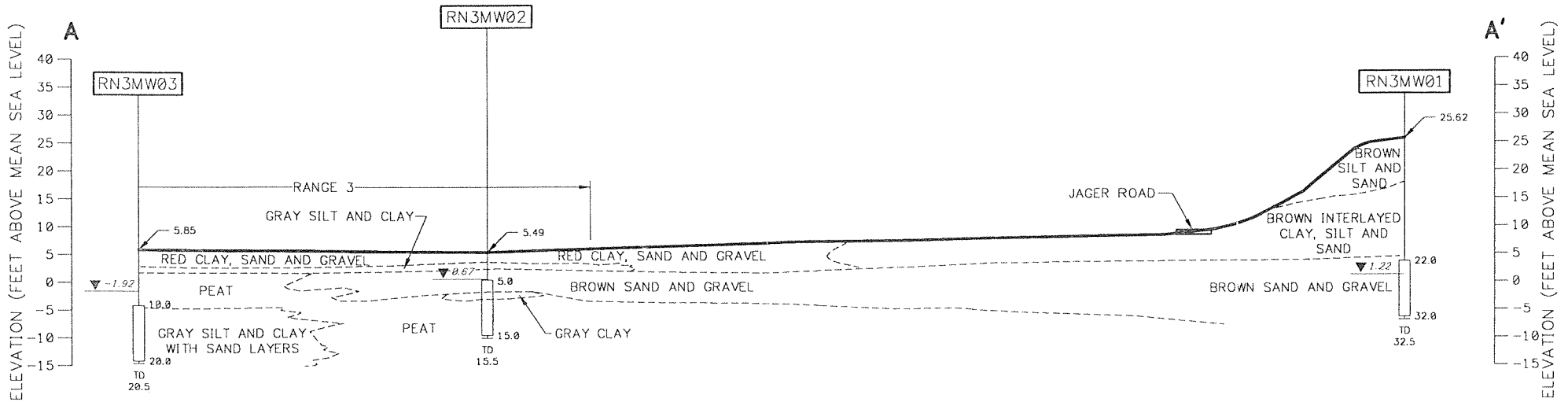
- Monitoring Well
- (1.22) Water level elevation measured at well Feet Mean Sea Level (MSL) (Water levels measured 8/17/97)
- 1.2 Potentiometric Surface Contour Elevation (Feet Mean Sea Level - MSL) (Dashed where inferred)
- Groundwater Flow Direction
- Site Boundary
- Intermittent Streams
- 10 Contour Interval - 1 foot
- Wooded Area
- Marsh/Wetlands

* NOTE:
Water levels at RN3MW04 and RN3MW03 were not used for potentiometric surface contours. See text for explanation.

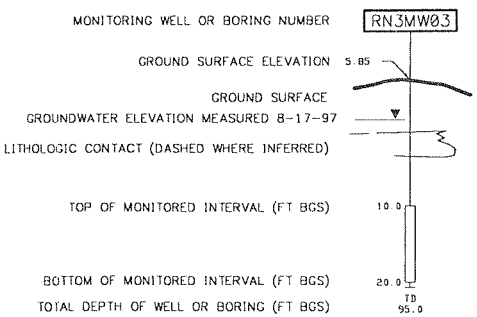
100 0 100 Feet

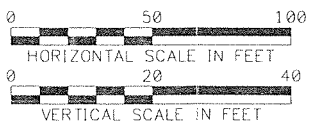
NO.	DATE	REVISIONS	DRAWN BY	DATE	Brown & Root Environmental	CONTRACT NO.	OWNER NO.
			D. PERRY	19-JAN-98		7591	
			CHECKED BY	DATE	POTENTIOMETRIC SURFACE CONTOUR FIGURE SWMU 2/3 - RANGE 3 BURN POINT/ CHICAMUXEN CREEK'S EDGE DUMP SITE A RCRA FACILITY INVESTIGATION/ VERIFICATION INVESTIGATION REPORT STUMP NECK ANNEX, INDIAN HEAD DIVISION NSWC INDIAN HEAD, MARYLAND	APPROVED BY SWC	DATE 1-19-98
			COST/SCHED-AREA			APPROVED BY	DATE 1-20-98
			SCALE AS NOTED			DRAWING NO. FIGURE 5-5	REV. 0

ACAD:K:\CADD\7581\7581cx02.dwg 01/14/98 MF



LEGEND





NOTE: ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL (FT AMSL)

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 10/29/97
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Brown & Root Environmental

GENERALIZED GEOLOGIC CROSS SECTION A-A'
SWMU 2/3 - RANGE 3 BURN POINT/
CHICAMUXEN CREEKS EDGE DUMP SITE A
RFI/VI REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581
OWNER NO. 0287
APPROVED BY GWR DATE 1-16-98
APPROVED BY DATE 1-16-98
DRAWING NO. FIGURE 5-6
REV. 0

FORM CADD NO. SOUTH_BH.DGN - REV 0 - 02/11/97

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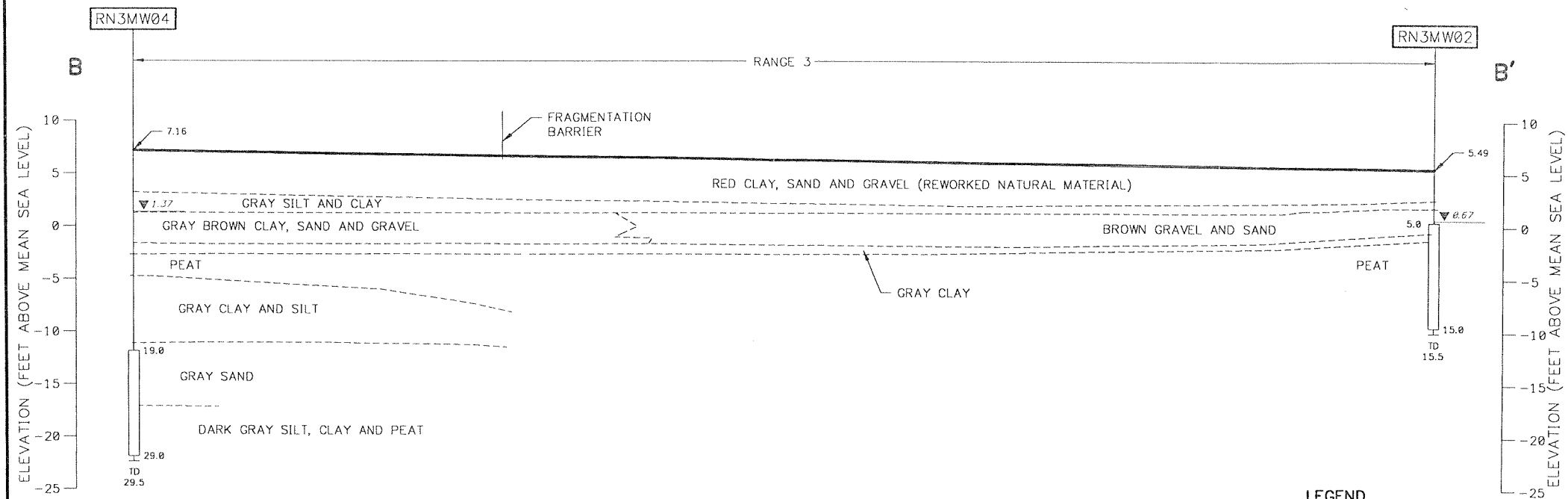
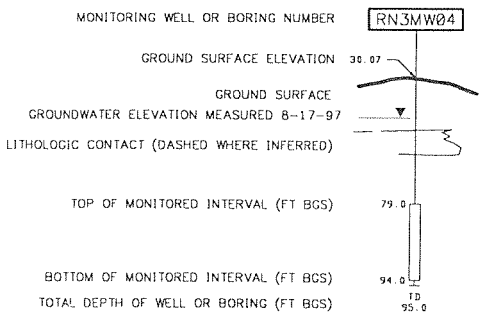
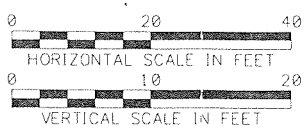


LEGEND





NOTE: ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL (FT AMSL)

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 10/30/97
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Brown & Root Environmental

GENERALIZED GEOLOGIC CROSS SECTION B-B'
SWMU 2/3 - RANGE 3 BURN POINT/
CHICAMUXEN CREEK'S EDGE DUMP SITE A
RFI/VI REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581
OWNER NO. 0287
APPROVED BY [signature] DATE 1-16-98
APPROVED BY [signature] DATE 1/16-98
DRAWING NO. FIGURE 5-7
REV. 0

FORM CADD NO. SOUTH_BH.DGN - REV 0 - 02/11/97

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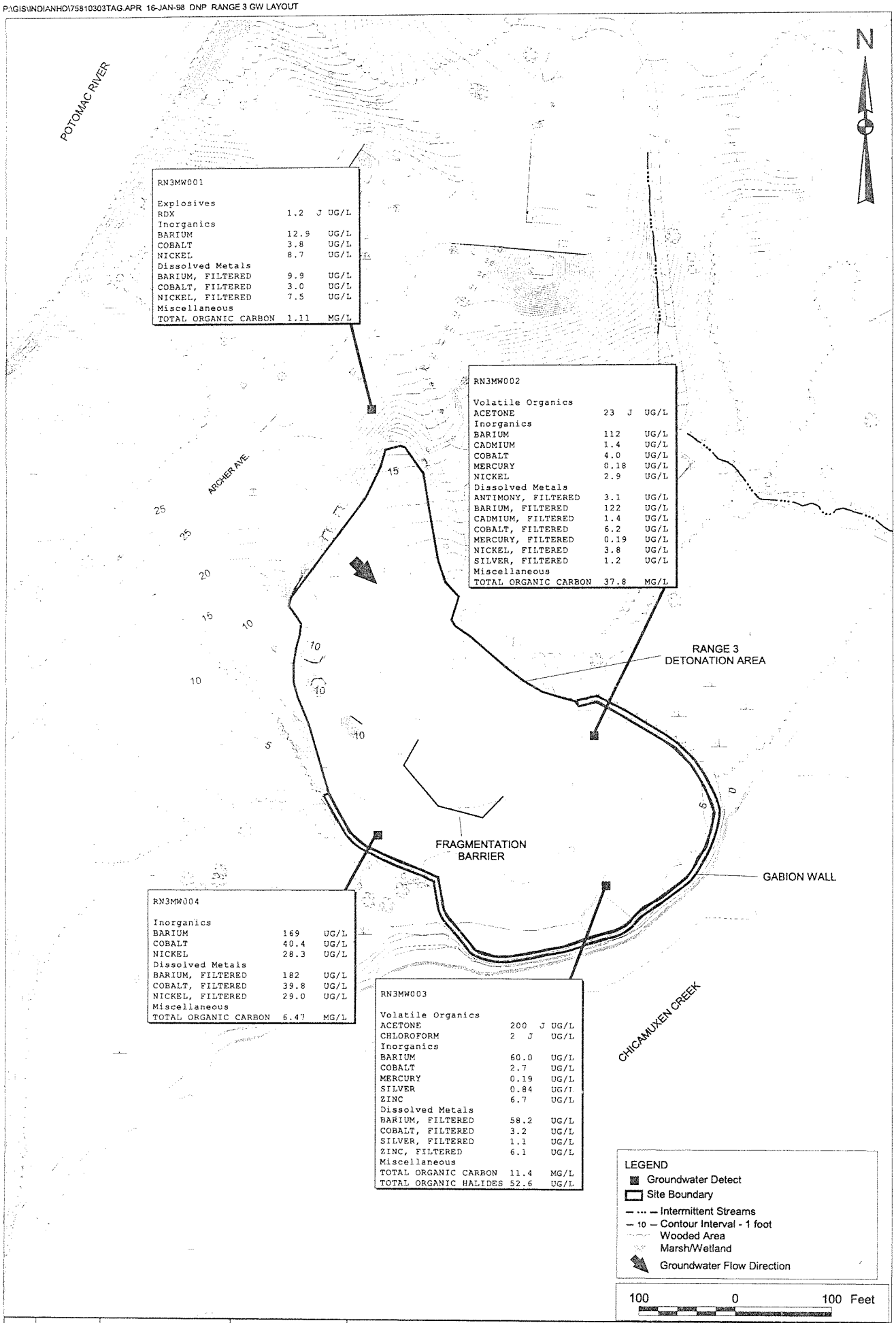


NO.	DATE	REVISIONS

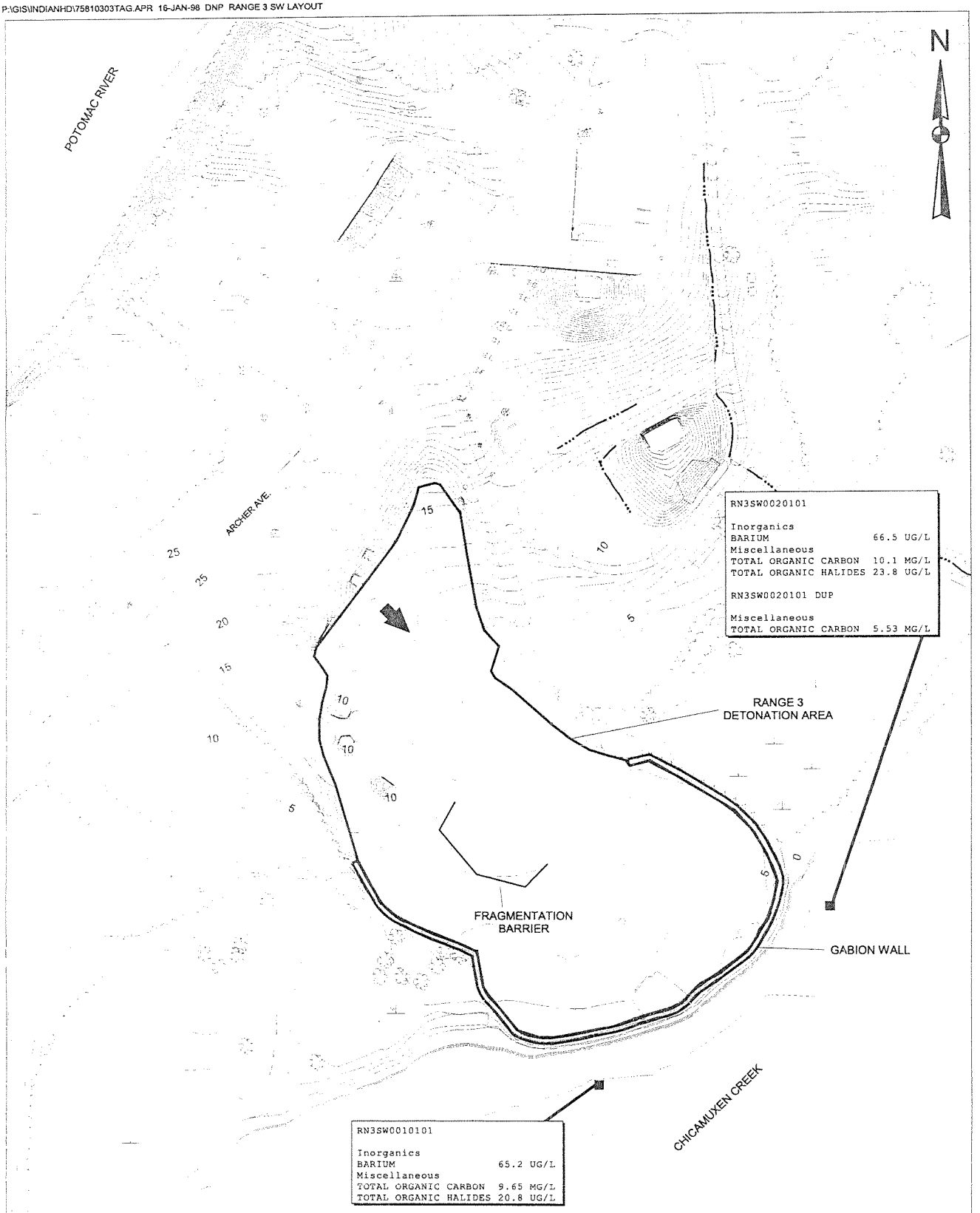
DRAWN BY D. PERRY	DATE 16-JAN-98
CHECKED BY D.T.	DATE 1/16/98
COST/SCHED-AREA	
SCALE AS NOTED	

Brown & Root Environmental

GROUNDWATER DETECTS
SWMU 2/3 - RANGE 3 BURN POINT/
CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581	OWNER NO.
APPROVED BY	DATE
APPROVED BY	DATE 1-16-98
DRAWING NO. FIGURE 5-10	REV. 0

P:\GIS\INDIANHD\75810303TAG.APR 16-JAN-98 DNP RANGE 3 SW LAYOUT



LEGEND
- Surface Water Detect
- Site Boundary
- Intermittent Streams
- 10 Contour Interval - 1 foot
- Wooded Area
- Marsh/Wetland
- Groundwater Flow Direction

100 0 100 Feet

NO.	DATE	REVISIONS

DRAWN BY D. PERRY DATE 16-JAN-98
CHECKED BY DLE DATE 1/16/98
COST/SCHED-AREA
SCALE AS NOTED

Brown & Root Environmental

SURFACE WATER DETECTS
SWMU 2/3 - RANGE 3 BURN POINT/
CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581
OWNER NO.
APPROVED BY
DATE
APPROVED BY MM DATE 1-16-98
DRAWING NO. FIGURE 5-11
REV. 0

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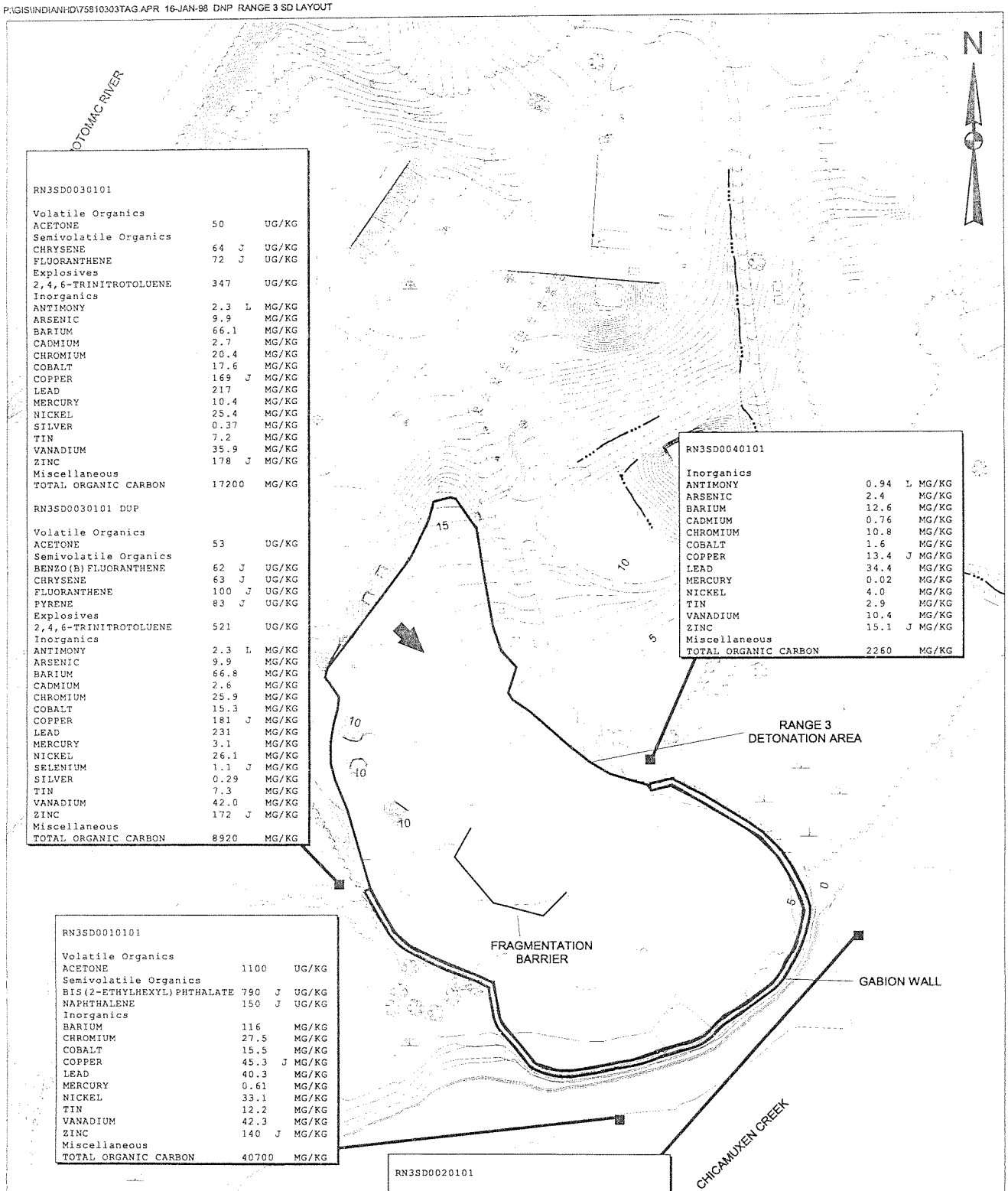


RN3SD0030101

Volatile Organics		
ACETONE	50	UG/KG
Semivolatile Organics		
CHRYSENE	64 J	UG/KG
FLUORANTHENE	72 J	UG/KG
Explosives		
2,4,6-TRINITROTOLUENE	347	UG/KG
Inorganics		
ANTIMONY	2.3 L	MG/KG
ARSENIC	9.9	MG/KG
BARIUM	66.1	MG/KG
CADMIUM	2.7	MG/KG
CHROMIUM	20.4	MG/KG
COBALT	17.6	MG/KG
COPPER	169 J	MG/KG
LEAD	217	MG/KG
MERCURY	10.4	MG/KG
NICKEL	25.4	MG/KG
SILVER	0.37	MG/KG
TIN	7.2	MG/KG
VANADIUM	35.9	MG/KG
ZINC	178 J	MG/KG
Miscellaneous		
TOTAL ORGANIC CARBON	17200	MG/KG

RN3SD0030101 DUP

Volatile Organics		
ACETONE	53	UG/KG
Semivolatile Organics		
BENZO(B)FLUORANTHENE	62 J	UG/KG
CHRYSENE	63 J	UG/KG
FLUORANTHENE	100 J	UG/KG
PYRENE	83 J	UG/KG
Explosives		
2,4,6-TRINITROTOLUENE	521	UG/KG
Inorganics		
ANTIMONY	2.3 L	MG/KG
ARSENIC	9.9	MG/KG
BARIUM	66.8	MG/KG
CADMIUM	2.6	MG/KG
CHROMIUM	25.9	MG/KG
COBALT	15.3	MG/KG
COPPER	181 J	MG/KG
LEAD	231	MG/KG
MERCURY	3.1	MG/KG
NICKEL	26.1	MG/KG
SELENIUM	1.1 J	MG/KG
SILVER	0.29	MG/KG
TIN	7.3	MG/KG
VANADIUM	42.0	MG/KG
ZINC	172 J	MG/KG
Miscellaneous		
TOTAL ORGANIC CARBON	8920	MG/KG

RN3SD0040101

Inorganics		
ANTIMONY	0.94 L	MG/KG
ARSENIC	2.4	MG/KG
BARIUM	12.6	MG/KG
CADMIUM	0.76	MG/KG
CHROMIUM	10.8	MG/KG
COBALT	1.6	MG/KG
COPPER	13.4 J	MG/KG
LEAD	34.4	MG/KG
MERCURY	0.02	MG/KG
NICKEL	4.0	MG/KG
TIN	2.9	MG/KG
VANADIUM	10.4	MG/KG
ZINC	15.1 J	MG/KG
Miscellaneous		
TOTAL ORGANIC CARBON	2260	MG/KG

RN3SD0010101

Volatile Organics		
ACETONE	1100	UG/KG
Semivolatile Organics		
BIS(2-ETHYLHEXYL)PHTHALATE	790 J	UG/KG
NAPHTHALENE	150 J	UG/KG
Inorganics		
BARIUM	116	MG/KG
CHROMIUM	27.5	MG/KG
COBALT	15.5	MG/KG
COPPER	45.3 J	MG/KG
LEAD	40.3	MG/KG
MERCURY	0.61	MG/KG
NICKEL	33.1	MG/KG
TIN	12.2	MG/KG
VANADIUM	42.3	MG/KG
ZINC	140 J	MG/KG
Miscellaneous		
TOTAL ORGANIC CARBON	40700	MG/KG

RN3SD0020101

Volatile Organics		
2-BUTANONE	110 L	UG/KG
ACETONE	800	UG/KG
CARBON DISULFIDE	29	UG/KG
Semivolatile Organics		
BENZO(A)PYRENE	150 J	UG/KG
DI-N-BUTYL PHTHALATE	260 J	UG/KG
Inorganics		
ARSENIC	8.5	MG/KG
BARIUM	142	MG/KG
CHROMIUM	41.2	MG/KG
COBALT	19.7	MG/KG
COPPER	305 J	MG/KG
LEAD	46.3	MG/KG
NICKEL	34.2	MG/KG
TIN	12.5	MG/KG
VANADIUM	56.2	MG/KG
ZINC	172 J	MG/KG
Miscellaneous		
TOTAL ORGANIC CARBON	30300	MG/KG

LEGEND
- Sediment Detect
- Site Boundary
- Intermittent Streams
- 10 Contour Interval - 1 foot
- Wooded Area
- Marsh/Wetland
- Groundwater Flow Direction

100 0 100 Feet

NO.	DATE	REVISIONS	DRAWN BY	DATE
			D. PERRY	16-JAN-98
			CHECKED BY	DATE
			D&T	1/16/98
			COST/SCHED-AREA	
			SCALE: AS NOTED	

Brown & Root Environmental

SEDIMENT DETECTS
SWMU 2/3 - RANGE 3 BURN POINT/
CHICAMUXEN CREEK'S EDGE DUMP SITE A
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581	OWNER NO.
APPROVED BY	DATE
APPROVED BY	DATE 1-16-98
DRAWING NO. FIGURE 5-12	REV. 0

6.0 SWMU 1 - RUM POINT LANDFILL

Section 6 provides a brief description and history of Rum Point Landfill (SWMU 1) and summarizes the scope and results of the environmental investigations and baseline risk assessments conducted for the RFI/VI.

6.1 SITE DESCRIPTION AND HISTORY

6.1.1 Site Description

Rum Point Landfill (SWMU 1) is an unlined landfill located west of Rum Point Road and is approximately 1.5 to 2 acres in size. The unit has been inactive since December 1989 and reportedly was used to dispose of biodegradable wastes only. Additionally, ash from the thermal treatment tank, located on Range 3 Burn Point, was disposed here on a one-time basis. The unit is a large, flat, packed dirt area overgrown with vegetation. The visible toe of the landfill, to the north and northwest, drops off approximately 30 feet into a wooded area where an unnamed intermittent creek runs south to north. The east side of the landfill drops off approximately 15 feet into a wooded area where an unnamed intermittent stream runs east to west and intersects the previously mentioned creek. Visible wastes at the landfill during the site visit and field investigation in the summer of 1997 included pieces of metal; rusted, empty 55-gallon drums, tires, and wood and concrete construction debris. The location and general features of Rum Point Landfill are shown on Figure 6-1.

6.1.2 Site History

It is not known when waste was first deposited in the Rum Point Landfill, and little is known about its history. Site observations indicate that the landfill was probably layered, with dirt possibly pushed south to north toward the toe of the landfill. The unit has reportedly been inactive since December 1989, and nothing was observed to refute this claim.

6.2 VI FIELD INVESTIGATION

This section discusses the field activities performed at the Rum Point Landfill during the VI. These activities consisted of field screening (soil-gas sampling survey), and of sampling of surface soil, subsurface soil, groundwater, sediment, and surface water. Soil-gas data are provided in Appendix A. Sample log sheets are provided in Appendices D through G. Table 6-1 provides a summary of the sampling and analytical program for the fixed-base lab samples. Table 6-2 presents a summary of monitoring well construction and groundwater level data.

6.2.1 Field Screening

At the Rum Point Landfill, a soil-gas survey grid was established consisting of 12 points at 50-foot centers and covering an area of approximately 13,750 sq. feet. A total of 12 soil-gas samples were collected and analyzed for VOCs on-site, as described in Section 2.1.2, in an attempt to assist in locating VOC sources that may be associated with the landfill's activities. The soil-gas target analyte list consisted of the following organic compounds:

- benzene
- toluene
- ethylbenzene
- xylenes
- total volatile hydrocarbons
- methylene chloride
- 1,1-dichloroethene
- 1,1-dichloroethane
- total-1,2-dichloroethene
- chloroform
- 1,2-dichloroethane
- 1,1,1-trichloroethane
- carbon tetrachloride
- trichloroethene
- tetrachloroethene

The soil-gas sampling locations are shown on Figure 6-2, and the soil-gas analysis positive detects are summarized in Table 6-3.

6.2.2 Soil Investigation

Four surface soil samples, four surface soil composite samples, and twelve subsurface soil samples were collected at the site to characterize the soil. The sampling locations are shown on Figure 6-3. The general locations were established in the B&R Environmental Work Plan Addenda (May 1997). The actual locations were selected by the field crew during the VI.

Soil borings RPLSB01 through RPLSB04 were completed using hollow-stem auger and split-spoon sampling techniques. One surface soil sample was collected at each soil boring location at a depth of 0 to 1 foot bgs, for a total of four samples. Twelve subsurface soil samples were collected from the four soil borings. The samples were obtained over 2-foot intervals ranging from beginning depths of 4 to 30 feet. All samples were collected for Appendix IX metals, Appendix IX VOA, and Appendix IX SVOA. See summary Table 6-1 provides the analytical program for each sample collected. Figure 6-8 provides the specific sampling depth and positive detections for each sample.

Four composite samples, RPLCP01 through RPLCP04, were collected from surface soils throughout the landfill from four equally spaced areas. The sample locations are shown on Figure 6-3. The samples were collected within the area of distressed vegetation.

6.2.3 Groundwater Investigation

Four monitoring wells (RPLMW01 through RPLMW04) were installed and sampled at the site to determine whether the groundwater beneath the site has been affected by landfill site activities. The wells were placed in locations proposed in the EnSafe Work Plan. The groundwater samples were analyzed for the following parameters: Appendix IX metals, Appendix IX VOA, Appendix IX SVOA. Table 6-1 provides a summary of the sampling and analytical program. Table 6-2 presents a summary of monitoring well construction and groundwater-level data.

Groundwater level measurements were obtained from all the wells at the site. The results are discussed in Section 6.3.2 in this report and presented on a potentiometric surface map (Figure 6-4).

6.2.4 Surface Water and Sediment Investigation

Three surface water and sediment sample pairs (RPLSW/SD01 through RPLSW/SD03) were collected at locations proposed in the EnSafe Work Plan. The surface water and sediment sampling locations are shown on Figure 6-3. The samples were analyzed for the following parameters: Appendix IX metals, Appendix IX VOA, Appendix IX SVOA. Table 6-1 presents a summary of the analytical program for these samples.

6.2.5 Summary of Environmental Investigation

The VI field investigation activities for Rum Point Landfill included a soil-gas sampling survey (12 sampling points). Four groundwater samples, eight surface soil samples, twelve subsurface soil samples, four sediment samples, and four surface water samples were collected for fixed-base laboratory analyses.

6.3 SITE CHARACTERISTICS

This section discusses the site-specific geology and hydrogeology of Rum Point Landfill.

6.3.1 Geology

Subsurface conditions at the site were investigated through the drilling and logging of six soil borings. No waste material was encountered at the site during the subsurface investigation. The cross-section locations are shown on Figure 6-3. Cross-section profiles A-A' and B-B' are shown on Figures 6-5 and 6-6 respectively and were generated to illustrate the subsurface materials encountered beneath the landfill.

Cross Section A-A'

Cross section A-A' traverses the site from the southwest portion of the site (RPLMW02) to the northwest (RPLMW03) (Figure 6-5). The materials encountered at well RPLMW02 consist of brown silt and sand 13 feet thick starting at the ground surface underlain by an approximately 22-foot thick layer of dark gray silt and fine sand with shell fragments. The shell fragment layer is underlain by a dark gray silt and fine sand approximately 13 feet thick. A distinct green sand with a thin clay layer above it was encountered underneath the dark gray silt and fine sand. A very stiff clay was encountered below the green sand. The boring was completed at the top of the clay below the green sand. Approximately 150 feet to the north at well RPLMW04, the subsurface material encountered at the ground surface to a depth of 17 feet bgs consisted of brown silt and clay. This surface material is underlain by a 20-foot-thick layer of dark gray silt and fine sand with shell fragments (same material encountered at RPLMW02), which gives way downward to the distinct green sand and clay sequence. The materials encountered at RPLMW04 extend to the RPLMW03 well location. However, the surface materials thin slightly toward well RPLMW03.

Cross Section B-B'

Cross section B-B' traverses northwest to southeast across the site from well RPLMW03 to well RPLMW01 (Figure 6-6). The materials encountered at well RPLMW03 consist of brown silt and clay 13 feet thick starting at the ground surface and are underlain by an approximately 20-foot-thick layer of dark gray silt and fine sand with shell fragments. The shell fragment layer is underlain by a thin clay layer above a distinct green sand. A very stiff clay was encountered below the green sand. The boring was completed at the top of the clay below the green sand. The materials encountered at well RPLMW01 consist of yellow-brown sand 19 feet thick starting at the ground surface and are underlain by an approximately 43-foot-thick layer of dark gray silt and fine sand with shell fragments. The shell fragment layer is underlain by a distinct green sand. A very stiff clay was encountered below the green sand.

Summary

The subsurface materials were relatively consistent across the study area vertically and horizontally. The surficial deposits generally consisted of yellow brown clay, silt, and sand mixtures and ranged in thickness from 12 feet to 20 feet. These surface materials were underlain by a distinct dark gray silt and fine sand with shell fragments ranging in thickness from 20 feet at the western edge of the landfill to 43 feet at the southeast corner of the site. The shell fragment layer was underlain by a distinct green sand, which overlies a very stiff clay. A thin, soft clay layer overlies the green sand in the west portion of the site.

6.3.2 Hydrogeology

Hydrogeologic conditions at Rum Point Landfill have been interpreted from data obtained during the field investigation activities. The groundwater beneath the site occurs under both unconfined and semiconfining conditions. The primary water-bearing zone (aquifer) is composed of a green sand. The overlying unit is a dark gray silt and fine sand that contains groundwater and also acts as a semiconfining unit to the green sand. Generally, groundwater flows to the north and discharges into local streams. There is also a downward flow component to the groundwater which indicates that the green sand aquifer is being recharged from the overlying finer grained unit. There is also a minor perched water zone supported by the semiconfining unit. The perched water is likely to be a result of surface infiltration to the top of the semiconfining unit through the unsaturated zone and probably continues downward into the semiconfining unit or migrates horizontally and discharges to the ground surface in the form of a spring.

Four monitoring wells were installed to characterize the site. In addition, two shallow wells (RPLMW01S and RPLMW04S) were installed at the site and are referred to as piezometers. The two piezometers were installed within the dark gray silt and fine sand formation, and the formation produced water, but not of sufficient quantity to sample the wells. It was determined in the field that these piezometers did not supply enough water to make sampling practical. Additionally, based on field observations during the drilling process, the dark gray silt and fine sand formation did not appear to be a water-bearing zone. Deeper wells (RPLMW01D and RPLMW04D) were installed adjacent to the piezometers with the screened interval across the water-bearing, green sand to sample the groundwater.

Perched water was encountered at 18-feet bgs at the interface between the sandy surface deposits found in this area and the distinct dark gray silt and fine sand with shell fragments during the drilling process at RPLMW01. This perched water zone was not encountered at the downgradient well locations to the west and northwest.

The primary water-bearing zone (green sand) was encountered at varying depths below the ground surface during the drilling process, at approximately 35-feet at well RPLMW03, 37-feet at RPLMW04D, 43-feet at RPLMW02, and 60-feet at RN3MW01D. However, once the wells were installed and water levels stabilized, measured depths to the groundwater below ground surface adjusted from the initial depths encountered during the drilling process in the wells RPLMW03, RPLMW04D, RPLMW02, and RPLMW01D to approximately 20-feet, 19-feet, 23-feet, and 23-feet, respectively. This is an indication that water within the green sand unit is under semiconfined conditions.

Synoptic groundwater-level measurements were taken at the site. The resulting depths to groundwater, groundwater elevations, and well construction details are presented on Table 6-2. The groundwater elevation data were used to generate a potentiometric surface map (Figure 6-4). The water levels from the two shallow piezometers were not used for the potentiometric surface map. The potentiometric surface contours are labeled in elevation (feet above mean sea level) and illustrate the estimated groundwater flow pattern across the site. Groundwater is flowing to the north-northwest. The average horizontal hydraulic gradient across the site, calculated graphically (Figure 6-4), is .084. Shallow groundwater is likely discharging into the streams adjacent to the site, whereas the deeper groundwater continues to flow farther north and discharges farther downstream and possibly into the Mattawoman Creek.

The downward migration of the groundwater from the dark silt/sand unit to the green sand unit is indicated by the water levels measured at well clusters RPLMW01 and RPLMW04. The water-level elevation in RPLMW01D is 2.5 feet lower than the water level in RPLMW01S, and the water level in RPLMW04D is lower than the water level in well RPLMW04S by 2.01 feet.

6.4 NATURE AND EXTENT OF CONTAMINATION

This section presents the results of the sampling and analysis of environmental samples collected at Rum Point Landfill as described in Sections 2.0 and 6.2. The location of Rum Point Landfill is shown on Figure 6-1. Table 6-1 provided a summary of the sampling and analytical program for environmental samples collected by B&RE and analyzed by General Physics Environmental Services (GP), according to the methods specified in Section 2.0. Analytical results provided by GP are summarized in Tables 6-4 through 6-8 and are presented in detail in Appendix M.

All data generated by GP were validated according to EPA National and Region III guidelines. The data validation was performed by B&RE validation chemists, who routinely validate data from numerous laboratories producing data under the EPA Contract Laboratory Program (CLP). A copy of the validation packages is available to the Navy, the State of Maryland Department of the Environment, and EPA Region III upon request. Additionally, data validation memoranda summarizing the results of the data validation are presented in Appendix N.

The soil gas survey data generated by Tracer were reviewed by a B&RE project chemist familiar with the methodology used to conduct the survey. The results of the evaluation are presented in Section 2.

6.4.1 Surface and Subsurface Soil

Surface and subsurface soil samples were collected at Rum Point Landfill during the field investigation conducted under CTO 287 and analyzed for the presence of site-related contamination. Summarizing from Section 6.2, the field investigation included the collection of soil gas survey samples at 12 locations. The field investigation also consisted of the collection of four surface and 12 subsurface soil samples outside the landfill and four composite surface soil samples from within the landfill. Analytical results for any parameter detected at least once in surface and subsurface soil samples sent to GP for analysis are presented in Tables 6-4 and 6-5, respectively. Additionally, descriptive statistics (i.e., frequency of detection, range of detection, arithmetic mean of positive detections, location of maximum positive detection) are summarized in Tables 6-9 through 6-12. Table 6-9 provides a comparison of descriptive statistics for surface and subsurface soil samples. Tables 6-10 through 6-12 are the COPC selection tables for Rum Point Landfill soil. The locations of the positive detections are depicted in Figures 6-7 and 6-8.

6.4.1.1 Surface Soil Characterization

In overview, there were minimal detections of organic compounds in Rum Point Landfill surface soil samples. Acetone was detected in three surface soil samples (C_{max} = 70 µg/kg). Four other volatile organic compounds were detected only once in the surface soil samples and at maximum concentrations ranging from 1 µg/kg (trans-1,2-dichloroethene and trichloroethene) to 3 µg/kg (4-methyl-2-pentanone). Sixteen semi-volatile organic compounds (PAHs and phthalates) were reported at concentrations ranging from 38 µg/kg (acenaphthene) to 1,800 µg/kg (pyrene). Semi-volatile compounds were detected in only one of seven surface soil samples except for benzo(g,h,i)perylene and pyrene, which were detected twice. With a few exceptions, the metals concentrations reported in surface soil samples are within the range of concentrations reported for the basewide background soil samples. The following paragraphs describe the surface soil data in detail.

Volatile and Semi-volatile Organic Compounds

The results of the analysis of soil gas survey samples collected at 12 locations are summarized in Table 6-3. The target analyte list was provided in Section 6.2. The following parameters were detected at least once:

Chemical	Range Detected (µg/L)	Detection Frequency	Location of Maximum	Detection Limit (µg/L)
Total volatile hydrocarbons	1 - 9	12/12	RPLSG05	0.9
Chloroform	0.006 - 0.007	2/12	RPLSG02	0.003

Maximum concentrations were noted for locations in the southern end of the landfill. The positive detections reported are relatively low when compared to soil gas survey results reported for Range 6 and are within an order of magnitude of the soil gas survey detection limits.

The following volatile and semi-volatile organic compounds were detected in Rum Point Landfill surface soil samples analyzed by GP:

Volatile Organic	Maximum Concentration (µg/kg)
Acetone	70
2-Methyl-2-penatone	3
Toluene	2
Trans-1,2-dichloroethene	1
Trichloroethene	1

Semi-volatile Organic	Maximum Concentration (µg/kg)
Acenaphthene	38
Acenaphthylene	600
Anthracene	170
Benzo(a)anthracene	920
Benzo(a)pyrene	1,400
Benzo(b)fluoranthene	1,300
Benzo(g,h,i)perylene	1,500
Benzo(k)fluoranthene	970
Bis(2-ethylhexyl)phthalate	96
Chrysene	53
Fluoranthene	1,000
Fluorene	96
Indeno(1,2,3-cd)pyrene	1,200
Naphthalene	40
Phenanthrene	440
Pyrene	1,800

The analytical data available for the surface soil samples suggest that the organic contamination is limited to the low-level (less than 100 µg/kg) presence of five volatile organic compounds and the detection of phthalate and PAH compounds that may or may not be site related. With the exception of acetone, all volatile organics were detected only once. The acetone concentration at the upgradient or background location exceeds those reported for the actual site samples. Semi-volatiles were only detected in one surface soil sample with the exception of benzo(g,h,i)perylene and pyrene which were detected twice. Bis(2-ethylhexyl)phthalate is a common laboratory contaminant, however, it should be noted that the detections were not qualified as possible "blank contamination" during the validation process. The PAH compounds (e.g., benzo(a)pyrene) are by-products of the combustion process and are often detected where fuels are used or discarded. They may not be directly related to the landfilling activities at Rum Point Landfill; they may be the result, in part, of past and current use of gasoline fueled vehicles in the Rum Point Landfill area. However, it should be noted that chlorinated hydrocarbons and PAHs were not noted in the samples collected outside the landfill area. The chlorinated hydrocarbons detected in the surface soils were not detected in the soil gas survey samples.

As will be discussed in the baseline human health risk assessment, benzo(a)pyrene was the only organic detected at concentration exceeding the EPA Region III RBCs for industrial exposures (Table 6-10). The maximum detected concentrations of benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and indeno(1,2,3-cd)pyrene exceed the EPA Region III RBCs for residential exposures. The detected concentrations of organics were less than the EPA SSLs for migration of compounds from soil to groundwater (Table 6-12).

Metals

Several inorganic compounds were detected in Rum Point Landfill surface soil samples at maximum concentrations exceeding the 95 percent upper tolerance limits ($UTL_{95\%}$) calculated for the basewide background soil dataset:

Metal	Maximum Concentration (mg/kg)	$UTL_{95\%\ BACKGROUND}$ (mg/kg)	Eastern United States Soil (mg/kg)[1]	Maryland Soils (mg/kg)[2]
Antimony	0.31	Not detected	<1-8.8	NA
Arsenic	6.2	4.25	<0.1 -73	1.1 - 7.1
Cadmium	0.33	0.26	NA	<0.01 - 5.6
Chromium	24.9	24.2	1 - 1000	15 - 100
Mercury	0.31	0.087	0.01 - 3.4	0.04 - 0.14
Thallium	0.66	Not detected	NA	NA

1 Shacklette and Boerngen, 1984.
2 Dragun, 1991.
NA - Not available.

However, with the exception of mercury, the positive detections reported are within the concentration range reported in the literature for soils of the Eastern United States and the State of Maryland. Mercury was the only metal detected at a concentration exceeding background concentrations reported for the State of Maryland. Arsenic is the only metal detected in the Rum Point Landfill surface soil samples at concentrations exceeding EPA Region III RBCs (Table 6-10). The detected concentrations of inorganics were less than the EPA SSLs for migration of compounds from soil to groundwater (Table 6-12).

6.4.1.2 Subsurface Soil Characterization

As summarized in Table 6-9, organics were detected less frequently in subsurface soil than in surface soil. Acetone in three samples (C_{max} = 5,000 µg/kg) and carbon disulfide in one sample (6 µg/kg) were the only volatile organic compounds detected in subsurface soil. Bis(2-ethylhexyl)phthalate in three samples (C_{max} = 270 µg/kg) was the only semivolatile organic compound detected in subsurface soil. Acetone and bis(2-ethylhexyl)phthalate were detected in background soil samples at maximum concentrations of 13,000 µg/kg and 640 µg/kg, respectively. The maximum concentrations of all organics were less than their respective EPA Region III RBCs (Table 6-11).

Several inorganic compounds were detected in the Rum Point Landfill subsurface soil samples at maximum concentrations exceeding the 95 percent upper tolerance limits ($UTL_{95\%}$) calculated for the basewide background soil dataset:

Metal	Maximum Concentration (mg/kg)	$UTL_{95\%\ BACKGROUND}$ (mg/kg)	Eastern United States (mg/kg)[1]	State of Maryland Soils (mg/kg)[2]
Arsenic	39.6	24.4	<0.1 - 73	1.1 - 7.1
Cadmium	1.5	0.39	NA	<0.01 - 5.6
Chromium	113	101	1 - 1000	15 - 100
Nickel	25.8	22.1	<5 - 700	ND - 30
Tin	4.1	Not detected	<0.1 - 10	NA

1 Shacklette and Boerngen, 1984.
2 Dragun, 1991.

In general, concentrations of metals in subsurface soil samples exceed those detected in surface soil samples. Arsenic, cadmium, and chromium were also detected at concentrations exceeding the background $UTL_{95\%}$ in surface soil. The positive detections reported for cadmium and nickel are within the concentration range reported in the literature for soils of the Eastern United States and the State of Maryland. However, the positive detections reported for arsenic and chromium exceed background concentrations reported for the State of Maryland. The maximum concentrations of arsenic and beryllium exceeded the EPA Region III RBCs for industrial exposures (Table 6-11).

The maximum concentrations of arsenic, beryllium, chromium, thallium, and vanadium exceeded the EPA Region III RBCs for residential exposures. The maximum detected concentrations of arsenic, chromium, and thallium exceeded the EPA SSLs for migration of compounds from soil to groundwater (Table 6-12).

6.4.2 Groundwater

Unfiltered and filtered groundwater samples were collected from the following monitoring wells located at Rum Point Landfill:

Monitoring Well	Screened Interval (feet below ground surface)	Turbidity Reading Unfiltered Sample
RPLMW001	25 to 35	94
RPLMW002	43 to 53	52
RPLMW003	33 to 43	78
RPLMW004	15 to 25	34

The results of the sampling and analysis of groundwater samples are presented in Table 6-6 and displayed in Figure 6-9. Additionally, descriptive statistics (i.e., frequency of detection, range of detection, arithmetic mean of positive detections, location of maximum positive detection) are summarized in Table 6-13, the COPC selection tables for Rum Point Landfill groundwater.

Volatile and Semi-volatile Organic Compounds

Organic concentrations noted in the upgradient monitoring well (RPLMW001) at Rum Point Landfill are similar to or exceed those noted in the downgradient monitoring wells. Carbon disulfide (6 μg/L), chloroform (2 μg/L), and toluene (7 μg/L) noted in the groundwater sample from well RPLMW01, and acetone (95 μg/L) noted in the groundwater sample from well RPLMW02, were the only volatile organics detected in groundwater samples. Monitoring well RPLMW01 is located upgradient of the landfill. Acetone was also detected in the surface and subsurface soil samples collected at RPLMW01. No volatile organic compounds were detected in the soil samples associated with RPLMW02. The maximum concentrations of all volatile organic compounds were less than their respective EPA Region III RBCs (Table 6-13).

Bis(2-ethylhexyl)phthalate (1 μg/L), di-n-butyl phthalate (1 μg/L), and diethyl phthalate (3 μg/L) in well RPLMW01 and bis(2-ethylhexyl)phthalate (4 μg/L) in well RPLMW03 were the only semi-volatile organic compounds detected in groundwater. No semi-volatile organic compounds were detected in surface and subsurface soil samples associated with wells RPLMW01 and RPLMW03. Phthalates are common laboratory contaminants, however, it should be noted that the detections were not qualified as possible "blank contamination" during the validation process. The maximum concentrations of all semi-volatile organic compounds were less than their respective EPA Region III RBCs (Table 6-13).

Metals

The following metals were detected in groundwater at Rum Point Landfill:

Metal	Maximum Concentration (μg/L) unfiltered samples
Arsenic	3
Barium	64.3
Chromium	29.6
Cobalt	1.2
Copper	7.4
Mercury	0.1
Nickel	15.3
Vanadium	6.8
Zinc	12.6

Concentrations of metals in on-site groundwater samples were within the range of basewide background values with the exception of arsenic and chromium. These metals were also detected in site soil sample at concentrations exceeding background. Concentrations of inorganics in unfiltered groundwater samples were comparable to filter samples with the exception of chromium (Table 6-13). Chromium was detected in unfiltered groundwater samples but not detected in filtered samples. Arsenic was the only metal detected (RPLMW03) at a concentration exceeding EPA Region III RBCs for tap water ingestion (Table 6-13). However, the concentration reported is less than the current federal SDWA MCL.

6.4.3 Surface Water

Three surface water samples were collect at Rum Point Landfill as shown on Figure 6-10. Surface water quality data suggest that landfilling activities have had minimal impact on surface water quality in the vicinity of Rum Point Landfill. Organics were only detected in the surface water sample from a location approximately 25 feet down gradient of the landfill (RPLSW002). Organics were not detected in the duplicate sample for this location. Carbon disulfide (7 µg/L) and di-n-butyl phthalate (1 µg/L) were the only organics reported. Barium (66.5 µg/L), vanadium (1.1 µg/L), and zinc (9.9 µg/L) were the only inorganics detected in surface water. The concentrations of barium and zinc in the down gradient samples were comparable to the concentrations in the upgradient sample. The detected concentrations of all compounds were less their respective EPA Region III RBCs for tap water ingestion.

6.4.4 Sediment

Three sediment samples were collected at Rum Point Landfill as shown on Figure 6-11. Sediment quality data suggest that landfilling activities have had minimal impact on sediment quality in the vicinity of Rum Point Landfill.

Volatile and Semi-volatile Organic Compounds

Di-n-octyl phthalate in one sample (RPLSD0002-D) at a concentration of 44 µg/kg was the only organic compound detected in sediment samples at Rum Point Landfill. Di-n-octyl phthalate is a plasticizer and a common laboratory contaminant, however, it should be noted that the detections were not qualified as possible "blank contamination" during the validation process.

Metals

The following inorganic compounds were detected in Rum Point Landfill sediment samples:

Metal	Maximum Concentration (mg/kg)	$UTL_{95\%\ BACKGROUND}$ for Sediments (mg/kg)	Site-Specific Soil Background Concentration[1]
Arsenic	2.6	63	4.25/24.4
Barium	13	577	144/191
Beryllium	0.21	10.9	0.9/2.46
Cadmium	0.54	1.85	0.26/0.388
Chromium	15.4	79.2	24.2/101
Cobalt	0.87	18	39.7/133
Copper	2.9	296	18.7/56.5
Lead	5.4	476	149/37.5
Mercury	0.03	0.778	0.87/0.13
Nickel	2.6	382	18.2/22.1
Selenium	0.96	6.45	1.09/8.93
Vanadium	15.7	196	53.5/133
Zinc	11.4	1660	38.1/79.5

1 Basewide background surface/subsurface soil concentrations (B&R Environmental, December 1997).

Concentrations of inorganic compounds were within $UTLs_{95\%}$ calculated for the basewide background soil and the basewide freshwater sediment data sets. Maximum concentrations of arsenic and beryllium exceeded EPA Region III RBCs for residential exposures (Table 6-15). Maximum concentrations of inorganics were below the EPA Region III RBCs for industrial exposures.

6.5 CONTAMINANT FATE AND TRANSPORT

The data indicate that no significant migration of chemicals from Rum Point Landfill into the surrounding area is occurring. No areas of significant contamination have been identified outside of the landfill area. Volatiles were detected sporadically and at low concentrations in soil samples collected from within and outside of the landfill. PAHs and phthalates were also detected sporadically and at low concentrations in soil samples collected from within and outside of the landfill. Low levels of volatiles and phthalates were detected in the groundwater monitoring well located upgradient of the landfill. Volatiles are not likely to bind to soil and are likely to be fairly mobile in the environment; consequently, volatiles are not considered to be persistent in the environment. PAHs and phthalate esters are fairly immobile chemicals, tend to bind to soil, and are considered to be relatively persistent chemicals in the environment.

Concentrations of several metals in surface soil exceeded site-specific background values but concentrations of metals in groundwater samples were generally within background levels. Concentrations of metals in sediment samples were within site-specific background levels. Metals are not typically considered to be mobile contaminants in the environment. Metals do not degrade via any of the identified fate processes (e.g., hydrolysis, photolysis, etc.) although under acidic soil conditions, metals may be solubilized and transported with infiltrating precipitation and groundwater migration.

6.6 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section contains the site-specific risk assessment for the identified exposure scenarios for Rum Point Landfill (SWMU 1). The risk assessment methodology was described in Section 2.5, and detailed calculations are contained in Appendix P.

6.6.1 Data Evaluation/Selection of Chemicals of Potential Concern

6.6.1.1 Data Evaluation SWMU 1 - Rum Point Landfill

All field samples collected for fixed-base laboratory analysis for the RFI/VI at NSWC Indian Head underwent the data validation process as described in Section 2.3. This section summarizes the SWMU-specific data validation results for SWMU 1 - Rum Point Landfill. Analytical data for samples collected from the Rum Point Landfill are contained in SDGs 9708011, 9706232, 9707063, 9707083, 9708030, and 9708087.

Some positive analytical results for acetone, methylene chloride, calcium, copper, tin, and antimony associated with Rum Point Landfill soils were flagged "B" during data validation indicating that they are false positives attributable to field/laboratory blank contamination. Additionally, some positive results reported for methylene chloride, beryllium, tin, vanadium, copper, lead, and zinc in Rum Point Landfill groundwater samples were flagged "B" during data validation indicating that they are false positives attributable to field/laboratory blank contamination. All methylene chloride and acetone results in surface water and sediment samples samples were qualified "B" during data validation indicating that they are false positives attributable to field/laboratory blank contamination. Tin, beryllium, and lead were qualified "B" during data validation of surface water and sediment samples which indicates that they are false positives attributable to laboratory/field blank contamination.

Nondetected results for the organic compounds: 2-butanone, acrolein, acrylonitrile, acetonitrile, propionitrile, isobutyl alcohol, vinyl acetate, 4-nitroquinoline-1-oxide, famphur, and kepone, in most soil and groundwater samples were qualified as rejected, "UR," during data validation. No positive results

were reported for any of the noted compounds. The rejection of results for the noted compounds were a result of extremely low (0.050 unitless) initial and continuing calibration relative response factors. These low response factors indicate that the laboratory's instruments could not achieve satisfactory sensitivity for the aforementioned compounds which severely compromises the associated positive and nondetected results.

The method of analysis for the determination of these volatile and semivolatile organic compounds utilizes Gas Chromatography/Mass Spectrometry (GC/MS). Isobutyl alcohol and 2-butanone are soluble in water and are difficult to purge effectively. There are technical adjustments the laboratory could have made that would have improved the responses for isobutyl alcohol and 2-butanone. Vinyl acetate may react under certain chromatographic conditions thus yielding a poor instrument response. Kepone is best analyzed by GC using an Electron Capture Detector (ECD). Acrolein and acrylonitrile, chemically, are more suited for analysis by High Performance Liquid Chromatography (HPLC). Acetonitrile may be analyzed using GC with a Nitrogen-Phosphorus Detector (NPD). The chemical properties of propionitrile, 4-nitroquinoline-1-oxide, and famphur may restrict these compounds from yielding satisfactory chromatographic response regardless of the analytical method of detection. However, the substitution of alternative analytical methods would be cost prohibitive in comparison to the value they would add to the final data. Therefore, the poor response of the aforementioned compounds is attributable to both the specific chemical properties and the use of GC/MS as all encompassing method of analysis in an attempt to eliminate a variety of complex alternatives. Furthermore, the rejection of result for these compounds in environmental matrices does not create any significant data gaps that would warrant resampling.

No inorganic analyte results were rejected during the data validation process.

6.6.1.2 Selection of Chemicals of Potential Concern

Chemicals of potential concern at this site were selected using the risk-based COPC screening levels (i.e., the Section 2.0 benchmarks) described in Section 2.5.1. COPC summary screening tables for all media are presented in Tables 6-10 through 6-15. The list of COPCs for the Rum Point Landfill is summarized in Table 6-16.

Maximum chemical concentrations in soil were compared to EPA Region III RBCs and site-specific background levels. Additionally, maximum concentrations in soil were compared to EPA SSLs for transfers from soil to air and for migration to groundwater to justify the exclusion of the inhalation pathway and to provide a cursory evaluation of potential transport of soil chemicals to groundwater. Since the

current and expected future site use is nonresidential only those compounds with concentrations exceeding nonresidential RBCs will be retained as COPCs.

A discussion of the chemicals identified as COPCs and the rationale for their selection is provided in the following subsections.

Surface Soil

Five VOCs, 16 SVOCs (primarily PAHs and phthalates), and 15 inorganics were detected in surface soil (0 to 2 feet bgs) at Rum Point Landfill. A comparison of the maximum detected soil concentrations to EPA Region III RBCs and EPA SSLs for soil to air is presented in Table 6-10. No volatile organic compounds were present in surface soil at concentrations in excess of the RBCs or SSLs. Maximum concentrations of benzo(a)pyrene and arsenic exceeded the RBCs for industrial exposures. Maximum concentrations of benzo(a)anthracene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, beryllium, and thallium exceeded the RBCs for residential exposures. Future site use is anticipated to be nonresidential so only those compounds exceeding nonresidential RBCs were retained as COPCs. Therefore, only benzo(a)pyrene and arsenic were retained as COPCs.

Maximum surface soil concentrations were also compared to EPA SSLs for migration to groundwater Table 6-12). The concentrations of all compounds were below the SSLs for migration to groundwater with the exception of thallium. The maximum detected concentration of thallium exceeded The SSL for migration to groundwater but was within the range of basewide background concentrations.

Surface/Subsurface Soil

Six VOCs, 16 SVOCs (primarily PAHs and phthalates), and 16 inorganics were detected in surface/subsurface soil (0 to >10 feet bgs) at Rum Point Landfill. A comparison of the maximum detected soil concentrations to EPA Region III RBCs and EPA SSLs for soil to air is presented in Table 6-11. No VOCs were present in surface/subsurface soil at concentrations in excess of the RBCs or SSLs. Maximum concentrations of benzo(a)pyrene, arsenic, and beryllium exceeded the RBCs for industrial and residential exposures. However, beryllium was not detected at concentrations exceeding background. Maximum concentrations of benzo(a)anthracene, benzo(b)fluoranthene, indeno(1,2,3-cd)pyrene, total chromium, and thallium exceeded the RBCs for residential exposures. Future site use is anticipated to be nonresidential, so only these compounds exceeding nonresidential RBCs will be retained as COPCs. Therefore, only benzo(a)pyrene, and arsenic were retained as COPCs.

Maximum surface/subsurface soil concentrations were also compared to EPA SSLs for migration to groundwater (Table 6-12). The maximum detected concentrations of arsenic, total chromium, and thallium exceeded the SSLs for migration to groundwater. The maximum detected concentration of thallium was within the range of basewide background concentrations.

Groundwater

One VOC (acetone), one SVOC [bis(2-ethylhexyl)phthalate], and nine inorganics were detected in unfiltered groundwater samples collected at Rum Point Landfill. Seven inorganics were found in the filtered groundwater samples. A comparison of the maximum detected groundwater concentrations to EPA Region III RBCs is presented in Table 6-13. The maximum detected concentrations of arsenic and total chromium in unfiltered groundwater samples and arsenic in filtered groundwater samples exceeded the RBCs, therefore, these compounds were retained as COPCs.

Surface Water/Fish

One VOC (carbon disulfide), one SVOC, and three inorganics were detected in surface water samples at Rum Point Landfill. A comparison of the maximum detected surface water concentrations to EPA Region III RBCs for tap water and fish ingestion is presented in Table 6-14. The concentrations of all compounds were below the RBCs. In addition, estimated concentrations in fish tissue were well below fish screening levels and this exposure scenario was eliminated from further consideration.

Sediment

One SVOC (di-n-octyl phthalate) and 13 inorganics were detected in sediment samples at Rum Point Landfill. A comparison of the maximum detected sediment concentrations to EPA Region III RBCs for soil is presented in Table 6-15. The residential screening levels were exceeded by the maximum concentrations of arsenic and beryllium, but no residential exposures are anticipated for Rum Point Landfill. No chemicals were selected as COPCs, since no maximum concentrations exceeded applicable screening levels.

6.6.2 Exposure Assessment

The location of Rum Point Landfill is shown on Figure 6-1. It is anticipated that future use of the site will remain nonresidential. Potential receptors for Rum Point Landfill include current/future adolescent trespassers, future maintenance workers, future full-time employees, and future construction workers.

Maintenance workers and full-time employees are assumed to enter the site to conduct maintenance (such as mowing) and related activities. The only medium of concern for these workers would be surface soil (0 to 2 feet bgs). Exposure to subsurface soil is expected to be limited to ground-intrusive activities. Although no major construction projects are planned for the site or the surrounding areas, construction workers are evaluated as potential receptors to assess future exposure to subsurface soil (assumed to be exposed to surface and subsurface soil to an estimated maximum depth of 10 feet bgs or greater). Since access to the site is not restricted adolescents are assumed to trespass on the site.

The primary routes of exposure for potential human receptors at Rum Point Landfill are incidental ingestion of soil and dermal contact with soil. Exposure routes associated with soil contact are evaluated for adolescent trespassers, maintenance workers, full-time employees, and construction workers. Other potential exposure routes included incidental dermal contact with groundwater by construction workers.

Ingestion of groundwater, inhalation of volatile emissions, direct contact with surface waters and sediments, and ingestion of wildlife were not considered for the following reasons:

- The shallow aquifer at NSWC Stump Neck is not used as a potable water supply either on base or in surrounding off-base areas. Shallow groundwater at the site is tidally influenced and the source of potable water is the deeper aquifers. The deeper aquifers are not believed to be impacted by the surficial aquifer. Thus, groundwater exposures by base personnel are eliminated.

- Potential exposure to fugitive dust and volatile emissions from Rum Point Landfill is considered to be minimal, thereby eliminating the need for quantitative evaluation of this exposure pathway. As shown in Tables 6-10 and 6-11 all reported surface and subsurface soil concentrations are less than the EPA SSLs for transfers from soil to air (USEPA, 1996a).

- Direct contact with surface water and sediment by potential human receptors was not evaluated because there were no COPCs identified for these media. Additionally, no COPCs were identified for consumption of fish taken from nearby surface waters.

- Ingestion of wildlife by hunters and their families was eliminated as a significant exposure pathway. The large size of the home ranges for game species at NSWC Stump Neck relative to the size of Rum Point Landfill is not expected to result in significant foraging at the site. Moreover, the restrictive nature of the site would limit access both to the game species and to human receptors.

Exposure assumptions for these receptors are presented in Table 2-14. Table 6-16 presents a summary of the COPCs and exposure site concentrations for Rum Point Landfill. A summary of the potentially significant exposures identified for quantitative evaluation for Rum Point Landfill is provided in Table 6-17. The dose-response factors (RfDs and CSFs) for COPCs at Rum Point Landfill were presented in Tables 2-10 and 2-11. Appendix P contains the toxicological profiles for the COPCs.

6.6.3 Risk Characterization

Potential cancer risks and hazard indices were calculated for maintenance workers, full-time employees, adolescent trespassers, and construction workers (future land use) using the methodology presented in Section 2.0. Both RME and CTE exposure scenarios were evaluated. Table 6-18 contains a summary of the estimated risks for Rum Point Landfill. All spreadsheets containing the detailed, chemical-specific risks for the site are included in Appendix P. The following text presents a summary of the results of the risk characterization.

6.6.3.1 Carcinogenic Effects

All estimated cancer risks for exposures to soil were within EPA's target risk range of 10^{-4} to 10^{-6}. The estimated cancer risk for adolescent trespassers based on RME and CTE exposures to surface soil were 7.2×10^{-6} and 3.3×10^{-6}, respectively. The estimated cancer risk for maintenance workers based on RME and CTE exposures were 6.8×10^{-6} and 1.2×10^{-6}, respectively. The estimated cancer risk for full-time employees based on RME and CTE exposures to surface soil were 3.4×10^{-5} and 1.2×10^{-5}, respectively. The estimated cancer risk for construction workers based on RME and CTE exposures to surface and subsurface soil were 2.1×10^{-6} and 1.7×10^{-6}, respectively.

The estimated cancer risks for construction workers exposed to groundwater were below EPA's target risk range of 10^{-4} to 10^{-6}. The cancer risk for construction workers exposed to groundwater was 3.2×10^{-9} for RME exposures and 1.6×10^{-9} for CTE exposures.

The combined cancer risk for construction workers exposed to both soil and groundwater were within EPA's target risk range of 10^{-4} to 10^{-6}. The cancer risk for construction workers exposed to both soil and groundwater was 2.6×10^{-6} for RME exposures and 1.7×10^{-6} for CTE exposures.

6.6.3.2 Noncarcinogenic Effects

All estimated hazard indices were below 1.0 indicating that no toxic effects are anticipated for these receptors under the defined exposure scenarios. The hazard indices for adolescent trespassers exposed

to surface soil were 0.015 for RME exposures and 0.0016 for CTE exposures. The hazard indices for maintenance workers exposed to surface soil were 0.0054 for RME exposures and 0.00057 for CTE exposures. The hazard indices for full-time employees exposed to surface soil were 0.027 for RME exposures and 0.0057 for CTE exposures. The hazard indices for construction workers exposed to surface and subsurface soil were 0.13 for RME exposures and 0.042 for CTE exposures.

The hazard indices for construction workers exposed to groundwater were less than the acceptable level of 1.0. The hazard indices for construction workers exposed to groundwater was 0.0034 for RME exposures and 0.0011 for CTE exposures.

The combined hazard index for construction workers exposed to both soil and groundwater was less than the acceptable level of 1.0. The hazard index for construction workers exposed to both soil and groundwater was 0.13 or RME exposures and 0.043 for CTE exposures.

6.6.4.3 Qualitative Evaluation of Groundwater

Because site groundwater in the surficial aquifers is not currently used or expected to be used in the future as a potable water supply and since potential exposure to this medium is not quantitatively addressed in the human health risk assessment (i.e., future residential use is not considered), a brief qualitative assessment of groundwater is included in this section. Table 6-19 contains a summary of the qualitative assessment of this medium.

Maximum detected concentrations in unfiltered and filtered groundwater samples collected at Rum Point Landfill were compared to EPA MCLs, SMCLs, and EPA Region III RBCs for tap water. As previously indicated, the shallow aquifer at the site is not used as a source of drinking water either on- or off-base. Therefore, the comparison of site concentrations to primary MCLs, SMCLs, and RBCs serves as a conservative assessment of potential risks.

No organics were detected in unfiltered groundwater samples at concentrations which exceed RBCs. Arsenic and chromium were the only inorganics detected in unfiltered groundwater samples at concentrations which exceed RBCs. It should be noted that the reported chromium concentration is for total chromium and the EPA Region III RBC is for hexavalent chromium. Concentrations of all compounds in unfiltered groundwater samples were below MCLs and SMCLs.

Arsenic was the only compound detected in filtered groundwater samples at concentrations exceeding RBCs. Concentrations of all compounds in filtered groundwater samples were below MCLs and SMCLs.

6.6.3 Uncertainty Analysis

A detailed discussion of uncertainties associated with the various aspects of risk assessment in general was provided in Section 2.8. There are no site-specific uncertainties for Rum Point Landfill.

6.6.4 Summary of Risk Assessment

The following items summarize the human health risk assessment for SWMU 1 Rum Point Landfill.

- The human health risk assessment for Rum Point Landfill considered exposures to adolescent trespassers, maintenance workers, full-time employees, and construction workers. Potential exposure pathways for direct contact with soil for all receptors included incidental ingestion and dermal contact with soil. Inhalation of fugitive dust and volatiles from soil were not considered since concentrations of all COPCs in soil were less than the EPA soil to air SSLs.

- Incremental lifetime cancer risks for all receptors were within or below EPA's target risk range of 10^{-4} to 10^{-6}.

- Noncarcinogenic risk estimates (HIs) for all receptors were less than 1.0 indicating that no toxic effects are anticipated for these receptors under the defined exposure scenarios.

6.7 ECOLOGICAL ISSUES

This section presents the ERA, ecological risk management, ERA/risk management summary and site-specific uncertainties for Rum Point Landfill.

6.7.1 Ecological Risk Assessment

This section presents the results of the ecological risk assessment performed at Rum Point Landfill, and consists of a discussion of the preliminary problem formulation, effects characterization, exposure assessment, and risk characterization.

6.7.1.1 Preliminary Problem Formulation

This section includes a discussion of available habitats, ecological receptors, contaminant sources, release mechanisms, migration pathways, exposure routes, selection of preliminary contaminants of potential concern (PCOCs), assessment and measurement endpoints, and the conceptual site model.

Habitat Types and Ecological Receptors

Rum Point Landfill is located in the inner portion of Stump Neck Annex west of Rum Point Road (near the intersection of Archer Road and Rum Point Road). The landfill is comprised of a flat area approximately 5 acres in size. Most of the flat landfill area is covered with turfgrass. The northeast and northwest portions of the flat area, however, are covered with brush and immature trees. The areas surrounding the flat area are characterized by steep topography (Figure 6-3). The landfill toes to the northeast, north, northwest, and west drop off quickly, and are extremely steep. Scattered exposed debris is present along the landfill toe. The slope continues down past the landfill toes in these areas to a deep ravine. Rum Point Road is located to the east of the landfill and a steep hill is located to the south.

A small stream is located at the bottom of the ravine. The stream originates upgradient and southwest of the landfill and runs along the western part of the landfill area to a point due north of the landfill. Another small drainage ditch that runs along the eastern portion of the landfill (parallel to Rum Point Road) and connects with the stream at this point. The stream then flows in a northerly direction until its discharge to Mattawoman Creek approximately one-half mile from Rum Point Landfill. Runoff from the landfill drains to the stream or the drainage ditch to the east.

The areas surrounding the landfill and including the landfill toes are mature forested areas. Several of the trees are among the largest on the base. Dominant trees include sycamore (*Platanus occidentalus*), beech (*Fagus grandifolia*), oaks (*Quercus* spp.), hickories (*Carya* spp.), red maple (*Acer rubrum*), and tulip poplar (*Liriodendron tulipera*). Pumpkin ash (*Fraxinus profunda*), green ash (*Fraxinus pennsylvanica*), basswood (*Tilia* sp.), and witch hazel (*Hamamelis virginiana*) are also present. Many of these species are uncommon on the coastal plain (MDNHP, 1992). The understory is sparse, but contains scattered brushy areas; pawpaw (*Asimina tribola*) is common in the understory.

Rum Point Landfill is located in the ravine portion of the Rum Point Protection Area, as designated by the Maryland Natural Heritage Program (MDNHP, 1992). According to MDNHP, the second-growth tulip forest in the ravine system supports the State threatened perennial narrow melicgrass (*Melica mutica*), and the State watch list species Virginia snakeroot (*Aristolochia serpentaria*). Narrow melicgrass was observed at two locations and Virginia snakeroot was observed at one location in the ravine system during MDNHP surveys in 1991-1992. These locations are not believed to include the Rum Point Landfill area.

The ravine system also provides habitat for plant species rarely found in the Coastal Plain, including hop hornbeam (*Ostrya virginiana*) and foamflower (*Tiarella cordifolia*) (MDNHP, 1992). Both species are found

primarily in rich wooded areas of the Piedmont and mountains. The area is the only known Coastal Plain occurrence of foamflower in Maryland. A few specimens of the southeastern adder's tongue fern (*Ophioglossom pycnosichum*), which was previously unreported in Charles County were observed in a narrow floodplain in the ravine by MDNHP. Furthermore, the forest appears to have a high species diversity of woody plants; at least 41 species of woody plants were noted during a May 1991 species survey.

Most of the site itself is disturbed and covered with grass, and thus, provides marginal terrestrial habitat. The surrounding areas, as described above, provide excellent upland habitat. Water in the stream adjacent to and immediately downgradient of the landfill is ephemeral and occurs only after periods of heavy rainfall. As such, a permanent aquatic community is not present. No water was present in the stream near the landfill during an October, 1997 site visit.

As mentioned above, runoff from the landfill, primarily the landfill toes and upper edges of the landfill, enters a stream and drainage ditch that run adjacent to the landfill. Since the central portion of the landfill is flat, precipitation will probably infiltrate rather than run off in that area. Communication between shallow groundwater and the stream probably occurs at the site. Since Mattawoman Creek and the wetland areas at the mouth of the stream next to Mattawoman Creek are located several thousand feet from the landfill, and since water flow in the creek near the landfill is low and ephemeral, the influence of the runoff from the landfill on these areas is expected to be insignificant.

Contaminant Sources, Release Mechanisms, and Migration Pathways

The major potential contaminant source at Rum Point Landfill is residual soil contamination from historical landfilling activities. The contaminant release pathways from this area include overland runoff and infiltration of contaminants. Air transport is unlikely since the site is heavily vegetated.

Precipitation runoff can carry contaminants via overland runoff to the stream and drainage ditch adjacent to most of the site. This is most probable near the edges of the site and along the landfill toes, since most of the site is flat, precluding significant runoff. Also, infiltrating precipitation can cause the contamination of subsurface soil and groundwater, which probably is a relevant contaminant transport mechanism since, again, water from precipitation on the landfill will tend to pond and infiltrate.

Exposure Routes

Terrestrial animals at Rum Point Landfill can be exposed to soil contaminants through the ingestion of contaminated food items. In addition, animals can incidentally ingest soil while grooming fur, preening feathers, digging, grazing close to the soil, or feeding on items that are covered with soil (such as roots and tubers). Terrestrial vegetation can be exposed to contaminants through direct aerial deposition and root translocation, although aerial deposition is probably minuscule since the site is heavily vegetated. Terrestrial receptors can also come into contact with contaminants in surface water in the stream and drainage ditch by using it for drinking, although this exposure route generally represents a negligible portion of total exposure for most receptors. Also, water in the stream and drainage ditch near the site is ephemeral. As mentioned above, since the stream is small and water in it is ephemeral, an aquatic community is not present near the site. Some semi-aquatic organisms, such as amphibians, may inhabit the stream during the wetter months of the year. Semi-aquatic organisms can be exposed to contaminants through direct contact with surface water and sediments in the stream, incidental ingestion of surface water and sediments in the stream, and consumption of contaminated food items. Exposure to contaminants in the soil via dermal contact can occur but is unlikely to represent a major exposure pathway because fur, feathers, and chitinous exoskeletons minimize the transfer of contaminants across dermal tissue.

Volatilization and soil-bound contaminant airborne suspension are not relevant at Rum Point Landfill since the site is heavily vegetated. In addition, inhalation does not represent a significant exposure pathway because this investigation assumes that air contaminant concentrations are quite low, even for burrowing wildlife. Furthermore, inhalation ecotoxicity data for chronic exposure are lacking. Hence, the air pathway was not considered for ecological receptors.

Selection of Preliminary Contaminants of Concern (PCOCs)

The PCOC selection process for this ERA is described in Section 2.6.

Assessment and Measurement Endpoints

A description of assessment and measurement endpoints for this ERA is presented in Section 2.6.

Conceptual Site Model

Figure 6-12 shows the conceptual model for Rum Point Landfill. It should be noted that although aquatic exposure routes are presented, the stream and drainage ditch adjacent to the site do not contain a permanent aquatic community. Aquatic exposure routes were included only as a conservative measure since some semi-aquatic organisms may utilize the stream in the wetter months of the year.

6.7.1.2 Ecological Effects Characterization

Ecologically-based screening levels (concentrations of contaminants in various media protective of ecological receptors) were compared to exposure point concentrations of detected analytes in surface water, groundwater, sediment, and surface soil to determine if they should be retained as ecological PCOCs at Rum Point Landfill. The thresholds were USEPA Region III BTAG screening levels (EPA, 1995), although AWQC were used for groundwater. The derivation of toxicity reference values (TRVs) for Rum Point Landfill foodchain modeling is also described in Section 2.6, as well as the selection of representative receptors. Briefly, the red fox, red-tailed hawk, meadow vole, short-tailed shrew, and woodcock were selected as representative ecological receptors for the foodchain modeling at Rum Point Landfill.

6.7.1.3 Exposure Assessment

This section presents the ecological exposure assessment for Rum Point Landfill and includes a discussion of exposure point contaminant concentrations.

Exposure Point Contaminant Concentrations

The maximum detected contaminant concentrations in surface water, groundwater, sediment, and surface soil were used as exposure point concentrations for screening against USEPA Region III BTAG screening levels, and AWQC. The maximum and mean concentrations of contaminants detected in Site 6 media were used in the foodchain modeling.

6.7.1.4 Risk Characterization

This section presents the results of the ecological risk assessment for Rum Point Landfill.

Results - Ecological Screening Assessment

Di-n-butylphthalate and carbon disulfide were retained as PCOCs for surface water since their maximum concentrations exceeded BTAG screening levels (Table 6-20). Arsenic was retained as a sediment PCOC since its maximum concentration exceeded its BTAG screening level (Table 6-21). Barium, beryllium, cobalt, selenium, and vanadium were retained as sediment PCOCs since no BTAG screening levels were available.

Beryllium, chromium, lead, mercury, nickel, and zinc were retained as inorganic surface soil PCOCs since their maximum concentrations exceeded BTAG screening levels (Table 6-22). Several PAHs in surface soils exceeded BTAG screening levels and were retained as PCOCs (Table 6-22). Bis(2-ethylhexyl)phthalate, 4-methyl-2-pentanone, and acetone were retained as PCOCs since no BTAG screening levels were available.

Maximum groundwater concentrations, barium, chromium, and mercury, exceeded AWQC and were retained as groundwater PCOCs (Table 6-23). Acetone was retained as a groundwater PCOC since no AWQC was available.

Results - Foodchain Modeling

The inorganics chromium, lead, mercury, and zinc were retained as PCOCs after terrestrial foodchain modeling since at least one EEI developed for these metals exceeded 1.0 when maximum concentrations were evaluated (Table 6-24). With the exception of zinc, at least one EEI developed for these metals also exceeded 1.0 when mean concentrations were evaluated (Table 6-25). The organic 4-methyl-2-pentanone was retained as a PCOC after terrestrial foodchain modeling since no toxicity data were available.

6.7.2 Risk Management

Risk management considerations for Rum Point Landfill contaminants in surface water, sediments, and surface soils are discussed below.

6.7.2.1 Surface Water

Di-n-butylphthalate and carbon disulfide were retained as PCOCs after screening against BTAG screening levels. Di-n-butylphthalate was detected in 1 of 3 surface water samples. The alternate guideline (Table

6-26) of 33 µg/L (an EPA Tier 2 value) is an order of magnitude greater than the one detected concentration. This organic was not detected in sediment, surface soil, subsurface soil or groundwater at Rum Point Landfill. Carbon disulfide was detected in 1 of 2 surface water samples; an EEQ of 3.5 was developed for this contaminant. No alternate guideline was available for carbon disulfide. However it was not detected in site sediment, surface soil, or groundwater, and was only detected in 1 of 12 subsurface soil samples. Hence, these two organics will not be retained as final PCOCs.

6.7.2.2 Sediment

Arsenic was retained as a sediment PCOC after screening maximum sediment contaminant concentrations against BTAG screening levels. However, its maximum detected concentration in sediments (2.6 mg/kg) was lower than the MOE LEL of 6 mg/kg (Table 6-26). As discussed in Section 2.6, the LEL is associated with low potential risks to benthic receptors. The maximum detected concentration of arsenic was also lower than the average background concentration in basewide sediments. No alternate guidelines were available for barium, beryllium, cobalt, selenium, or vanadium, which were all sediment PCOCs after the foodchain modeling. However, all of these inorganics had maximum detected concentrations that were lower than their average basewide background concentrations, with the exception of selenium. The maximum detected concentration of selenium (0.96 mg/kg) was slightly higher than the average basewide background concentration (0.93 mg/kg) and lower than the maximum detected concentration in background. As a result, none of these metals will be retained as final PCOCs.

6.7.2.3 Surface Soil

Chromium, lead, mercury, zinc, and 4-methyl-2-pentanone were retained as surface soil PCOCs after the foodchain modeling. The following paragraphs discuss the risk management considerations for each of these chemicals.

The maximum detected concentration of chromium in Rum Point Landfill surface soils (24.9 mg/kg) was slightly higher than the maximum detected basewide background concentration (20.8 mg/kg) and the average concentration (15.8 mg/kg) was slightly higher than the average basewide concentration in background (12 mg/kg; Table 6-26). Boerngen and Shacklette (1981) present a range of regional background chromium concentrations of 15-20 mg/kg. The maximum Rum Point Landfill concentration is slightly higher than this range; the average Rum Point Landfill concentration falls within this range.

The maximum concentration of lead (20.3 mg/kg) in Rum Point Landfill surface soils was essentially equal to the average concentration in site-specific background (20 mg/kg), and the average concentration in Rum Point Landfill surface soils (11.8 mg/kg) was below the average basewide background concentration (Table 6-26). Boerngen and Shacklette (1981) presented a range of background lead concentrations in Maryland coastal plain counties of 10-15 mg/kg. The maximum Rum Point Landfill concentration slightly exceeds this range and the average SWMU 1 concentration falls within this range. The maximum site-specific concentration of lead is well below the ORNL alternate guidelines presented in Table 6-26, which are indicative of potential toxicity to soil organisms.

The maximum concentration of mercury in Rum Point Landfill surface soils (0.31 mg/kg) exceeds maximum and average basewide background concentrations and regional background concentrations (0.04-0.07 mg/kg; Boerngen and Shacklette, 1981). The average concentration of mercury (0.078 mg/kg) is less than the ORNL alternate guidelines presented on Table 6-26, which are indicative of toxicity to soil organisms, and is comparable to the regional range of background soil mercury concentrations.

The maximum concentration of zinc in surface soils (32 mg/kg) is slightly higher than the maximum concentration of zinc in basewide background (30.8 mg/kg) and the range of regional background concentrations (15-26 mg/kg) presented by Boerngen and Shacklette (1981). The maximum concentration is an order of magnitude lower than both of the alternate guidelines presented on Table 6-26, which are ORNL values indicative of potential risks to soil organisms. The average concentration of zinc in Rum Point Landfill surface soils (22.2 mg/kg) is slightly higher than the average basewide concentration (18.1 mg/kg) and within the range of regional concentrations. In addition, only one EEI developed for zinc using the food chain modeling was greater than 1.0 (1.26 for the woodcock using the NOAEL and maximum concentration). The EEI using the NOAEL and average concentration of zinc was less than 1.0.

The organic 4-methyl-2-pentanone was detected in 1 of 7 surface soil samples at a concentration of 3 µg/kg. No BTAG screening level or alternate guideline was available for this compound (Table 6-26). The compound was not a PCOC in surface water or sediment in the streams adjacent to the site, indicating the absence of off-site migration.

In summary, chromium, lead, mercury, and zinc exceeded BTAG screening levels and at least one EEI value developed using in the foodchain modeling exceeded one. However, the maximum and average detected concentrations of these metals in Rum Point Landfill surface soils were either in the range of or only slightly exceeded basewide background concentrations and the background concentrations reported in the literature for the region. Although the bioavailabilty of these four metals at Rum Point Landfill is not

known, metals at hazardous waste sites are usually in poorly available forms (Will and Suter, 1995). In addition, none of these four metals was a PCOC in surface water and sediments in the streams adjacent to the site, suggesting a lack of off-site migration. Chromium, mercury, and zinc were detected in groundwater, but their absence in adjacent surface water and sediments indicates that discharge via groundwater has not occurred. The landfill and landfill toe supports a diverse and abundant flora, including large, mature hardwood trees typical of the surrounding Porter Woods Protection Area. No evidence of plant stress is apparent. For these reasons, although these metals may be slightly elevated relative to background, chromium, lead, mercury, zinc will not be retained as surface soil PCOCs.

6.7.3 ERA and Risk Management Summary and Conclusions

The maximum detected concentrations of contaminants detected in Rum Point Landfill surface water, groundwater, sediment, and surface soil were compared to BTAG screening levels. All of the contaminants with maximum concentrations that exceeded BTAG screening levels were retained as PCOCs and the PCOCs for surface soils were included in terrestrial foodchain modeling at the site for several representative ecological receptors. Contaminants demonstrating at least one EEI greater than 1.0 in the foodchain modeling (for all representative receptors) using maximum concentrations were retained as PCOCs. Finally, those PCOCs were assessed using risk management considerations to develop a list of final PCOCs. As a result of these analyses, the following conclusions are drawn:

- The concentrations of two organic compounds in surface water exceeded BTAG screening levels but these organics were not detected in sediments or surface soils at Rum Point Landfill.

- Six inorganic compounds detected in sediments had maximum concentrations in excess of BTAG screening levels, but these concentrations were less than or comparable to average basewide background concentrations.

- Chromium, lead, and mercury had maximum concentrations in surface soils that were slightly elevated relative to basewide background. However, none of these metals was identified as a PCOC in surface water or sediments, suggesting the absence of off-site migration. Despite some elevated hits of these metals in soils, their concentrations do not appear to be high enough to warrant additional ecological study or remediation based on ecological concerns. Also, qualitatively the terrestrial flora does not appear to be stressed.

6.7.4 Site-specific Uncertainties

The following items summarize site-specific uncertainties for the ERA at Rum Point Landfill:

- There were low numbers of surface water and sediment samples, reducing confidence in the use of the average concentration as a representative exposure concentration.

- Carbon disulfide and 4-methyl-2-pentanone were present in surface water and surface soil, respectively. No BTAG screening level was available for carbon disulfide and no toxicity data (e.g., NOAEL or LOAEL) were available for 4-methyl-2-pentanone. Qualitatively, the concentrations of both of these compounds appear to be relatively low, but without adequate toxicity data, a definitive determination of their significance cannot be made.

- No BTAG screening levels or alternate guidelines were available for barium, beryllium, cobalt, selenium, or vanadium, which were all sediment PCOCs after the foodchain modeling. Although the maximum concentrations of all of these inorganics were comparable to or less than basewide background concentrations, the general lack of toxicity data for these metals precludes a thorough toxicological evaluation of their presence in site sediments.

- Chromium, lead, and mercury maybe slightly elevated in Rum Point Landfill surface soils relative to background. As mentioned earlier, metals at hazardous waste sites are usually in poorly available forms (Will and Suter, 1995). However, the lack of site-specific bioavailability data introduces uncertainty into the ERA.

6.8 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Section 6.8 summarizes the environmental investigations conducted to date, the nature and extent of the chemicals detected in the environmental media, and the results of the baseline risk assessment. Conclusions and recommendations are provided.

The following items summarize the investigative work conducted to date:

1. The field investigation included the collection of soil gas survey samples at 12 locations. Fourteen aromatic hydrocarbons (e.g., benzene) and chlorinated hydrocarbons (e.g., tetrachloroethene) were the target analytes of concern.

2. Surface and subsurface soil samples were collected from four boring/monitoring well locations. Four additional surface soil samples were collected by compositing the soils from four locations within four subareas of the landfill (i.e., the landfill was divided into four subareas or quadrants for sampling purposes). Eight surface and 12 subsurface samples were submitted to a fixed-base laboratory (GP) for analysis.

3. Four monitoring wells (one upgradient; 3 downgradient) were installed. One round of synoptic water level measurements were recorded.

4. Surface water and sediment samples were collected from three locations (one upstream; two downstream) in two intermittent streams at Rum Point Landfill.

5. Environmental samples collected for analysis by the fixed-base laboratory were analyzed for a comprehensive suite of analytes including volatile organic and semivolatile organic compounds and metals.

The following items summarize the environmental conditions at the Rum Point Landfill:

1. The subsurface materials are relatively consistent across the study area vertically and horizontally. The surficial deposits generally consist of yellow brown clay, silt, and sand mixtures and range in thickness from 12 to 20 feet. These surficial materials are underlain by a distinct dark gray silt and fine sand with shell fragments ranging in thickness from 20 feet at the western edge of the landfill to 43 feet at the southeast corner of the site. The shell fragment layer is underlain by a distinct green sand, which overlies a very stiff clay. A softer clay layer overlies the green sand in the western portion of the site.

2. The groundwater beneath the site occurs primarily under semiconfining conditions. The water-bearing zone (aquifer) is composed of a green sand. The semiconfining unit is a dark gray silt and fine sand. Generally, the groundwater flows to the north by northwest and discharges into local streams. There is also a downward flow component to the groundwater flow pattern, which indicates that the green sand aquifer is being recharged from the overlying, leaky, semiconfining unit. The deeper groundwater flows north, possibly discharging into the Mattawoman Creek. There is also a minor perched zone supported by the semiconfining unit.

3. Volatile (e.g., acetone) and semi-volatile (e.g., bis(2-ethylhexyl)phthalate) organic compounds were detected in soils, groundwater, surface waters, and sediments. The organic contamination detected is limited to the low-level (generally less than 100 µg/kg; less than 10 µg/L) presence of several volatile organic compounds, and the detection of phthalate and PAH compounds. The phthalate compounds are common plasticizers. The PAHs are by-products of the combustion process. Site-related as well as non-site-related activities may have contributed to the presence of the phthalates and PAHs in the environmental media. For some organics, concentrations detected in samples from upgradient or background locations exceed those noted in samples collected at the site. Benzo(a)pyrene (in soils) was the only organic detected at a concentration exceeding EPA Region III RBCs for industrial exposures.

4. Several metals (e.g., arsenic, cadmium, chromium, copper, mercury, nickel and tin) were detected in surface or subsurface soils at maximum concentrations exceeding basewide background concentrations. However, all positive detections are within the concentration range reported in the literature for soils of the Eastern United States. A few metals (e.g., arsenic, chromium, and mercury) were detected at maximum concentrations exceeding background soils concentrations reported in the literature for the State of Maryland. Although the maximum detected concentrations exceeded facility background concentrations, the exceedances noted were often within two times the background concentration. Arsenic was the only metal detected at concentrations exceeding background and the EPA Region III RBCs developed for an industrial land use scenario. Arsenic, chromium and thallium were detected at maximum concentrations exceeding the EPA SSLs for migration of compounds from soil to groundwater.

5. Metals concentrations in groundwater were within the range of basewide background concentrations with the exceptions of arsenic and chromium. However, arsenic was the only metal detected at a concentration exceeding EPA Region III RBCs for tap water. The concentration reported was less than the current federal SDWA MCL.

6. Metals concentrations detected in surface waters suggest that historic activities at Rum Point Landfill have had minimal impact on surface water quality. Concentrations in upstream samples are comparable to those noted in downstream samples. Metals concentrations in sediments appear to reflect background conditions.

The following items summarize the baseline human health risk assessment conducted for Rum Point Landfill:

1. The human health risk assessment for Rum Point Landfill considered exposures to maintenance workers, full-time employees, construction workers, and current/future adolescent trespassers. Potential exposure pathways for direct contact with soil for all receptors included incidental ingestion of and dermal contact with soil. Other potential exposure routes included incidental dermal contact with groundwater by construction workers. Inhalation of fugitive dust and volatiles from soil were not considered since concentrations of all COPCs in soil were less than the SSLs developed by the EPA for the migration of contaminants from soil to air.

2. Arsenic and benzo(a)pyrene were the only target analytes selected as COPCs for the evaluation of exposures to soils. Arsenic and chromium were the only COPCs selected for the evaluation of exposures to groundwater. No COPCs were selected for surface water or sediments.

3. Incremental lifetime cancer risk estimates developed for all receptors were within the EPA's target risk range of 10^{-4} to 10^{-6}.

4. Noncarcinogenic risk estimates (HIs) calculated for all human receptors evaluated were less than unity indicating that adverse noncarcinogenic health effects are not anticipated under the conditions established in the exposure assessment.

The following items summarize the baseline ecological risk assessment conducted for Rum Point Landfill:

1. The concentrations of two organic compounds in surface water exceeded BTAG screening levels but these organics were not detected in sediments or surface soils at Rum Point Landfill.

2. Six inorganic compounds detected in sediments had maximum concentrations in excess of BTAG screening levels, but these concentrations were less than or comparable to average basewide background concentrations.

3. Chromium, lead, and mercury had maximum concentrations in surface soils that were slightly elevated relative to basewide background. However, none of these metals was identified as a PCOC in surface water or sediments, suggesting the absence of off-site migration. Despite some elevated detections of these metals in soil, their concentrations do not appear to be high enough to warrant additional ecological study or remediation based on ecological concerns. Also, qualitatively, the terrestrial flora does not appear to be stressed.

It is recommended that the risk managers for NSWC Indian Head consider a "No further action" decision for the Rum Point Landfill - SWMU 1. The human health risk assessment indicates that the cancer risk estimates for human receptors of concern are within the EPA's target risk range of 10^{-4} to 10^{-6}. COPCs contributing to the risk estimates exceeding 10^{-6} were detected infrequently at concentrations exceeding background. Adverse noncarcinogenic health effects are not anticipated for the human receptors of concern. The ecological risk assessment indicates that risks to ecological receptors appear to be relatively low. Although some metals were detected in soils at concentrations exceeding EPA SSLs for migration of compounds from soil to groundwater, the available groundwater data do not indicate that significant contaminant migration has occurred.

TABLE 6-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM FOR SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE	MEDIA	Explosives SW846 8330	APP IX Metals SW846 6010A/7000	APP IX SVOA SW846 8270B	APP IX VOA SW846 8240B	TOC SW846 9060	TOX SW846 9020B	Miscellaneous
RPLCP0010101	Surface Soil		X	X	X			
RPLCP0010101-D	Surface Soil		X	X	X			
RPLCP0020101	Surface Soil		X	X	X			
RPLCP0030101	Surface Soil		X	X	X			
RPLCP0040101	Surface Soil		X	X	X			
RPLMW002F001	Groundwater		X					
RPLMW002U001	Groundwater		X	X	X			
RPLMW003F001	Groundwater		X					
RPLMW003U001	Groundwater		X	X	X			
RPLMW004F001	Groundwater		X					
RPLMW004U001	Groundwater		X	X	X			
RPLSB0010101	Subsurface soil		X	X	X			
RPLSB0010201	Subsurface soil		X	X	X			
RPLSB0010301	Subsurface soil		X	X	X			
RPLSB0010401	Subsurface soil		X	X	X			
RPLSB0020101	Subsurface soil		X	X	X			
RPLSB0020201	Subsurface soil		X	X	X			
RPLSB0020301	Subsurface soil		X	X	X			
RPLSB0030101	Subsurface soil		X	X	X			
RPLSB0030201	Subsurface soil		X	X	X			
RPLSB0040101	Subsurface soil		X	X	X			
RPLSB0040201	Subsurface soil		X	X	X			
RPLSB0040301	Subsurface soil		X	X	X			
RPLSD0010001	Sediment		X					
RPLSD0020001	Sediment		X	X	X			
RPLSD0020001-D	Sediment		X	X	X			
RPLSD0030001	Sediment		X	X	X			
RPLSS0010101	Surface Soil		X	X	X			
RPLSS0010101-D	Surface Soil		X	X	X			
RPLSS0020101	Surface Soil		X	X	X			
RPLSS0040101	Surface Soil		X	X	X			

TABLE 6-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM FOR SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE	MEDIA	Explosives SW846 8330	APP IX Metals SW846 6010A/7000	APP IX SVOA SW846 8270B	APP IX VOA SW846 8240B	TOC SW846 9060	TOX SW846 9020B	Miscellaneous
RPLSS0040101-D	Surface Soil		X	X	X			
RPLSW0010001	Surface Water		X	X	X			
RPLSW0020001	Surface Water		X	X	X			
RPLSW0020001-D	Surface Water		X	X	X			
RPLSW0030001	Surface Water		X	X	X			

APP IX - Appendix IX
VOA - Volatile organic analyte
SVOA - Semi-volatile organic analyte
TOC - Total organic carbon
TOH - Total organic halides
Miscellaneous - Parmeters include ammonia and nitrate/nitrite.

TABLE 6-2

WELL CONSTRUCTION SUMMARY FOR SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Well Number	Ground Elevation (Ft. msl)	Top of Riser Elevation (Ft. msl)	Total Well Depth (Ft. bgs)	Monitored Interval (Ft. bgs)	Depth to Groundwater (Ft tor)	Depth to Groundwater (Ft. bgs)	Groundwater Elevation (Ft. msl)
RPLMW01(S)	89.49	91.55	36	25-35	22.74	20.68	68.81
RPLMW01(D)	89.59	91.23	70	60-70	24.92	23.28	66.31
RPLMW02	74.91	77.12	55	43-53	25.39	23.18	51.73
RPLMW03	60.96	63.30	43	33-43	22.68	20.34	40.62
RPLMW04(S)	65.4	67.89	25	15-25	20.81	18.32	47.08
RPLMW04(D)	64.01	66.05	46	36-46	20.98	18.94	45.07

* Water levels measured 8/17/97.
Ft. msl - Feet above mean sea level.
Ft bgs - Feet below ground surface.
Ft tor - Feet below top of riser.

TABLE 6-3

SUMMARY OF SOIL GAS POSITIVE DETECTS FOR SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Grid Location Identification	Laboratory Sample Identification	Total Volatile Hydrocarbons (ug/l)	Chloroform (ug/l)	1,1,1-Trichloroethane (ug/)	Carbon tetrachloride (ug/l)	Trichloroethene (ug/l)	Tetrachloroethene (ug/l)
RPLSG01	RSG0010102	2	<0.003	<0.005	<0.001	<0.002	<0.002
RPLSG02	RSG0020101	3	0.007	<0.005	<0.001	<0.002	<0.002
RPLSG03	RSG0030101	7	<0.003	<0.005	<0.001	<0.002	<0.002
RPLSG04	RSG0040101	3	<0.003	<0.005	<0.001	<0.002	<0.002
RPLSG05	RSG0050101	9	0.006	<0.005	<0.001	<0.002	<0.002
RPLSG06	RSG0060101	8	<0.003	<0.005	<0.001	<0.002	<0.002
RPLSG07	RSG0070101	2	<0.003	<0.005	<0.001	<0.002	<0.002
RPLSG08	RSG0080101	2	<0.003	<0.005	<0.001	<0.002	<0.002
RPLSG09	RSG0090101	1	<0.003	<0.005	<0.001	<0.002	<0.002
RPLSG10	RSG0100101	3	<0.003	<0.005	<0.001	<0.002	<0.002
RPLSG11	RSG0110101	2	<0.003	<0.005	<0.001	<0.002	<0.002
RPLSG12	RSG0120101	3	<0.003	<0.005	<0.001	<0.002	<0.002

TABLE 6-4
SUMMARY OF POSITIVE DETECTIONS IN SURFACE SOIL FOR SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RPLSS0010101	RPLSS0010101-D	RPLSS0020101	RPLSS0030101	RPLSS0040101	RPLSS0040101-D	
SAMPLE DATE:	07/11/97	07/11/97	07/12/97	07/12/97	07/15/97	07/15/97	/ /
LOCATION:	RPLSS0010101	RPLDUP009	RPLSS0020101	RPLSS0030101	RPLSS0040101	RPLDUP010	
FIELD DUPLICATE OF:		RPLSS0010101				RPLSS0040101	
VOLATILES (µg/kg)							
ACETONE				2200			
TOLUENE					2 J		
SEMIVOLATILES (µg/kg)							
BIS(2-ETHYLHEXYL)PHTHALATE			96 J				
METALS (mg/kg)							
ANTIMONY	0.31 L		0.31 L				
ARSENIC	1.9		2.5	1.8	3.1	4.0	
BARIUM	16.0	14.5	18.6	12.5	21.7	25.7	
BERYLLIUM	0.26	0.21	0.32		0.39 K	0.41 K	
CADMIUM	0.22 K	0.15 K	0.33 K	0.25 K			
CHROMIUM	8.2 J	5.9 J	10.3 J	9.6 J	20.4	22.0	
COBALT	1.8	1.7	1.6	0.84	2.7	3.1	
LEAD	7.8 J	4.3 J	9.3 J	3.5 J	5.3 K	4.5 K	
MERCURY	0.02	0.02	0.07	0.08			
NICKEL	3.7	3.9	5.2	2.2	5.9	6.8	
SELENIUM	0.48	0.30	0.63	0.65	0.64	0.75	
THALLIUM						0.66 K	
VANADIUM	13.5	8.5	12.5	13.6	21.5	26.0	
ZINC	11.7 J	10.2 J	14.8 J	7.0 J	19.4	23.1	

TABLE 6-5
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RPLSB0010101	RPLSB0010201	RPLSB0010301	RPLSB0010401	RPLSB0020101	RPLSB0020201	RPLSB0020301
SAMPLE DATE:	07/11/97	07/11/97	07/12/97	07/11/97	07/12/97	07/12/97	07/12/97
LOCATION:	RPLSB0010101	RPLSB0010201	RPLSB0010301	RPLSB0010401	RPLSB0020101	RPLSB0020201	RPLSB0020301
FIELD DUPLICATE OF:							
VOLATILES (µg/kg)							
ACETONE						5000 K	
CARBON DISULFIDE	6						
SEMIVOLATILES (µg/kg)							
BIS(2-ETHYLHEXYL)PHTHALATE					270 J	57 J	190 J
METALS (mg/kg)							
ANTIMONY	0.53 L	0.34 L	0.43 L	0.62 L	0.86 L	1.0 L	0.39 L
ARSENIC	9.4	7.5	2.4	3.9	13.0	39.6	12.6
BARIUM	21.7	22.0	11.2	14.2	8.2	17.2	30.8
BERYLLIUM	0.41	0.69	0.42	1.0	1.0	1.9	0.50
CADMIUM	0.89	0.51 K	0.44 K	0.83 K	0.81 K	1.5	1.4
CHROMIUM	34.9 J	30.2 J	42.4 J	47.2 J	65.6 J	89.6 J	38.0 J
COBALT	0.69	2.2	0.63	2.8	1.0	3.2	0.70
COPPER					6.4	6.9	
LEAD	3.6 J	3.8 J	4.5 J	4.8 J	4.5 J	5.7 J	3.2 J
MERCURY	0.02		0.03	0.02	0.03		
NICKEL	7.5	7.7	2.5	8.6	5.7	25.8	10.7
SELENIUM	2.2	1.7	1.3	2.0	3.4	3.6	2.8
TIN						4.1 L	
VANADIUM	27.9	30.6	41.8	29.9	51.8	56.4	26.1
ZINC	24.1 J	34.4 J	14.6 J	37.5 J	26.5 J	100 J	28.5 J

TABLE 6-5
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RPLSB0030101	RPLSB0030201	RPLSB0040101	RPLSB0040201	RPLSB0040301	/ /	/ /
SAMPLE DATE:	07/12/97	07/12/97	07/15/97	07/15/97	07/15/97		
LOCATION:	RPLSB0030101	RPLSB0030201	RPLSB0040101	RPLSB0040201	RPLSB0040301		
FIELD DUPLICATE OF:							
VOLATILES (µg/kg)							
ACETONE	1800	3800		610			
METALS (mg/kg)							
ANTIMONY		0.42 L					
ARSENIC	2.0	7.6	7.7	12.1	10.1		
BARIUM	15.0	12.5	19.3	30.0	24.3		
BERYLLIUM	0.12	0.33	1.4 K	1.8 K	1.9 K		
CADMIUM	0.23 K	0.37 K					
CHROMIUM	10.0 J	38.0 J	113	83.5	99.3		
COBALT	0.86	0.34	1.7	2.1	0.25		
COPPER		5.2					
LEAD	4.0 J	3.4 J	5.7 K	5.2 K	4.3 K		
MERCURY	0.07	0.02	0.02				
NICKEL	3.0	1.9	9.5	16.7	9.2		
SELENIUM	0.68	2.6	1.0	1.9	2.2		
THALLIUM			0.66 K	2.2 K	2.7 K		
VANADIUM	16.7	28.4	84.2	59.9	79.6		
ZINC	10.3 J	8.2 J	39.4	43.6	37.5		

TABLE 6-6
SUMMARY OF POSITIVE DETECTIONS IN GROUNDWATER FOR SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RPLMW001U001	RPLMW001F001	RPLMW002U001	RPLMW002F001	RPLMW003U001	RPLMW003F001	RPLMW004U001
SAMPLE DATE:	08/06/97	08/06/97	08/12/97	08/12/97	08/06/97	08/06/97	08/13/97
LOCATION:	RPLMW001U001	RPLMW001F001	RPLMW002U001	RPLMW002F001	RPLMW003U001	RPLMW003F001	RPLMW004U001
FIELD DUPLICATE OF:							
VOLATILES (µg/L)							
ACETONE			95				
CARBON DISULFIDE	6						
CHLOROFORM	2 J						
TOLUENE	7						
SEMIVOLATILES (µg/L)							
BIS(2-ETHYLHEXYL)PHTHALATE	1 J				4 J		
DI-N-BUTYL PHTHALATE	1 J						
DIETHYL PHTHALATE	3 J						
METALS (mg/L)							
ARSENIC					3.0 L		
BARIUM	60.3		55.8		64.3		26.4
CHROMIUM	2.5		16.0		8.0		29.6
COBALT			0.78				1.2
COPPER							7.4
MERCURY	0.13				0.10		
NICKEL			11:8				15.3
VANADIUM			0.85		6.8		1.8
ZINC			6.0				12.6
DISSOLVED METALS (µg/L)							
ARSENIC, FILTERED						2.2 L	
BARIUM, FILTERED		60.3		60.9		55.8	
MERCURY, FILTERED		0.16				0.14	
NICKEL, FILTERED				6.8			

TABLE 6-6
SUMMARY OF POSITIVE DETECTIONS IN GROUNDWATER FOR SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RPLMW001U001	RPLMW001F001	RPLMW002U001	RPLMW002F001	RPLMW003U001	RPLMW003F001	RPLMW004U001
SAMPLE DATE:	08/06/97	08/06/97	08/12/97	08/12/97	08/06/97	08/06/97	08/13/97
LOCATION:	RPLMW001U001	RPLMW001F001	RPLMW002U001	RPLMW002F001	RPLMW003U001	RPLMW003F001	RPLMW004U001
FIELD DUPLICATE OF:							
DISSOLVED METALS (µg/L)							
ZINC, FILTERED				6.9			

TABLE 6-6
SUMMARY OF POSITIVE DETECTIONS IN GROUNDWATER FOR SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RPLMW004F001						
SAMPLE DATE:	08/13/97	/ /	/ /	/ /	/ /	/ /	/ /
LOCATION:	RPLMW004F001						
FIELD DUPLICATE OF:							
DISSOLVED METALS (µg/L)							
BARIUM, FILTERED	24.7						
COBALT, FILTERED	0.83						
COPPER, FILTERED	3.3						
NICKEL, FILTERED	12.3						
ZINC, FILTERED	8.4						

TABLE 6-7
SUMMARY OF POSITIVE DETECTIONS IN SURFACE WATER FOR SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RPLSW0010001	RPLSW0020001	RPLSW0020001-D	RPLSW0030001			
SAMPLE DATE:	06/27/97	06/27/97	06/27/97	06/27/97	/ /	/ /	/ /
LOCATION:	RPLSW0010001	RPLSW0020001	RPLDUP001	RPLSW0030001			
FIELD DUPLICATE OF:			RPLSW0020001				
VOLATILES (µg/L)							
CARBON DISULFIDE		7					
SEMIVOLATILES (µg/L)							
DI-N-BUTYL PHTHALATE		1 J					
METALS (µg/L)							
BARIUM	22.9	33.6	31.8	31.2			
VANADIUM	0.87	1.1	1.1				
ZINC	7.4	3.9		9.9			

TABLE 6-8
SUMMARY OF POSITIVE DETECTIONS IN SEDIMENT FOR SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	RPLSD0010001	RPLSD0020001	RPLSD0020001-D	RPLSD0030001			
SAMPLE DATE:	06/27/97	06/27/97	06/27/97	06/27/97	/ /	/ /	/ /
LOCATION:	RPLSD0010001	RPLSD0020001	RPLDUP004	RPLSD0030001			
FIELD DUPLICATE OF:			RPLSD0020001				
SEMIVOLATILES (µg/kg)							
DI-N-OCTYL PHTHALATE			44 J				
METALS (mg/kg)							
ARSENIC	2.6	0.63 L	0.73 L	0.91 L			
BARIUM	13.0 J	4.3 J	3.9 J	5.8 J			
BERYLLIUM	0.21			0.16			
CADMIUM	0.54	0.23	0.16	0.28			
CHROMIUM	15.4 J	5.7 J	5.3 J	8.3 J			
COBALT	0.87	0.41	0.40	0.44			
COPPER	2.9	0.71	0.67	0.75			
LEAD	5.4	1.6	2.1	2.8			
MERCURY	0.03		0.03				
NICKEL	2.6	0.64	0.66	0.72			
SELENIUM	0.96 J	0.43 J		0.35 J			
VANADIUM	15.7	4.7	4.6	7.2			
ZINC	11.4	4.5	4.7	7.0			

TABLE 6-9

COMPARISON OF SURFACE SOIL AND SUBSURFACE SOIL DATA FOR SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

	SURFACE SOIL				SUBSURFACE SOIL			
Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum
Volatile Organic Compounds (µg/kg)								
4-Methyl-2-pentanone	1/7	3	3.00	RPLCP0020101	ND	ND	ND	ND
Acetone	3/7	23-70	30.92	RPLCP0010101	3/11	610-5000	3136.67	RPLSB0020201
Carbon disulfide					1/11	6	6.00	RPLSB0010101
Toluene	1/7	2	2.00	RPLSS0040101	ND	ND	ND	ND
Trans-1,2-dichloroethene	1/7	1	1.00	RPLCP0040101	ND	ND	ND	ND
Trichloroethene	1/7	1	1.00	RPLCP0030101	ND	ND	ND	ND
Semivolatile Organic Compounds (µg/kg)								
Acenaphthene	1/7	38	38	RPLCP0020101	ND	ND	ND	ND
Acenaphthylene	1/7	600	600	RPLCP0020101	ND	ND	ND	ND
Anthracene	1/7	170	170	RPLCP0020101	ND	ND	ND	ND
Benzo(a)anthracene	1/7	920	920.00	RPLCP0020101	ND	ND	ND	ND
Benzo(a)pyrene	1/7	1400	1400.00	RPLCP0020101	ND	ND	ND	ND
Benzo(b)fluoranthene	1/7	1300	1300.00	RPLCP0020101	ND	ND	ND	ND
Benzo(g,h,i)perylene	2/7	37-1500	768.50	RPLCP0020101	ND	ND	ND	ND
Benzo(k)fluoranthene	1/7	970	970.00	RPLCP0020101	ND	ND	ND	ND
Bis(2-ethylhexyl)phthalate	1/7	96	96.00	RPLSS0020101	3/11	57-270	172.33	RPLSB0020101
Chrysene	1/7	970	970.00	RPLCP0020101	ND	ND	ND	ND
Fluoranthene	1/7	1000	1000.00	RPLCP0020101	ND	ND	ND	ND
Fluorene	1/7	96	96.00	RPLCP0020101	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	1/7	1200	1200.00	RPLCP0020101	ND	ND	ND	ND
Naphthlene	1/7	40	40.00	RPLCP0020101	ND	ND	ND	ND
Phenanthrene	1/7	440	440.00	RPLCP0020101	ND	ND	ND	ND
Pyrene	2/7	59-1800	929.50	RPLCP0020101	ND	ND	ND	RPLSB0020101
Inorganics (mg/kg)								
Antimony	2/7	0.31	0.26	010101, RPLSS	8/11	0.34-1.00	0.57	RPLSB0020201
Arsenic	6/7	1.9-6.2	3.77	RPLCP0010101	11/11	2.4-39.6	11.45	RPLSB0020201
Barium	7/7	14.5-42.7	26.91	RPLCP0040101	11/11	8.2-30.8	19.22	RPLSB0020301
Beryllium	7/7	0.19-0.42	0.28	RPLCP0010101	11/11	0.33-1.9	1.03	RPLSB0020201/ RPLSB0040301
Cadmium	3/7	0.15-0.33	0.22	RPLSS0020101	8/11	0.37-1.5	0.84	RPLSB0020201
Chromium	7/7	5.9-24.9	15.78	RPLCP0010101	11/11	30.2-113	61.97	RPLSB0040101
Cobalt	7/7	1.6-4.6	3.03	RPLCP0030101	11/11	0.25-3.2	1.42	RPLSB0020201
Copper	4/7	6.7-12.9	10.49	RPLCP0020101	3/11	5.2-6.9	6.17	RPLSB0020201
Lead	7/7	4.3-20.3	11.78	RPLCP0020101	11/11	3.2-5.7	4.43	RPLSB0020201
Mercury	6/7	0.02-0.31	0.09	RPLCP0020101	6/11	0.02-0.03	0.02	RPLSB0010301/RPLSB0020101

TABLE 6-9

COMPARISON OF SURFACE SOIL AND SUBSURFACE SOIL DATA FOR SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

	SURFACE SOIL				SUBSURFACE SOIL			
Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum
Nickel	7/7	3.7-8.7	6.05	RPLCP0030101	11/11	1.9-25.8	9.62	RPLSB0020201
Selenium	7/7	0.3-1.1	0.63	RPLCP0010101	11/11	1.0-3.6	2.25	RPLSB0020201
Thallium	2/7	0.66	0.43	PLSS0040101-	3/11	0.66-2.7	1.85	RPLSB0040301
Tin					1/11	4.1	4.10	RPLSB0020201
Vanadium	7/7	8.5-31.5	22.50	RPLCP0040101	11/11	26.1-84.2	46.96	RPLSB0040101
Zinc	7/7	10.2-32	22.34	RPLCP0040101	11/11	8.2-100	35.85	RPLSB0020201

* Screening level exceeded by maximum site concentration.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.

TABLE 6-10

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT
SURFACE SOIL (0 TO 2 FEET) - SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATIN REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tol. Limit for Background	Greater Than Background?	SSL Transfer from Soil to Air (5)	Selected as COPC?
					Industrial	Residential					
Volatile Organic Compounds (µg/kg)											
4-Methyl-2-pentanone	1/7	3	3.00	RPLCP0020101	16000000	630000	N	ND (6)	Yes (7)	(8)	No
Acetone	3/7	23-70	30.92	RPLCP0010101	20000000	780000	N	13000	No	100000000	No
Toluene	1/7	2	2.00	RPLSS0040101	41000000	1600000	N	ND	Yes (7)	650000	No
Trans-1,2-dichloroethene	1/7	1	1.00	RPLCP0040101	4100000	160000	N	ND	Yes (7)	3100000	No
Trichloroethene	1/7	1	1.00	RPLCP0030101	520000	58000	C	ND	Yes (7)	5000	No
Semivolatile Organic Compounds (µg/kg)											
Acenaphthene	1/7	38	38	RPLCP0020101	12000000	470000	N	ND	Yes (7)	-	No
Acenaphthylene	1/7	600	600	RPLCP0020101	-	-	-	ND	Yes (7)	-	No (9)
Anthracene	1/7	170	170	RPLCP0020101	61000000	2300000	N	ND	Yes (7)	-	No
Benzo(a)anthracene	1/7	920	920.00	RPLCP0020101	7800	**880***	C	ND	Yes (7)	-	No
Benzo(a)pyrene	1/7	1400	1400.00	RPLCP0020101	**780**	**88**	C	ND	Yes (7)	-	Yes
Benzo(b)fluoranthene	1/7	1300	1300.00	RPLCP0020101	7800	**880**	C	ND	Yes (7)	-	No
Benzo(g,h,i)perylene	2/7	37-1500	768.50	RPLCP0020101	-	-		ND	Yes (7)	-	No (9)
Benzo(k)fluoranthene	1/7	970	970.00	RPLCP0020101	78000	8800	C	ND	Yes (7)	-	No
Bis(2-ethylhexyl)phthalate	1/7	96	96.00	RPLSS0020101	410000	46000	C	640	No	31000000	No
Chrysene	1/7	970	970.00	RPLCP0020101	780000	88000	C	ND	Yes (7)	-	No
Fluoranthene	1/7	1000	1000.00	RPLCP0020101	8200000	310000	N	ND	Yes (7)	-	No
Fluorene	1/7	96	96.00	RPLCP0020101	8200000	310000	N	ND	Yes (7)	-	No
Indeno(1,2,3-cd)pyrene	1/7	1200	1200.00	RPLCP0020101	7800	**880**	C	ND	Yes (7)	-	No
Naphthalene	1/7	40	40.00	RPLCP0020101	8200000	310000	N	ND	Yes (7)	-	No
Phenanthrene	1/7	440	440.00	RPLCP0020101	-	-		ND	Yes (7)	-	No (9)
Pyrene	2/7	59-1800	929.50	RPLCP0020101	6100000	230000	N	ND	Yes (7)	-	No
Inorganics (mg/kg)											
Antimony	2/7	0.31	0.26	PLSS0010101, RPLSS00201	82	3.1	N	ND	Yes (7)	-	No
Arsenic	6/7	1.9-6.2	3.77	RPLCP0010101	**3.8**	**0.43**	C	4.25	Yes	750	Yes
Barium	7/7	14.5-42.7	26.91	RPLCP0040101	14000	550	N	144	No	690000	No
Beryllium	7/7	0.19-0.42	0.28	RPLCP0010101	1.3	**0.15**	C	0.905	No	1300	No
Cadmium	3/7	0.15-0.33	0.22	RPLSS0020101	100	3.9	N	0.26	Yes	1800	No
Chromium (11)	7/7	5.9-24.9	15.78	RPLCP0010101	1000	39	N	24.2	Yes	270	No
Cobalt	7/7	1.6-4.6	3.03	RPLCP0030101	12000	470	N	39.7	No	-	No
Copper	4/7	6.7-12.9	10.49	RPLCP0020101	8200	310	N	18.7	No	-	No
Lead	7/7	4.3-20.3	11.78	RPLCP0020101	2000 (12)	400 (12)	N	149	No	-	No
Mercury	6/7	0.02-0.31	0.09	RPLCP0020101	61	2.3	N	0.087	Yes	10	No
Nickel	7/7	3.7-8.7	6.05	RPLCP0030101	4100	160	N	18.2	No	13000	No
Selenium	7/7	0.3-1.1	0.63	RPLCP0010101	1000	39	N	1.09	No	-	No
Thallium	2/7	0.66	0.43	RPLSS0040101-D	14 (13)	**0.55 (13)**	N	ND	Yes (7)	-	No
Vanadium	7/7	8.5-31.5	22.50	RPLCP0040101	1400	55	N	53.5	No	-	No
Zinc	7/7	10.2-32	22.34	RPLCP0040101	61000	2300	N	38.1	No	-	No

* Screening level exceeded by maximum site concentration.

TABLE 6-10

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT
SURFACE SOIL (0 TO 2 FEET) - SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATIN REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 Soil Screening Levels (SSLs) for transfers from soil to air (USEPA, 1996) included for qualitative evaluation only.
6 ND = not detected; NA = not applicable.
7 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
Organic background data presented for information purposes, but not for COPC selection.
8 Data not available.
9 Sufficient toxicity criteria not available; maximum concentration below screening levels of related chemicals (naphthalene, fluoranthene,fluorene).
10 HMX = octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine; RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine.
11 Considered as hexavalent chromium.
12 OSWER screening level for lead in soil (USEPA, 1993).
13 Toxicity criteria for thallic oxide used.

TABLE 6-11

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT
ALL SOIL - SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tolerance Limit for Background		Greater Than Background?	SSL Transfer from Soil to Air (5)	Selected as COPC?
					Industrial	Residential		Surface	Subsurface			
Volatile Organic Compounds (µg/kg)												
4-Methyl-2-pentanone	1/18	3	3.00	RPLCP0020101	16000000	630000	N	ND (6)	ND	Yes (7)	(8)	No
Acetone	6/18	23-5000	1583.79	RPLSB0020201	20000000	780000	N	13000	1800	Yes	100000000	No
Carbon disulfide	1/18	6	6.00	RPLSB0010101	20000000	780000	N	ND	ND	Yes (7)	720000	No
Toluene	1/18	2	2.00	RPLSS0040101	41000000	1600000	N	ND	ND	Yes (7)	650000	No
Trans-1,2-dichloroethene	1/18	1	1.00	RPLCP0040101	4100000	160000	N	ND	ND	Yes (7)	3100000	No
Trichloroethene	1/18	1	1.00	RPLCP0030101	520000	58000	C	ND	ND	Yes (7)	5000	No
Semivolatile Organic Compounds (µg/kg)												
Acenaphthene	1/18	38	38.00	RPLCP0020101	12000000	470000	N	ND	ND	Yes (7)	-	No
Acenaphthylene	1/18	600	600.00	RPLCP0020101	-	-	-	ND	ND	Yes (7)	-	No (9)
Anthracene	1/18	170	170.00	RPLCP0020101	61000000	2300000	N	ND	ND	Yes (7)	-	No
Benzo(a)anthracene	1/18	920	920.00	RPLCP0020101	7800	**880***	C	ND	ND	Yes (7)	-	No
Benzo(a)pyrene	1/18	1400	1400.00	RPLCP0020101	**780**	**88**	C	ND	ND	Yes (7)	-	Yes
Benzo(b)fluoranthene	1/18	1300	1300.00	RPLCP0020101	7800	**880**	C	ND	ND	Yes (7)	-	No
Benzo(g,h,i)perylene	2/18	37-1500	768.50	RPLCP0020101	-	-		ND	ND	Yes (7)	-	No (9)
Benzo(k)fluoranthene	1/18	970	970.00	RPLCP0020101	78000	8800	C	ND	ND	Yes (7)	-	No
Bis(2-ethylhexyl)phthalate	4/18	57-270	153.25	RPLSB0020101	410000	46000	C	640	ND	No	31000000	No
Chrysene	1/18	970	970.00	RPLCP0020101	780000	88000	C	ND	ND	Yes (7)	-	No
Fluoranthene	1/18	1000	1000.00	RPLCP0020101	8200000	310000	N	ND	ND	Yes (7)	-	No
Fluorene	1/18	96	96.00	RPLCP0020101	8200000	310000	N	ND	ND	Yes (7)	-	No
Indeno(1,2,3-cd)pyrene	1/18	1200	1200.00	RPLCP0020101	7800	**880**	C	ND	ND	Yes (7)	-	No
Naphthalene	1/18	40	40.00	RPLCP0020101	8200000	310000	N	ND	ND	Yes (7)	-	No
Phenanthrene	1/18	440	440.00	RPLCP0020101	-	-		ND	ND	Yes (7)	-	No (9)
Pyrene	2/18	59-1800	929.50	RPLCP0020101	6100000	230000	N	ND	ND	Yes (7)	-	No
Inorganics (mg/kg)												
Antimony	10/18	0.31-1	0.51	RPLSB0020201	82	3.1	N	ND	3.6	No	-	No
Arsenic	17/18	1.9-39.6	8.74	RPLSB0020201	**3.8**	**0.43**	C	4.25	24.4	Yes	750	Yes
Barium	18/18	8.2-42.7	22.21	RPLCP0040101	14000	550	N	144	191	No	690000	No
Beryllium	18/18	0.19-1.9	0.74	RPLSB0020201	**1.3**	**0.15**	C	0.905	2.46	No	1300	No
Cadmium	11/18	0.15-1.5	0.67	RPLSB0020201	100	3.9	N	0.26	0.388	Yes	1800	No
Chromium (10)	18/18	5.9-113	44.01	RPLSB0040101	1000	**39**	N	24.2	101	Yes	270	No
Cobalt	18/18	0.25-4.6	2.05	RPLCP0030101	12000	470	N	39.7	133	No	-	No
Copper	7/18	5.2-12.9	8.64	RPLCP0020101	8200	310	N	18.7	56.5	No	-	No
Lead	18/18	3.2-20.3	7.29	RPLCP0020101	2000 (11)	400 (11)	N	149	37.5	No	-	No
Mercury	12/18	0.02-0.31	0.06	RPLCP0020101	61	2.3	N	0.087	0.13	Yes	10	No
Nickel	18/18	1.9-25.8	8.23	RPLSB0020201	4100	160	N	18.2	22.1	Yes	13000	No
Selenium	18/18	0.3-3.6	1.62	RPLSB0020201	1000	39	N	1.09	8.93	No	-	No
Thallium	5/18	0.66-2.7	1.28	RPLSB0040301	14 (12)	**0.55 (12)**	N	ND	3.10	No	-	No
Tin	1/18	4.1	4.10	RPLSB0020201	100000	4700	N	ND	ND	Yes (7)	-	No
Vanadium	18/18	8.5-84.2	37.45	RPLSB0040101	1400	**55**	N	53.5	133	No	-	No
Zinc	18/18	8.2-100	30.59	RPLSB0020201	61000	2300	N	38.1	79.5	Yes	-	No

* Screening levels exceeded by maximum site concentration have been bolded.

TABLE 6-11

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT
ALL SOIL - SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 Soil Screening Levels (SSLs) for transfers from soil to air (USEPA, 1996) included for qualitative evaluation only.
6 ND = not detected; NA = not applicable.
7 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
Organic background data presented for information purposes, but not for COPC selection.
8 Data not available.
9 Sufficient toxicity criteria not available; maximum concentration below screening levels of related chemicals (naphthalene, fluoranthene,fluorene).
10 Considered as hexavalent chromium.
11 OSWER screening level for lead in soil (USEPA, 1993).
12 Toxicity criteria for thallic oxide used.

TABLE 6-12

SOIL CONCENTRATION VERSUS SOIL SCREENING LEVELS (SSLs) FOR PROTECTION OF GROUNDWATER
ALL SOIL - SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Upper Tolerance Limit for Background		Greater Than Background?	SSL Transfer from Soil to GW-20DAF(3)
					Surface	Subsurface		
Volatile Organic Compounds (µg/kg)								
4-Methyl-2-pentanone	1/18	3	3.00	RPLCP0020101	ND (4)	ND	Yes (5)	(6)
Acetone	6/18	23-5000	1583.79	RPLSB0020201	13000	1800	Yes	16000
Carbon disulfide	1/18	6	6.00	RPLSB0010101	ND	ND	Yes (5)	32000
Toluene	1/18	2	2.00	RPLSS0040101	ND	ND	Yes (5)	12000
Trans-1,2-dichloroethene	1/18	1	1.00	RPLCP0040101	ND	ND	Yes (5)	700
Trichloroethene	1/18	1	1.00	RPLCP0030101	ND	ND	Yes (5)	60
Semivolatile Organic Compounds (µg/kg)								
Acenaphthene	1/18	38	38.00	RPLCP0020101	ND	ND	Yes (5)	570000
Acenaphthylene	1/18	600	600.00	RPLCP0020101	ND	ND	Yes (5)	-
Anthracene	1/18	170	170.00	RPLCP0020101	ND	ND	Yes (5)	12000000
Benzo(a)anthracene	1/18	920	920.00	RPLCP0020101	ND	ND	Yes (5)	2000
Benzo(a)pyrene	1/18	1400	1400.00	RPLCP0020101	ND	ND	Yes (5)	8000
Benzo(b)fluoranthene	1/18	1300	1300.00	RPLCP0020101	ND	ND	Yes (5)	5000
Benzo(g,h,i)perylene	2/18	37-1500	768.50	RPLCP0020101	ND	ND	Yes (5)	-
Benzo(k)fluoranthene	1/18	970	970.00	RPLCP0020101	ND	ND	Yes (5)	49000
Bis(2-ethylhexyl)phthalate	4/18	57-270	153.25	RPLSB0020101	640	ND	No	3600000
Chrysene	1/18	970	970.00	RPLCP0020101	ND	ND	Yes (5)	160000
Fluoranthene	1/18	1000	1000.00	RPLCP0020101	ND	ND	Yes (5)	4300000
Fluorene	1/18	96	96.00	RPLCP0020101	ND	ND	Yes (5)	560000
Indeno(1,2,3-cd)pyrene	1/18	1200	1200.00	RPLCP0020101	ND	ND	Yes (5)	14000
Naphthalene	1/18	40	40.00	RPLCP0020101	ND	ND	Yes (5)	84000
Phenanthrene	1/18	440	440.00	RPLCP0020101	ND	ND	Yes (5)	-
Pyrene	2/18	59-1800	929.50	RPLCP0020101	ND	ND	Yes (5)	4200000
Inorganics (mg/kg)								
Antimony	10/18	0.31-1	0.51	RPLSB0020201	ND	3.6	No	5
Arsenic	17/18	1.9-39.6	8.74	RPLSB0020201	4.25	24.4	Yes	**29***
Barium	18/18	8.2-42.7	22.21	RPLCP0040101	144	191	No	1600
Beryllium	18/18	0.19-1.9	0.74	RPLSB0020201	0.905	2.46	No	63
Cadmium	11/18	0.15-1.5	0.67	RPLSB0020201	0.26	0.388	Yes	8
Chromium (7)	18/18	5.9-113	44.01	RPLSB0040101	24.2	101	Yes	**38**
Cobalt	18/18	0.25-4.6	2.05	RPLCP0030101	39.7	133	No	-
Copper	7/18	5.2-12.9	8.64	RPLCP0020101	18.7	56.5	No	-

TABLE 6-12

SOIL CONCENTRATION VERSUS SOIL SCREENING LEVELS (SSLs) FOR PROTECTION OF GROUNDWATER
ALL SOIL - SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Upper Tolerance Limit for Background		Greater Than Background?	SSL Transfer from Soil to GW-20DAF(3)
					Surface	Subsurface		
Lead	18/18	3.2-20.3	7.29	RPLCP0020101	149	37.5	No	-
Mercury	12/18	0.02-0.31	0.06	RPLCP0020101	0.087	0.13	Yes	2
Nickel	18/18	1.9-25.8	8.23	RPLSB0020201	18.2	22.1	Yes	130
Selenium	18/18	0.3-3.6	1.62	RPLSB0020201	1.09	8.93	No	5
Thallium	5/18	0.66-2.7	1.28	RPLSB0040301	ND	3.10	No	**0.7**
Tin	1/18	4.1	4.10	RPLSB0020201	ND	ND	Yes (5)	-
Vanadium	18/18	8.5-84.2	37.45	RPLSB0040101	53.5	133	No	6000
Zinc	18/18	8.2-100	30.59	RPLSB0020201	38.1	79.5	Yes	12000

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Soil Screening Levels (SSLs) for migration from soil to groundwater (USEPA, 1996) corresponding to a dilution and attenuation factor (DAF) of 20.
4 ND = not detected; NA = not applicable.
5 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
Organic background data presented for information purposes, but not for COPC selection.
6 Data not available.
7 Considered as hexavalent chromium.

TABLE 6-13A

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT
UNFILTERED GROUNDWATER - SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	UTL for Background (5)	Greater Than Background?	Selected as COPC?
Volatile Organic Compounds (µg/L)									
Acetone	1/3	95	95	RPLMW002U001	370	N	ND (6)	Yes (7)	No
Semivolatile Organic Compounds (µg/L)									
Bis(2-ethylhexyl)phthalate	1/3	4	4.00	RPLMW003U001	4.8	C	1	Yes	No
Inorganics (ug/L)									
Arsenic	1/3	3	3.00	RPLMW003U001	**0.045***	C	ND	Yes (7)	Yes
Barium	3/3	26.4-64.3	48.83	RPLMW003U001	260	N	253.5	No	No
Chromium (8)	3/3	8-29.6	17.87	RPLMW004U001	18	N	20.9	Yes	Yes
Cobalt	2/3	0.78-1.2	0.99	RPLMW004U001	220	N	39.6	No	No
Copper	1/3	7.4	7.40	RPLMW004U001	150	N	22.4	No	No
Mercury	1/3	0.1	0.10	RPLMW003U001	1.1	N	0.13	No	No
Nickel	2/3	11.8-15.3	13.55	RPLMW004U001	73	N	39	No	No
Vanadium	3/3	0.85-6.8	3.15	RPLMW003U001	26	N	24.1	No	No
Zinc	2/3	6-12.6	9.30	RPLMW004U001	1100	N	45.2	No	No

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 Only nonturbid background samples included.
6 ND = not detected; NA = not applicable.
7 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
Organic background data presented for information purposes, but not for COPC selection.
8 Considered as hexavalent chromium.

TABLE 6-13B

FILTERED GROUNDWATER VERSUS SCREENING LEVELS
FILTERED GROUNDWATER - SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	Upper Tol. Limit for Background	Greater Than Background?
Inorganics (µg/L)								
Arsenic, Filtered	1/3	2.2	2.20	RPLMW003F001	**0.045***	C	ND (5)	Yes (6)
Barium, Filtered	3/3	24.7-60.9	47.13	RPLMW002F001	260	N	114	No
Cobalt, Filtered	1/3	0.83	0.83	RPLMW004F001	220	N	13	No
Copper, Filtered	1/3	3.3	3.30	RPLMW004F001	150	N	3.8	No
Mercury, Filtered	1/3	0.14	0.14	RPLMW003F001	1.1	N	0.16	No
Nickel, Filtered	2/3	6.8-12.3	9.55	RPLMW004F001	73	N	41.4	No
Zinc, Filtered	2/3	6.9-8.4	7.65	RPLMW004F001	1100	N	10.3	No

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6. Unfiltered data and screening levels presented only for qualitative analysis, not for COPC selection.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 ND = not detected; NA = not applicable.
6 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background. Organic background data presented for information purposes, but not for COPC selection.

TABLE 6-14

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT
SURFACE WATER - SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	Biocon-centration Factor (5)	Estimated Maximum Fish Conc. (6)	Risk-Based Screening Level, Fish (3)	Selected as COPC?
Volatile Organics (µg/L)										
Carbon disulfide	1/3	7	7	RPLSW0020001	100	N	10 (7)	70	140000	No
Semivolatile Organics (µg/L)										
Di-n-butyl phthalate	1/3	1	3.25	RPLSW0020001	370	N	89	89	140000	No
Inorganics (µg/L)										
Barium	3/3	22.9-33.6	28.93	RN6SW0030001	260	N	10 (7)	336	95000	No
Vanadium	2/3	0.87-1.1	0.99	RN6SW0040001	26	N	10 (7)	11	9500	No
Zinc	3/3	3.9-9.9	6.63	RN6SW0040001	1100	N	47	465	410000	No

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 USEPA, June 14, 1991 unless otherwise noted.
6 Estimated by multiplying Bioconcentration Factor times maximum site concentration.
7 Factor assumed, because no value is available.

TABLE 6-15

SELECTION OF CHEMCIALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT
SEDIMENT - SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tol. Limit for Background	Greater Than Background?	Selected as COPC?
					Industrial	Residential				
Semivolatile Organic Compounds (µg/kg)										
Di-n-octyl phthalate	1/3	44	44.00	RPLSD0020001-D	410000	160000	N	ND (5)	Yes (6)	No
Inorganics (mg/kg)										
Arsenic	3/3	0.63-2.6	1.40	RPLSD0010001	3.8	**0.43***	C	63	No	No
Barium	3/3	3.9-13	7.63	RPLSD0010001	14000	550	N	577	No	No
Beryllium	2/3	0.16-0.21	0.19	RPLSD0010001	1.3	**0.15**	C	10.9	No	No
Cadmium	3/3	0.16-0.54	0.34	RPLSD0010001	100	3.9	N	1.85	No	No
Chromium (7)	3/3	5.3-15.4	9.73	RPLSD0010001	1000	39	N	79.2	No	No
Cobalt	3/3	0.4-0.87	0.57	RPLSD0010001	12000	470	N	118	No	No
Copper	3/3	0.67-2.9	1.45	RPLSD0010001	8200	310	N	297	No	No
Lead	3/3	1.6-5.4	3.35	RPLSD0010001	2000 (8)	400 (8)	N	476	No	No
Mercury	2/3	0.03	0.03	LSD0010001, RPLSD0020001	61	2.3	N	0.778	No	No
Nickel	3/3	0.64-2.6	1.32	RPLSD0010001	4100	160	N	382	No	No
Selenium	3/3	0.35-0.96	0.53	RPLSD0010001	1000	39	N	6.45	No	No
Vanadium	3/3	4.6-15.7	9.18	RPLSD0010001	1400	55	N	196	No	No
Zinc	3/3	4.5-11.4	7.67	RPLSD0010001	61000	2300	N	1660	No	No

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 ND = not detected; NA = not applicable.
6 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
Organic background data presented for information purposes, but not for COPC selection.
7 Considered as hexavalent chromium.
8 OSWER screening level for lead in soil (USEPA, 1993).

TABLE 6-16

CHEMICALS OF POTENTIAL CONCERN AND EXPOSURE CONCENTRATIONS
SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC, INDIAN HEAD, MARYLAND

Medium	Organics		Inorganics	
	Chemical	Exposure Point Concentration[1]	Chemical	Exposure Point Concentration[1]
Surface Soil	Benzo(a)pyrene	1.4 mg/kg (max.)	Arsenic	5.85 mg/kg (max.) 3.77mg/kg (ave.)
All Soil (Surface/ Subsurface Soil)	Benzo(a)pyrene	1.4 mg/kg (max.)	Arsenic	17.1 mg/kg
Sediments	None[2]	-	None[2]	-
Groundwater (Unfiltered)	None[2]	-	Arsenic Chromium III[3] Chromium VI[3]	3.00 µg/L (max.) 26.6µg/L (max) 16.1 µg/L (ave.) 3.00µg/L (max.) 1.80 µg/L (ave.)
Surface Water/Fish Tissue	None[2]	-	None[2]	-

1 95 Percent UCLs of the arithmetic mean were used as exposure point concentrations for RME and CTE, unless they exceeded the maximum concentration or fewer than 10 sample were analyzed. In these instances, the maximum concentrations were used for the RME. The mean of positive detects for data sets with fewer than 10 samples (if less than the maximum) were used for the CTE. Statistics for distribution of data sets and 95 percent UCLs are presented in Appendix I.

2 No maximum analyte concentrations exceeded screening levels and\or background concentrations.

3 10 Percent evaluated as hexavalent chromium and 90 percent evaluated as trivalent chromium.

TABLE 6-17

SUMMARY OF EXPOSURE SCENARIOS FOR
SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC, INDIAN HEAD, MARYLAND

Medium	Receptor	Exposure Route
Current Scenario		
Surface Soil[1]	Adolescent Trespasser	Incidental Ingestion Dermal Contact
Future Scenario		
Surface Soil	Maintenance Worker/ Full-Time Employee	Incidental Ingestion Dermal Contact
	Adolescent Trespasser	Incidental Ingestion Dermal Contact
Surface/Subsurface Soil[2]	Construction Worker	Incidental Ingestion Dermal Contact
Groundwater	Construction Worker	Dermal Contact

1 Surface soil is defined as soil collected from depths of 0 to 2 feet bgs.

2 Surface soil/subsurface soil is defined as soil collected from depths of 0 to >10 feet bgs.

TABLE 6-18

SUMMARY OF CANCER RISKS AND HAZARD INDICES [1]
SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

EXPOSURE ROUTE	ADOLESCENT TRESPASSER [2]		MAINTENANCE WORKER [2]		FULL-TIME EMPLOYEE [2]		CONSTRUCTION WORKER [3]	
	RME [4]	CTE [5]	RME	CTE	RME	CTE	RME	CTE
INCREMENTAL CANCER RISK								
Soil								
Incidental Ingestion of Soil	9.0E-07	1.9E-07	8.0E-07	6.0E-08	4.0E-06	6.0E-07	7.2E-07	3.0E-07
Dermal Contact with Soil	6.3E-06	3.1E-06	6.0E-06	1.1E-06	3.0E-05	1.1E-05	1.4E-06	1.4E-06
Total Risk - Soil	**7.2E-06**	**3.3E-06**	**6.8E-06**	**1.2E-06**	**3.4E-05**	**1.2E-05**	**2.1E-06**	**1.7E-06**
Groundwater								
Dermal Contact with Groundwater	NA	NA	NA	NA	NA	NA	3.2E-09	1.6E-09
Cumulative Risk	**7.2E-06**	**3.3E-06**	**6.8E-06**	**1.2E-06**	**3.4E-05**	**1.2E-05**	**2.1E-06**	**1.7E-06**
HAZARD INDEX								
Soil								
Incidental Ingestion of Soil	0.0065	0.001	0.0023	0.00037	0.011	0.0037	0.08	0.033
Dermal Contact with Soil	0.0081	0.00052	0.0031	0.0002	0.015	0.002	0.045	0.009
Total Hazard Index - Soil	**0.015**	**0.0016**	**0.0054**	**0.00057**	**0.027**	**0.0057**	**0.13**	**0.042**
Groundwater								
Dermal Contact with Groundwater	NA	NA	NA	NA	NA	NA	0.0034	0.0011
Total Hazard Index	**0.015**	**0.0016**	**0.0054**	**0.00057**	**0.0**	**0.0057**	**0.13**	**0.043**

Notes:
1 - Chemical specific risks present in Appendix P.
2 - Adolescent trespasser, maintenance worker, and full-time employee are exposed to surface soil.
3 - Construction worker is exposed to surface/subsurface soil and groundwater.
4 - Reasonable Maximum Exposures
5 - Central Tendency Exposures
NA - Not applicable, exposure route not evaluated for this receptor.

TABLE 6-19A

QUALITATIVE EVALUATION OF UNFILTERED GROUNDWATER SAMPLES
SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	EPA Drinking Water Standard		EPA Drinking Water Health Advisories	
						MCL	MCLG	Value	Receptor
Volatile Organic Compounds (µg/L)									
Acetone	1/3	95	95	370	N	NA	NA	NA	NA
Semivolatile Organic Compounds (µg/L)									
Bis(2-Ethylhexyl)Phthalate	1/3	4	4.00	4.8	C	6	0	700	DWEL, 70-KG ADULT
Inorganics (µg/L)									
Arsenic	1/3	3	3.00	**0.045***	C	50	NA	NA	NA
Barium	3/3	26.4-64.3	48.83	260	N	2000	2000	2000	LIFETIME, 70-KG ADULT
Chromium (8)	3/3	8-29.6	17.87	**18**	N	100	100	100	LIFETIME, 70-KG ADULT
Cobalt	2/3	0.78-1.2	0.99	220	N	NA	NA	NA	NA
Copper	1/3	7.4	7.40	150	N	1300	1300	NA	NA
Mercury	1/3	0.1	0.10	1.1	N	2	2	2	LIFETIME, 70-KG ADULT
Nickel	2/3	11.8-15.3	13.55	73	N	100	100	100	LIFETIME, 70-KG ADULT
Vanadium	3/3	0.85-6.8	3.15	26	N	NA	NA	NA	NA
Zinc	2/3	6-12.6	9.30	1100	N	5000	NA	2000	LIFETIME, 70-KG ADULT

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
NA Data not available

TABLE 6-19B

QUALITATIVE EVALUATION OF FILTERED GROUNDWATER SAMPLES
SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	EPA Drinking Water Standard		EPA Drinking Water Health Advisories	
						MCL	MCLG	Value	Receptor
Inorganics (µg/L)									
Arsenic, Filtered	1/3	2.2	2.20	**0.045***	C	50	NA	NA	NA
Barium, Filtered	3/3	24.7-60.9	47.13	260	N	2000	2000	2000	LIFETIME, 70-KG ADULT
Cobalt, Filtered	1/3	0.83	0.83	220	N	NA	NA	NA	NA
Copper, Filtered	1/3	3.3	3.30	150	N	1300	1300	NA	NA
Mercury, Filtered	1/3	0.14	0.14	1.1	N	2	2	2	LIFETIME, 70-KG ADULT
Nickel, Filtered	2/3	6.8-12.3	9.55	73	N	100	100	100	LIFETIME, 70-KG ADULT
Zinc Filtered	2/3	6.9-8.4	7.65	1100	N	5000	NA	2000	LIFETIME, 70-KG ADULT

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6. Unfiltered data and screening levels presented only for qualitative analysis, not for COPC selection.
4 N = noncarcinogenic basis; C = carcinogenic basis.
NA Data not available

TABLE 6-20

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN
SWMU 1 - RUM POINT LANDFILL - SURFACE WATER
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	BTAG Screening Level	EEQ	Retained as PCOC?
		Min.	Max.				
Inorganics (µg/L)							
Barium	3/3	22.9	33.6	RPLSW0020001	1000	0.03	N
Vanadium	2/3	0.87	1.1	RPLSW0020001-D	10000	0.00	N
Zinc	3/3	3.9	9.9	RPLSW0030001	110	0.09	N
Semivolatile Organic Compounds (µg/L)							
Di-N-Butyl Phthalate	1/3	1	1	RPLSW0020001	0.3	3.33	Y
Carbon Disulfide	1/3	7	7	RPLSW0020001	2	3.50	Y

NA = Not Available
EEQ = Ecological Effects Quotient

TABLE 6-21

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN
SWMU 1 - RUM POINT LANDFILL - SEDIMENT
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	BTAG Screening Level	EEQ	Retained as PCOC?
		Min.	Max.				
Inorganics (mg/kg)							
Arsenic	3/3	0.63	2.6	RPLSD0010001	0.057	45.61	Y
Barium	3/3	3.9	13	RPLSD0010001	NA	NA	Y
Beryllium	2/3	0.16	0.21	RPLSD0010001	NA	NA	Y
Cadmium	3/3	0.16	0.54	RPLSD0010001	1.2	0.45	N
Chromium	3/3	5.3	15.4	RPLSD0010001	260	0.06	N
Cobalt	3/3	0.4	0.87	RPLSD0010001	NA	NA	Y
Copper	3/3	0.67	2.9	RPLSD0010001	34	0.09	N
Lead	3/3	1.6	5.4	RPLSD0010001	46.7	0.12	N
Mercury	2/3	0.03	0.03	RPLSD0010001	0.15	0.20	N
Nickel	3/3	0.64	2.6	RPLSD0010001	20.9	0.12	N
Selenium	3/3	0.35	0.96	RPLSD0010001	NA	NA	Y
Vanadium	3/3	4.6	15.7	RPLSD0010001	NA	NA	Y
Zinc	3/3	4.5	11.4	RPLSD0010001	150	0.08	N
Semivolatile Organic Compounds (µg/kg)							
Di-N-Octyl Phthalate	1/3	44	44	RPLSD0020001-D	6200	0.00	N

NA = Not Available
EEQ = Ecological Effects Quotient

TABLE 6-22

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN FOR SWMU 1
SWMU 1 - RUM POINT LANDFILL - SURFACE SOIL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD CDIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	BTAG Screening Level	EEQ	Retained as PCOC?
		Min.	Max.				
Inorganics (mg/kg)							
Antimony	2/7	0.31	0.31	RPLSS0020101	0.48	0.65	N
Arsenic	6/7	1.9	6.2	RPLCP0010101	328	0.02	N
Barium	7/7	14.5	42.7	RPLCP0040101	440	0.10	N
Beryllium	7/7	0.19	0.42	RPLCP0010101	0.02	21.00	Y
Cadmium	3/7	0.15	0.33	RPLSS0020101	2.5	0.13	N
Chromium	7/7	5.9	24.9	RPLCP0010101	0.02	1245.00	Y
Cobalt	7/7	1.6	4.6	RPLCP0030101	200	0.02	N
Copper	4/7	6.7	12.9	RPLCP0020101	15	0.86	N
Lead	7/7	4.3	20.3	RPLCP0020101	0.01	2030.00	Y
Mercury	6/7	0.02	0.31	RPLCP0020101	0.058	5.34	Y
Nickel	7/7	3.7	8.7	RPLCP0030101	2	4.35	Y
Selenium	7/7	0.3	1.1	RPLCP0010101	1.8	0.61	N
Thallium	2/7	0.66	0.66	RPLSS0040101-D	1	0.66	N
Vanadium	7/7	8.5	31.5	RPLCP0040101	58	0.54	N
Zinc	7/7	10.2	32	RPLCP0040101	10	3.20	Y
Semivolatile Organic Compounds (µg/kg)							
Acenaphthene	1/7	38	38	RPLCP0020101	100	0.38	N
Acenaphthylene	1/7	600	600	RPLCP0020101	100	6.00	Y
Anthracene	1/7	170	170	RPLCP0020101	100	1.70	Y
Benzo(a)anthracene	1/7	920	920	RPLCP0020101	100	9.20	Y
Benzo(a)pyrene	1/7	1400	1400	RPLCP0020101	100	14.00	Y
Benzo(b)fluoranthene	1/7	1300	1300	RPLCP0020101	100	13.00	Y

TABLE 6-22

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN FOR SWMU 1
SWMU 1 - RUM POINT LANDFILL - SURFACE SOIL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD CDIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	BTAG Screening Level	EEQ	Retained as PCOC?
		Min.	Max.				
Benzo(g,h,i)perylene	2/7	37	1500	RPLCP0020101	100	15.00	Y
Benzo(k)fluoranthene	1/7	970	970	RPLCP0020101	100	9.70	Y
Bis(2-ethylhexyl)phthalate	1/7	96	96	RPLSS0020101	NA	NA	Y
Chrysene	1/7	970	970	RPLCP0020101	100	9.70	Y
Fluoranthene	1/7	1000	1000	RPLCP0020101	100	10.00	Y
Fluorene	1/7	96	96	RPLCP0020101	100	0.96	N
Indeno(1,2,3-cd)pyrene	1/7	1200	1200	RPLCP0020101	100	12.00	Y
Naphthalene	1/7	40	40	RPLCP0020101	100	0.40	N
Phenanthrene	1/7	440	440	RPLCP0020101	100	4.40	Y
Pyrene	2/7	59	1800	RPLCP0020101	100	18.00	Y
4-Methyl-2-pentanone	1/7	3	3	RPLCP0020101	NA	NA	Y
Volatile Organic Compounds (μg/kg)							
Acetone	3/7	23	70	RPLCP0010101	NA	NA	Y
Toluene	1/7	2	2	RPLSS0040101	100	0.02	N
Trans-1,2-Dichloroethene	1/7	1	1	RPLCP0040101	870000	0.00	N
Trichloroethene	1/7	1	1	RPLCP0030101	300	0.00	N

NA = Not Available
EEQ = Ecological Effects Quotient

TABLE 6-23

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN
SWMU 1 - RUM POINT LANDFILL - GROUNDWATER
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	AWQC	EEQ	Retained as PCOC?
		Min.	Max.				
Inorganics (mg/kg)							
Arsenic	1/3	3	3	RPLMW003U001	8.1	0.37	N
Barium	3/3	26.4	64.3	RPLMW003U001	3.9	16.49	Y
Chromium	3/3	8	29.6	RPLMW004U001	10	2.96	Y
Cobalt	2/3	0.78	1.2	RPLMW004U001	3	0.40	N
Copper	1/3	7.4	7.4	RPLMW004U001	11	0.67	N
Mercury	1/3	0.1	0.1	RPLMW003U001	0.003	33.33	Y
Nickel	2/3	11.8	15.3	RPLMW004U001	160	0.10	N
Vanadium	3/3	0.85	6.8	RPLMW003U001	19	0.36	N
Zinc	2/3	6	12.6	RPLMW004U001	100	0.13	N
Semivolatile Organic Compounds (µg/L)							
Bis(2-Ethylhexyl)Phthalate	1/3	4	4	RPLMW003U001	32	0.13	N
Volatile Organic Compounds (µg/L)							
Acetone	1/3	95	95	RPLMW002U001	NA	NA	Y

NA = Not Available
EEQ = Ecological Effects Quotient

TABLE 6-24

RESULTS OF TERRESTRIAL FOODCHAIN MODELING FOR SWMU 1 - RUM POINT LANDFILL
MAXIMUM CONCENTRATIONS
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Potential Concern	Shrew		Hawk		Fox		Vole		Woodcock	
	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI
Inorganics (mg/kg)										
Beryllium	0.53	0.05	NA	NA	0.10	0.01	0.28	0.03	NA	NA
Chromium	100.26	10.03	104.80	10.48	19.60	1.96	52.50	5.25	136.57	1.37
Lead	92.63	9.26	28.48	2.85	18.11	1.81	48.50	4.85	37.11	3.71
Mercury	4.24	0.42	13.05	1.30	4.15	0.41	2.22	0.22	14.17	1.42
Nickel	0.10	0.00	0.05	0.03	0.02	0.00	0.05	0.00	0.06	0.04
Zinc	0.88	0.09	0.97	0.10	0.17	0.02	0.46	0.05	1.26	0.13
Semivolatile Organic Compounds (µg/kg)										
Acenaphthylene	0.32	0.16	0.03	0.00	0.06	0.03	0.17	0.08	0.03	0.00
Anthracene	0.09	0.04	0.00	0.00	0.02	0.00	0.05	0.02	0.00	0.00
Benzo(a)anthracene	0.48	0.24	0.04	0.00	0.09	0.05	0.25	0.13	0.05	0.00
Benzo(a)pyrene	0.74	0.37	0.06	0.00	0.14	0.07	0.39	0.19	0.08	0.00
Benzo(b)fluoranthene	0.68	0.34	0.05	0.00	0.13	0.07	0.36	0.18	0.07	0.00
Benzo(g,h,i)perylene	0.79	0.39	0.06	0.00	0.15	0.08	0.41	0.21	0.08	0.00
Benzo(k)fluoranthene	0.51	0.26	0.04	0.00	0.10	0.05	0.27	0.13	0.05	0.00
Bis(2-ethylhexyl)phthalate	0.04	0.00	NA	NA	0.00	0.00	0.02	0.00	NA	NA
Chrysene	0.51	0.26	0.04	0.00	0.10	0.05	0.27	0.13	0.05	0.00
Fluoranthene	0.53	0.26	0.04	0.00	0.10	0.05	0.28	0.14	0.05	0.00
Indeno(1,2,3-cd)pyrene	0.63	0.32	0.05	0.00	0.12	0.06	0.33	0.17	0.07	0.00
Phenanthrene	0.23	0.12	0.02	0.00	0.05	0.02	0.12	0.06	0.02	0.00
Pyrene	0.95	0.47	0.08	0.00	0.19	0.09	0.50	0.25	0.10	0.00
4-Methyl-2-pentanone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds (µg/kg)										
Acetone	0.00	0.00	NA	NA	0.00	0.00	0.00	0.00	NA	NA

NA = Not Available
EEI = Ecological Effects Index

TABLE 6-25

RESULTS OF TERRESTRIAL FOODCHAIN MODELING FOR SWMU 1 - RUM POINT LANDFILL
MEAN CONCENTRATIONS
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Shrew		Hawk		Fox		Vole		Woodcock	
	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI
Inorganics (mg/kg)										
Beryllium	0.35	0.03	NA	NA	0.07	0.00	0.18	0.02	NA	NA
Chromium	63.50	6.35	66.38	6.64	12.41	1.24	33.25	3.32	86.50	0.86
Lead	53.71	5.37	16.51	1.65	10.50	1.05	28.12	2.81	21.52	2.15
Mercury	1.07	0.11	3.27	0.33	1.04	0.10	0.56	0.06	3.56	0.36
Nickel	0.07	0.00	0.03	0.02	0.01	0.00	0.03	0.00	0.04	0.03
Zinc	0.61	0.06	0.68	0.07	0.12	0.01	0.32	0.03	0.88	0.09
Semivolatile Organic Compounds (µg/kg)										
Acenaphthylene	0.09	0.04	0.00	0.00	0.02	0.00	0.05	0.02	0.00	0.00
Anthracene	0.10	0.05	0.00	0.00	0.02	0.00	0.05	0.03	0.01	0.00
Benzo(a)anthracene	0.15	0.08	0.01	0.00	0.03	0.01	0.08	0.04	0.02	0.00
Benzo(a)pyrene	0.19	0.09	0.02	0.00	0.04	0.02	0.10	0.05	0.02	0.00
Benzo(b)fluoranthene	0.18	0.09	0.01	0.00	0.04	0.02	0.10	0.05	0.02	0.00
Benzo(g,h,i)perylene	0.19	0.09	0.01	0.00	0.04	0.02	0.10	0.05	0.02	0.00
Benzo(k)fluoranthene	0.16	0.08	0.01	0.00	0.03	0.02	0.08	0.04	0.02	0.00
Bis(2-ethylhexyl)phthalate	0.00	0.00	NA	NA	0.00	0.00	0.00	0.00	NA	NA
Chrysene	0.16	0.08	0.01	0.00	0.03	0.02	0.08	0.04	0.02	0.00
Fluoranthene	0.16	0.08	0.01	0.00	0.03	0.02	0.08	0.04	0.02	0.00
Indeno(1,2,3-cd)pyrene	0.17	0.09	0.01	0.00	0.03	0.02	0.09	0.05	0.02	0.00
Phenanthrene	0.12	0.06	0.00	0.00	0.02	0.01	0.06	0.03	0.01	0.00
Pyrene	0.21	0.11	0.02	0.00	0.04	0.02	0.11	0.06	0.02	0.00
4-Methyl-2-pentanone	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile Organic Compounds (µg/kg)										
Acetone	0.00	0.00	NA	NA	0.00	0.00	0.00	0.00	NA	NA

NA = Not Available
EEI = Ecological Effects Index

TABLE 6-26

RISK MANAGEMENT CONSIDERATIONS FOR SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Frequency of Detection	Range of Detections		Location of Maximum	Mean Concentration	BTAG Screening Level	Alternate Guideline(s)1	Max/Mean Background	Retained as Final PCOC?
		Minimum	Maximum						
Surface Water (µg/L)									
Di-n-butyl phthalate	1/3	1	1	RPLSW0020001	3.25	0.3	33	NA	N
Carbon disulfide	1/3	7	7	RPLSW0020001	7	2	NA	NA	N
Sediment2,3									
Arsenic	3/3	0.63	2.6	RPLSD0010001	1.4	0.057	6/33	10.6/3.3	N
Barium	3/3	3.9	13	RPLSD0010001	7.63	NA	NA	175/42	N
Beryllium	2/3	0.16	0.21	RPLSD0010001	0.14	NA	NA	1/0.52	N
Cobalt	3/3	0.4	0.87	RPLSD0010001	0.57	NA	NA	17.6/5.97	N
Selenium	3/3	0.35	0.96	RPLSD0010001	0.53	NA	NA	2.3/0.93	N
Vanadium	3/3	4.6	15.7	RPLSD0010001	9.18	NA	NA	158/41.2	N
Surface Soil [3]									
Chromium	7/7	5.9	24.9	RPLCP0010101	15.8	0.02	0.4/10	20.8/12	N
Lead	7/7	4.3	20.3	RPLCP0020101	11.8	0.01	500/900	149/20	N
Mercury	6/7	0.02	0.31	RPLCP0020101	0.078	0.058	0.1/309	0.08/0.04	N
Zinc	7/7	10.2	32.0	RPLCP0040101	22.2	10	200/100	30.8/18.1	N
4-Methyl-2-Pentanone	1/7	3	3	RPLCP0020101	2.89	NA	NA	ND	N

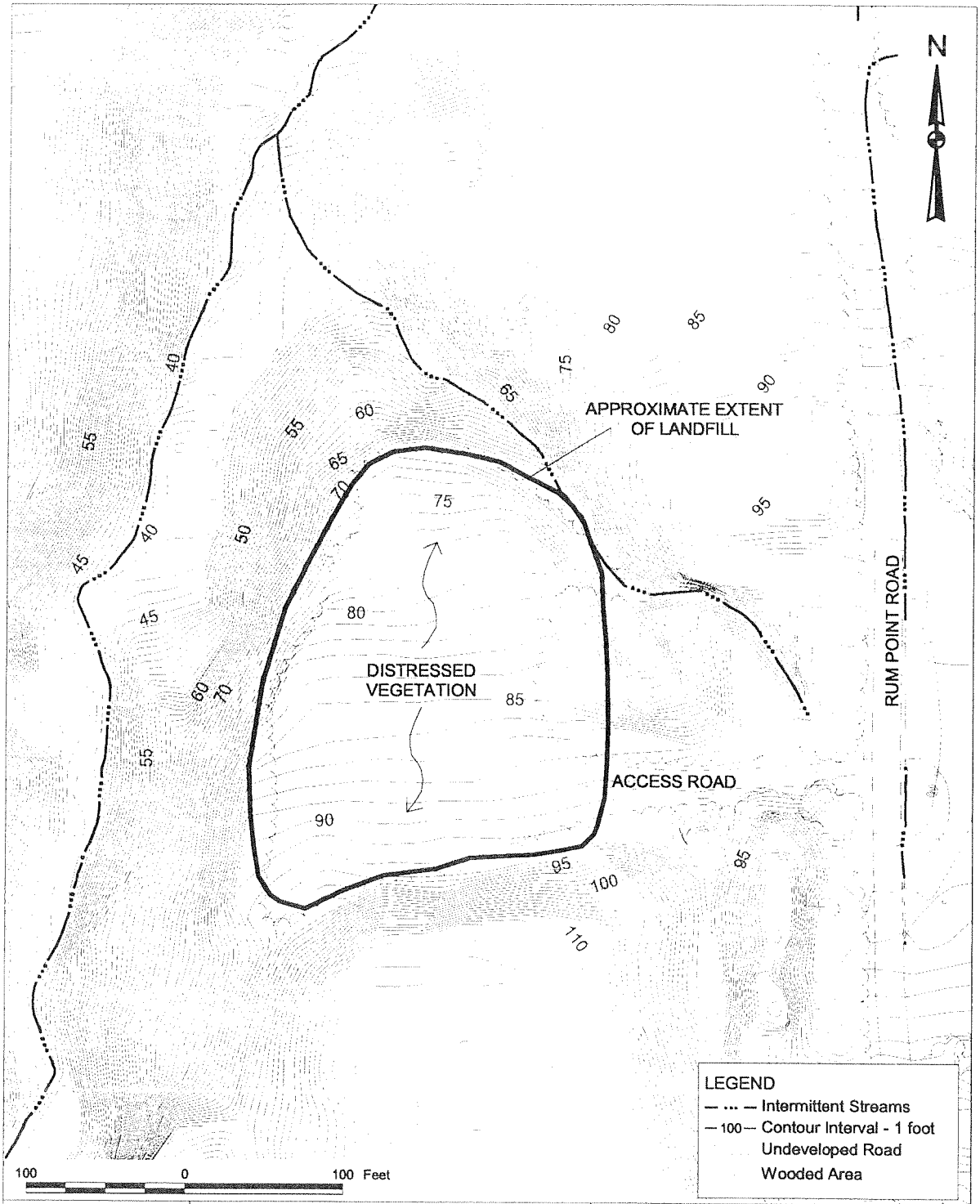
1 Alternate guidelines are as follows: surface water = AWQC or Tier 2 values (USEPA, 1996); sediment = MOE LELS and SELs (MOE, 1992); soil = ORNL screening levels for earthworms/soil microbes (when 2 values are present) (Will and Suter, 1995) or Dutch guidelines (when one value is present) (NMHSP&E, 1994)

2 Since no aquatic foodchain modeling was appropriate at this site, these are PCOCs from screening vs. BTAG screening levels

3 Inorganics = mg/kg, organics = ug/kg

NA = Not Available

ND = Not Detected



DRAWN BY: D. PERRY — DATE: 19-JAN-98	Brown & Root Environmental	CONTRACT NUMBER: 7581	OWNER No.: —
CHECKED BY — DATE	SITE CONDITIONS FIGURE SWMU 1 - RUM POINT LANDFILL RCRA FACILITY INVESTIGATION/ VERIFICATION INVESTIGATION REPORT STUMP NECK ANNEX, INDIAN HEAD DIVISION NSWC INDIAN HEAD, MARYLAND	APPROVED BY: JWR — DATE: 1-19-98	
COST/SCHEDULE-AREA		APPROVED BY: [signature] — DATE: 1-20-98	
SCALE: AS NOTED		DRAWING No.: FIGURE 6-1	REV: 0

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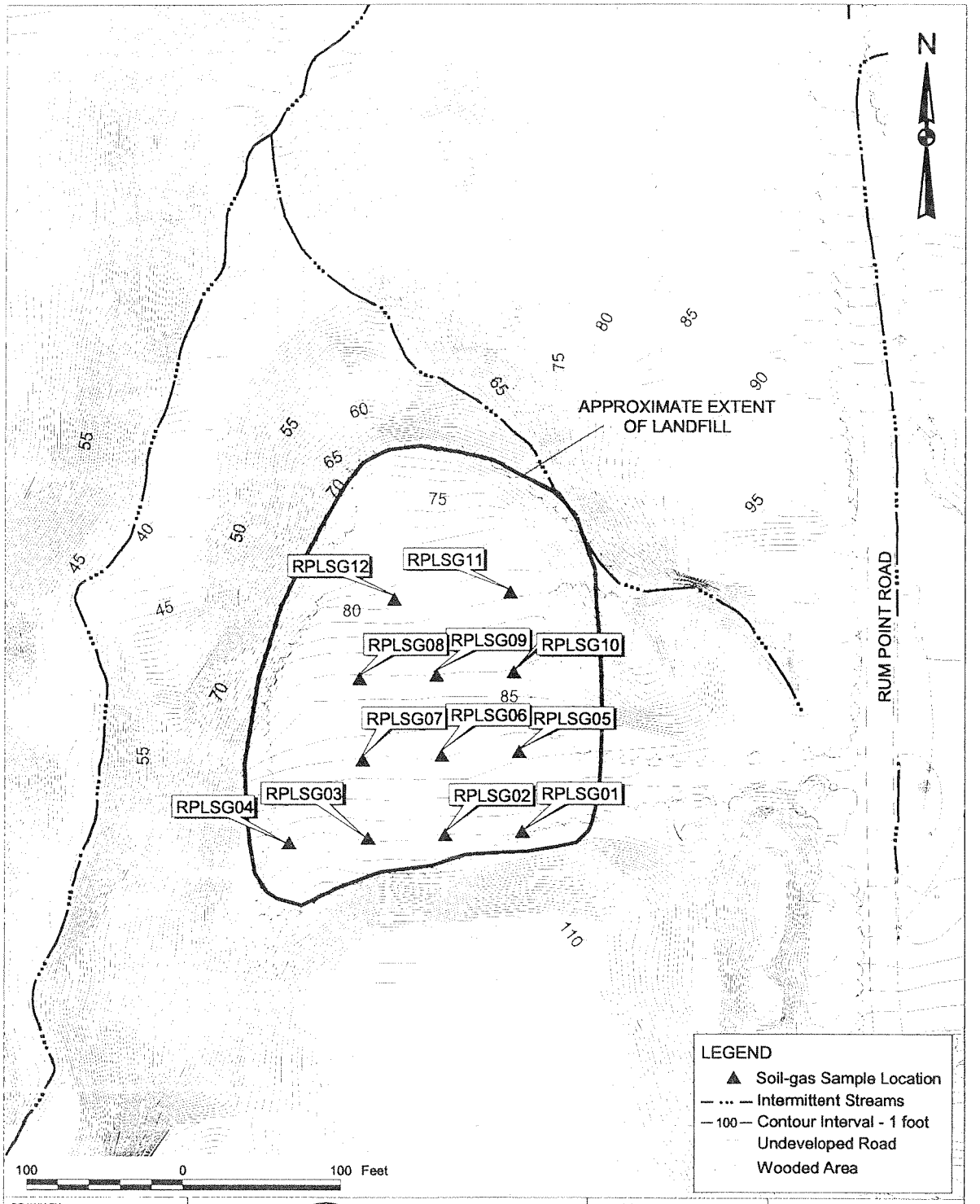

DRAWN BY D. PERRY	DATE 19-JAN-98	Brown & Root Environmental	CONTRACT NUMBER 7581 / OWNER No. —
CHECKED BY	DATE	SOIL-GAS SAMPLE LOCATIONS SWMU 1 - RUM POINT LANDFILL RCRA FACILITY INVESTIGATION/ VERIFICATION INVESTIGATION REPORT STUMP NECK ANNEX, INDIAN HEAD DIVISION NSWC INDIAN HEAD, MARYLAND	APPROVED BY JWR DATE 1-19-98
COST/SCHEDULE-AREA			APPROVED BY DMP DATE 1-20-98
SCALE AS NOTED			DRAWING No. FIGURE 6-2 / REV 0

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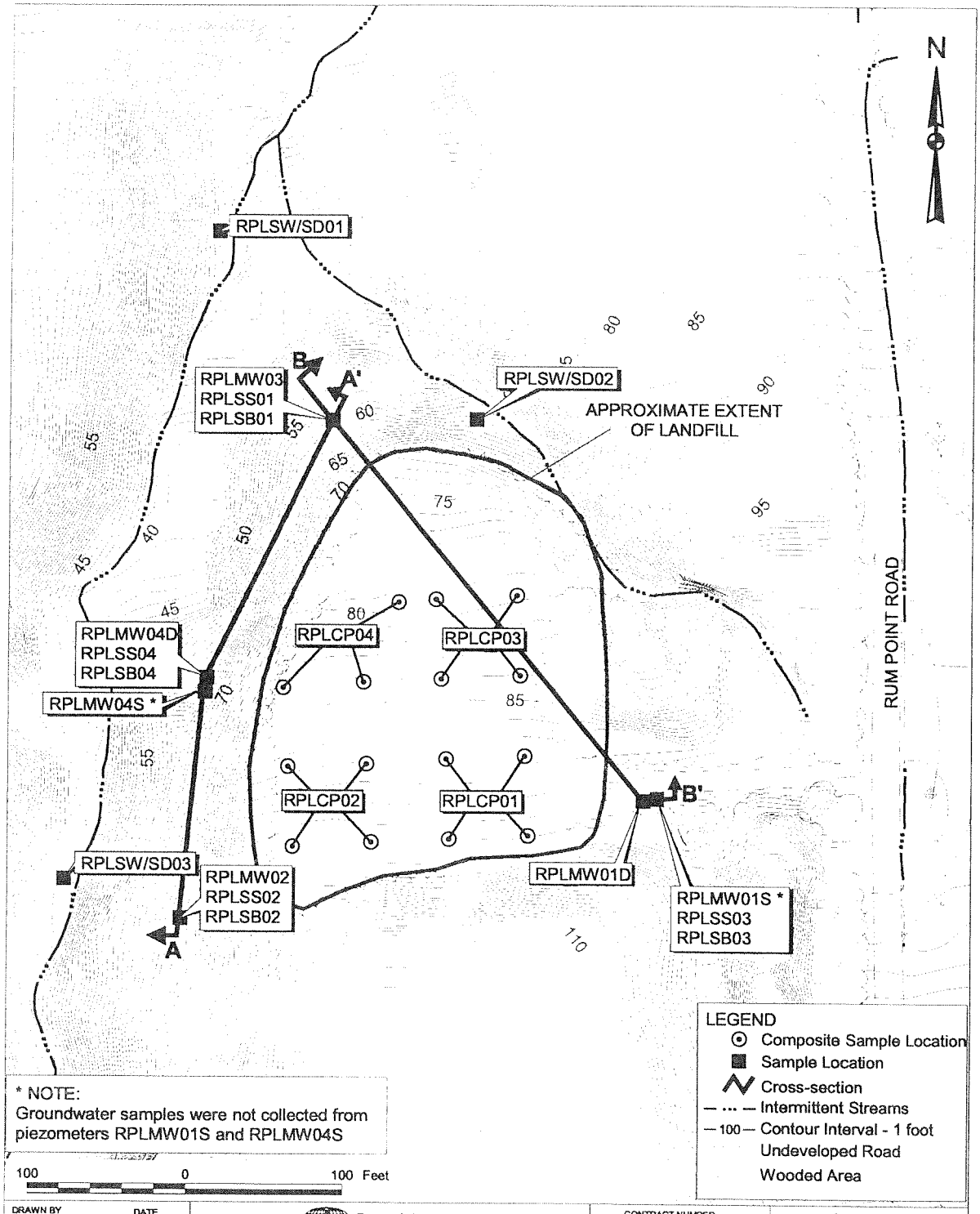

* NOTE:
Groundwater samples were not collected from piezometers RPLMW01S and RPLMW04S

DRAWN BY: D. PERRY	DATE: 19-JAN-98	Brown & Root Environmental	CONTRACT NUMBER: 7581	OWNER No.: —
CHECKED BY:	DATE:	CROSS-SECTION, SAMPLE, AND COMPOSITE SAMPLE LOCATIONS SWMU 1 - RUM POINT LANDFILL RCRA FACILITY INVESTIGATION/ VERIFICATION INVESTIGATION REPORT STUMP NECK ANNEX, INDIAN HEAD DIVISION NSWC INDIAN HEAD, MARYLAND	APPROVED BY: [signature]	DATE: 1-19-98
COST/SCHEDULE-AREA			APPROVED BY: [signature]	DATE: 1-20-98
SCALE: AS NOTED			DRAWING No.: FIGURE 6-3	REV: 0

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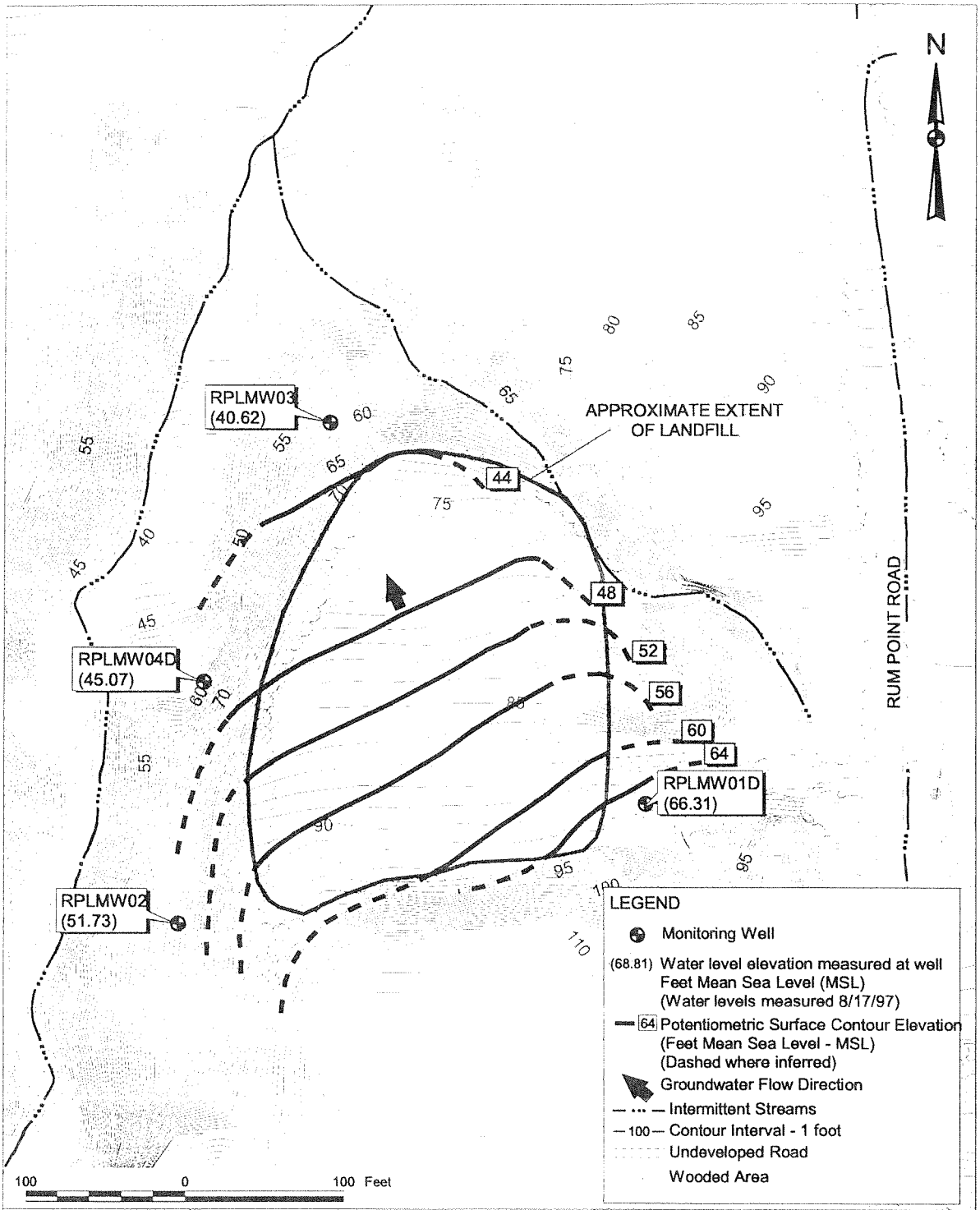

DRAWN BY: D. PERRY — DATE: 19-JAN-98	Brown & Root Environmental	CONTRACT NUMBER: 7581	OWNER No.: —
CHECKED BY — DATE	POTENTIOMETRIC SURFACE CONTOUR FIGURE SWMU 1 - RUM POINT LANDFILL RCRA FACILITY INVESTIGATION/ VERIFICATION INVESTIGATION REPORT STUMP NECK ANNEX, INDIAN HEAD DIVISION NSWC INDIAN HEAD, MARYLAND	APPROVED BY: [signature] — DATE: 1-14-98	
COST/SCHEDULE-AREA		APPROVED BY: [signature] — DATE: 1-20-98	
SCALE: AS NOTED		DRAWING No.: FIGURE 6-4	REV: 0

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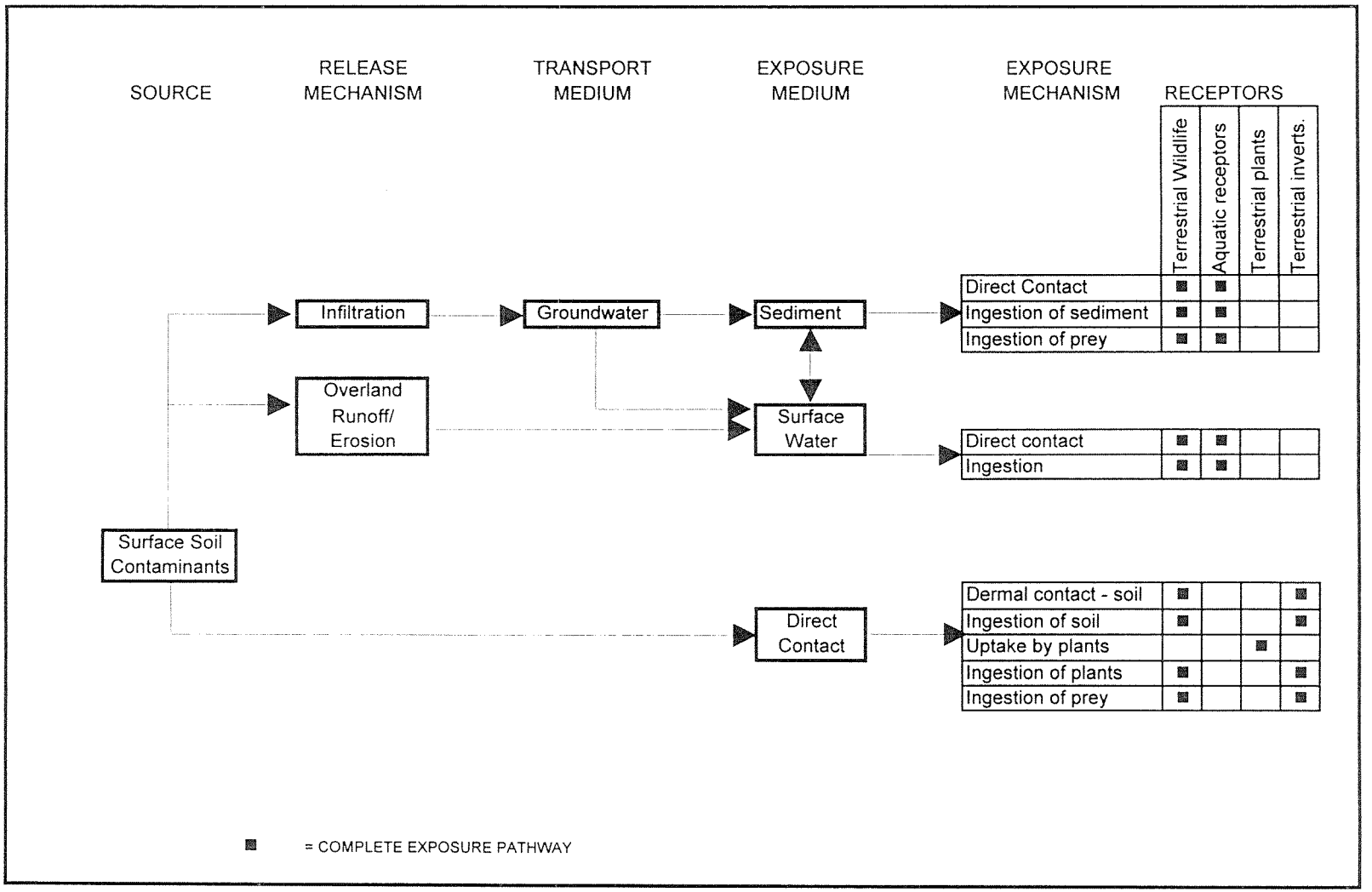
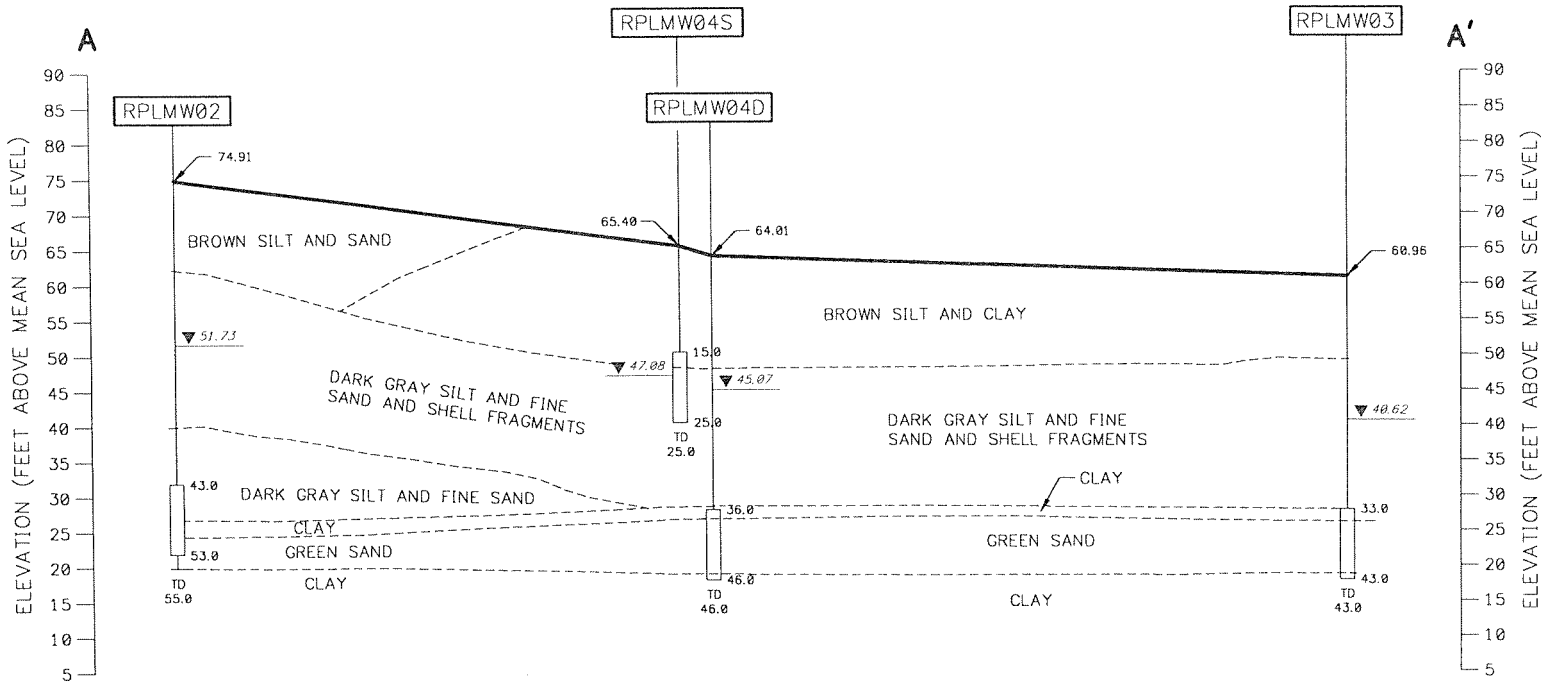
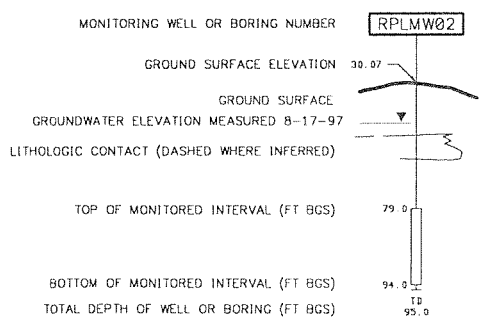


FIGURE 6-12

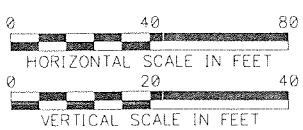
CONCEPTUAL SITE MODEL - SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND



LEGEND



NOTE: ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL (FT AMSL)



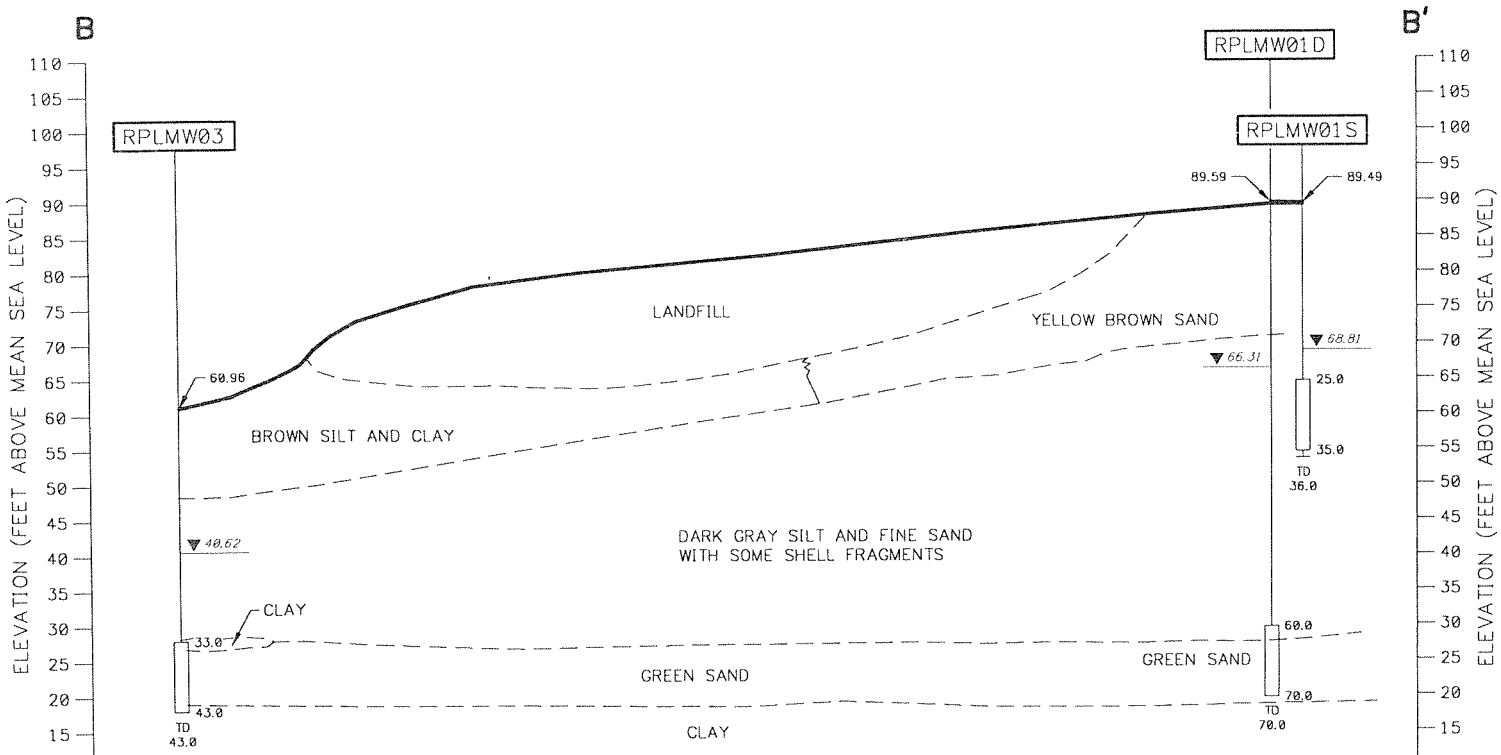
NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

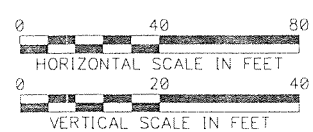
DRAWN BY HJP DATE 10/30/97
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Brown & Root Environmental

GENERALIZED GEOLOGIC CROSS SECTION A-A'
SWMU 1 - RUM POINT LANDFILL
RFI/VI REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581
OWNER NO. 0287
APPROVED BY DATE 1-16-98
APPROVED BY DATE 1-16-98
DRAWING NO. FIGURE 6-5
REV. 0





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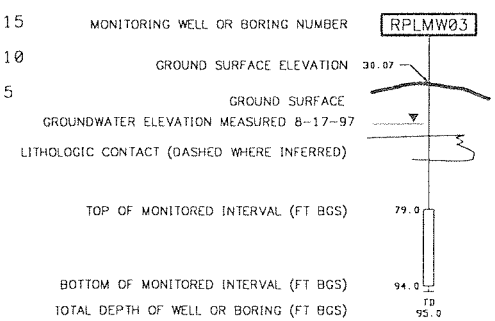

NOTE: ELEVATIONS IN FEET
ABOVE MEAN SEA LEVEL (FT AMSL)

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 10/30/97
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Brown & Root Environmental

GENERALIZED GEOLOGIC CROSS SECTION B-B'
SWMU 1 - RUM POINT LANDFILL
RFI/VI REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581
OWNER NO. 0287
APPROVED BY DATE 1-16-98
APPROVED BY DATE 1/16/98
DRAWING NO. FIGURE 6-6
REV. 0

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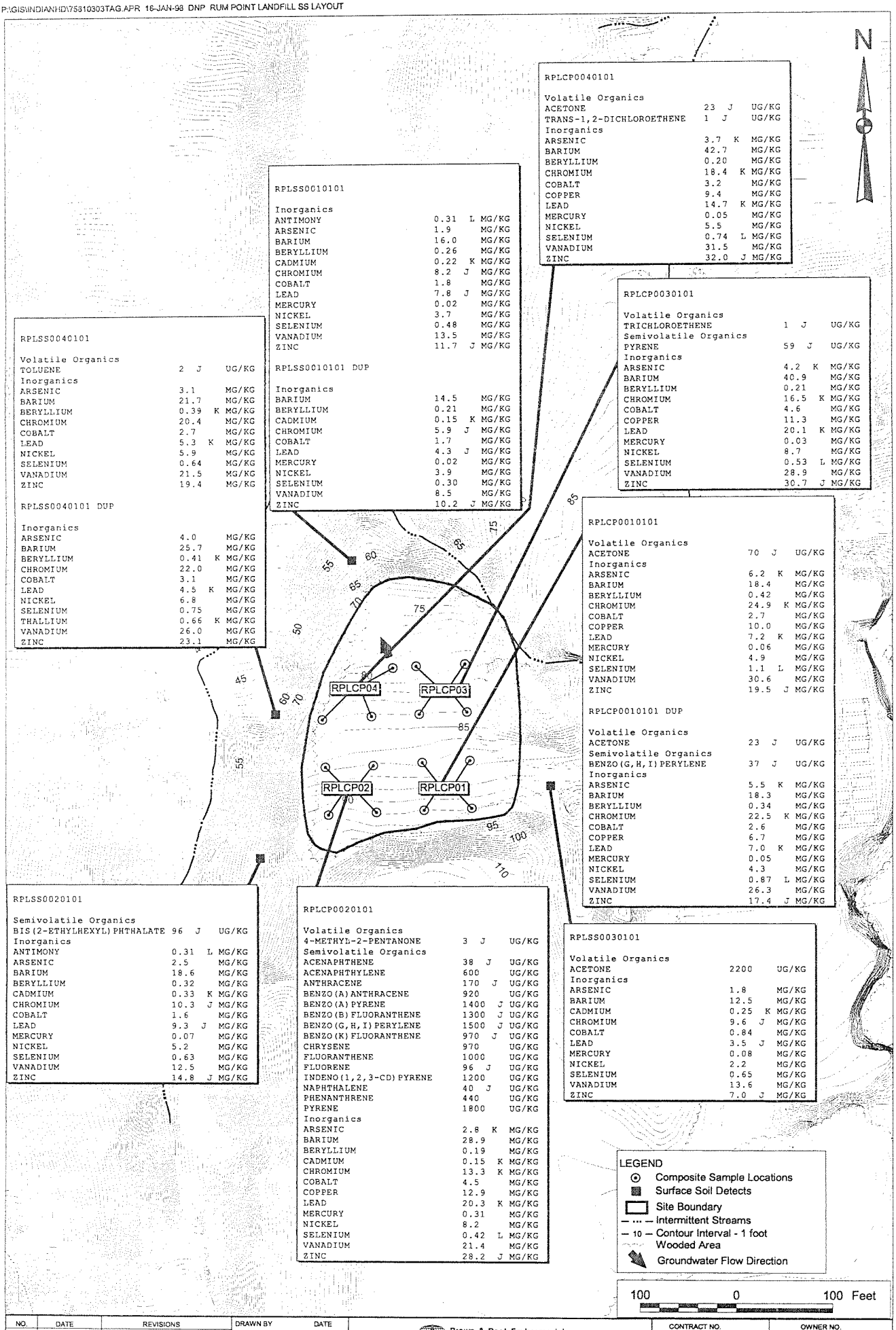

NO.	DATE	REVISIONS

DRAWN BY: D. PERRY — DATE: 16-JAN-98
CHECKED BY: DJL — DATE: 1/16/98
COST/SCHED-AREA:
SCALE: AS NOTED

Brown & Root Environmental

SURFACE SOIL DETECTS
SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO.: 7581 — OWNER NO.:
APPROVED BY: — DATE:
APPROVED BY: — DATE: 1-16-98
DRAWING NO.: FIGURE 6-7 — REV.: 0

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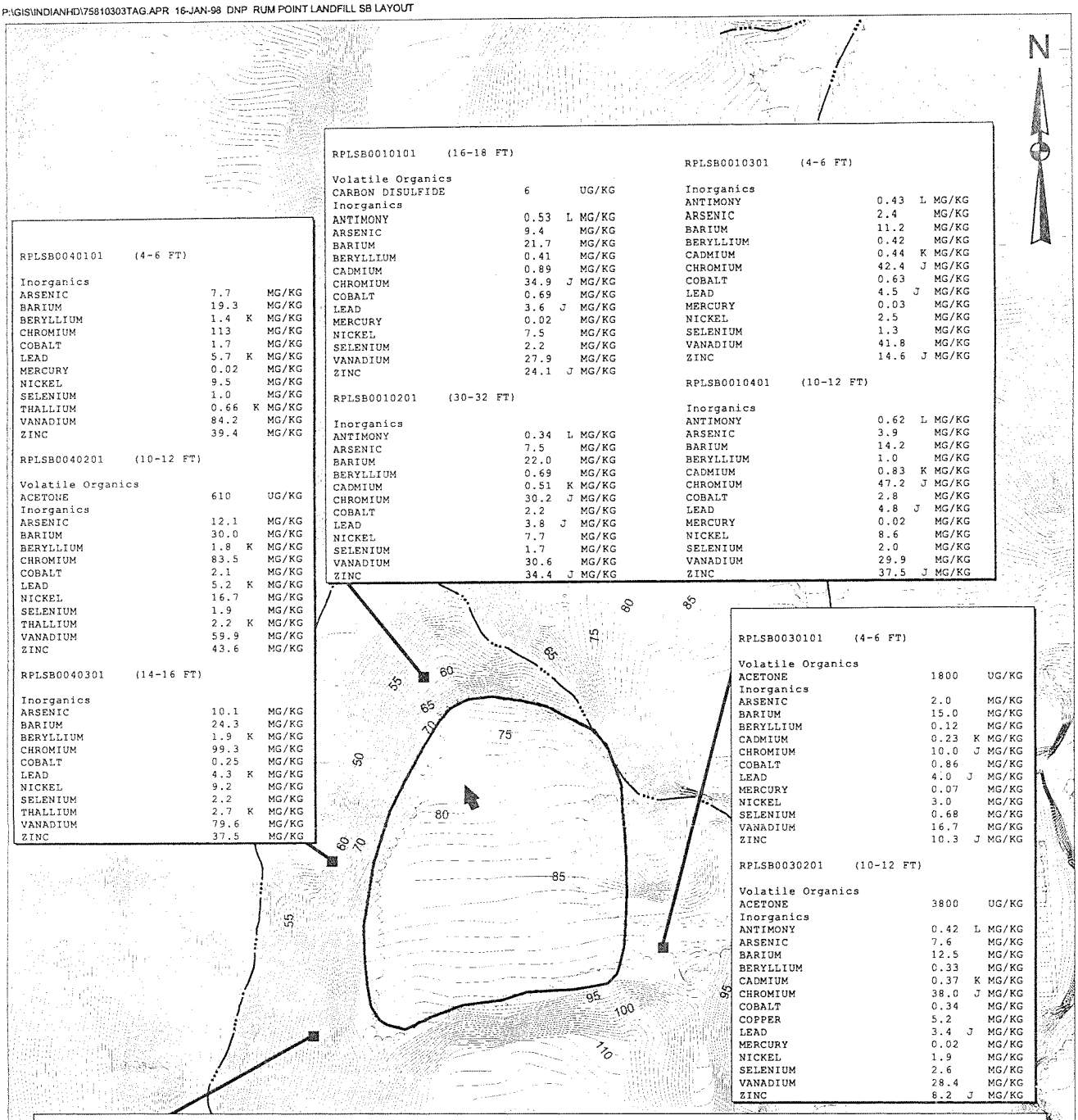


RPLSB0010101 (16-18 FT)

Volatile Organics			
CARBON DISULFIDE	6		UG/KG
Inorganics			
ANTIMONY	0.53	L	MG/KG
ARSENIC	9.4		MG/KG
BARIUM	21.7		MG/KG
BERYLLLUM	0.41		MG/KG
CADMIUM	0.89		MG/KG
CHROMIUM	34.9	J	MG/KG
COBALT	0.69		MG/KG
LEAD	3.6	J	MG/KG
MERCURY	0.02		MG/KG
NICKEL	7.5		MG/KG
SELENIUM	2.2		MG/KG
VANADIUM	27.9		MG/KG
ZINC	24.1	J	MG/KG

RPLSB0010201 (30-32 FT)

Inorganics			
ANTIMONY	0.34	L	MG/KG
ARSENIC	7.5		MG/KG
BARIUM	22.0		MG/KG
BERYLLIUM	0.69		MG/KG
CADMIUM	0.51	K	MG/KG
CHROMIUM	30.2	J	MG/KG
COBALT	2.2		MG/KG
LEAD	3.8	J	MG/KG
NICKEL	7.7		MG/KG
SELENIUM	1.7		MG/KG
VANADIUM	30.6		MG/KG
ZINC	34.4	J	MG/KG

RPLSB0010301 (4-6 FT)

Inorganics			
ANTIMONY	0.43	L	MG/KG
ARSENIC	2.4		MG/KG
BARIUM	11.2		MG/KG
BERYLLIUM	0.42		MG/KG
CADMIUM	0.44	K	MG/KG
CHROMIUM	42.4	J	MG/KG
COBALT	0.63		MG/KG
LEAD	4.5	J	MG/KG
MERCURY	0.03		MG/KG
NICKEL	2.5		MG/KG
SELENIUM	1.3		MG/KG
VANADIUM	41.8		MG/KG
ZINC	14.6	J	MG/KG

RPLSB0010401 (10-12 FT)

Inorganics			
ANTIMONY	0.62	L	MG/KG
ARSENIC	3.9		MG/KG
BARIUM	14.2		MG/KG
BERYLLIUM	1.0		MG/KG
CADMIUM	0.83	K	MG/KG
CHROMIUM	47.2	J	MG/KG
COBALT	2.8		MG/KG
LEAD	4.8	J	MG/KG
MERCURY	0.02		MG/KG
NICKEL	8.6		MG/KG
SELENIUM	2.0		MG/KG
VANADIUM	29.9		MG/KG
ZINC	37.5	J	MG/KG

RPLSB0040101 (4-6 FT)

Inorganics			
ARSENIC	7.7		MG/KG
BARIUM	19.3		MG/KG
BERYLLIUM	1.4	K	MG/KG
CHROMIUM	113		MG/KG
COBALT	1.7		MG/KG
LEAD	5.7	K	MG/KG
MERCURY	0.02		MG/KG
NICKEL	9.5		MG/KG
SELENIUM	1.0		MG/KG
THALLIUM	0.66	K	MG/KG
VANADIUM	84.2		MG/KG
ZINC	39.4		MG/KG

RPLSB0040201 (10-12 FT)

Volatile Organics			
ACETONE	610		UG/KG
Inorganics			
ARSENIC	12.1		MG/KG
BARIUM	30.0		MG/KG
BERYLLIUM	1.8	K	MG/KG
CHROMIUM	83.5		MG/KG
COBALT	2.1		MG/KG
LEAD	5.2	K	MG/KG
NICKEL	16.7		MG/KG
SELENIUM	1.9		MG/KG
THALLIUM	2.2	K	MG/KG
VANADIUM	59.9		MG/KG
ZINC	43.6		MG/KG

RPLSB0040301 (14-16 FT)

Inorganics			
ARSENIC	10.1		MG/KG
BARIUM	24.3		MG/KG
BERYLLIUM	1.9	K	MG/KG
CHROMIUM	99.3		MG/KG
COBALT	0.25		MG/KG
LEAD	4.3	K	MG/KG
NICKEL	9.2		MG/KG
SELENIUM	2.2		MG/KG
THALLIUM	2.7	K	MG/KG
VANADIUM	79.6		MG/KG
ZINC	37.5		MG/KG

RPLSB0030101 (4-6 FT)

Volatile Organics			
ACETONE	1800		UG/KG
Inorganics			
ARSENIC	2.0		MG/KG
BARIUM	15.0		MG/KG
BERYLLIUM	0.12		MG/KG
CADMIUM	0.23	K	MG/KG
CHROMIUM	10.0	J	MG/KG
COBALT	0.86		MG/KG
LEAD	4.0	J	MG/KG
MERCURY	0.07		MG/KG
NICKEL	3.0		MG/KG
SELENIUM	0.68		MG/KG
VANADIUM	16.7		MG/KG
ZINC	10.3	J	MG/KG

RPLSB0030201 (10-12 FT)

Volatile Organics			
ACETONE	3800		UG/KG
Inorganics			
ANTIMONY	0.42	L	MG/KG
ARSENIC	7.6		MG/KG
BARIUM	12.5		MG/KG
BERYLLIUM	0.33		MG/KG
CADMIUM	0.37	K	MG/KG
CHROMIUM	38.0	J	MG/KG
COBALT	0.34		MG/KG
COPPER	5.2		MG/KG
LEAD	3.4	J	MG/KG
MERCURY	0.02		MG/KG
NICKEL	1.9		MG/KG
SELENIUM	2.6		MG/KG
VANADIUM	28.4		MG/KG
ZINC	8.2	J	MG/KG

RPLSB0020101 (4-6 FT)

Semivolatile Organics			
BIS(2-ETHYLHEXYL) PHTHALATE	270	J	UG/KG
Inorganics			
ANTIMONY	0.86	L	MG/KG
ARSENIC	13.0		MG/KG
BARIUM	8.2		MG/KG
BERYLLIUM	1.0		MG/KG
CADMIUM	0.81	K	MG/KG
CHROMIUM	65.6	J	MG/KG
COBALT	1.0		MG/KG
COPPER	6.4		MG/KG
LEAD	4.5	J	MG/KG
MERCURY	0.03		MG/KG
NICKEL	5.7		MG/KG
SELENIUM	3.4		MG/KG
VANADIUM	51.8		MG/KG
ZINC	26.5	J	MG/KG

RPLSB0020201 (10-12 FT)

Volatile Organics			
ACETONE	5000	K	UG/KG
Semivolatile Organics			
BIS(2-ETHYLHEXYL) PHTHALATE	57	J	UG/KG
Inorganics			
ANTIMONY	1.0	L	MG/KG
ARSENIC	39.6		MG/KG
BARIUM	17.2		MG/KG
BERYLLIUM	1.9		MG/KG
CADMIUM	1.5		MG/KG
CHROMIUM	89.6	J	MG/KG
COBALT	3.2		MG/KG
COPPER	6.9		MG/KG
LEAD	5.7	J	MG/KG
NICKEL	25.8		MG/KG
SELENIUM	3.6		MG/KG
TIN	4.1	L	MG/KG
VANADIUM	56.4		MG/KG
ZINC	100	J	MG/KG

RPLSB0020301 (14-16 FT)

Semivolatile Organics			
BIS(2-ETHYLHEXYL) PHTHALATE	190	J	UG/KG
Inorganics			
ANTIMONY	0.39	L	MG/KG
ARSENIC	12.6		MG/KG
BARIUM	30.8		MG/KG
BERYLLIUM	0.50		MG/KG
CADMIUM	1.4		MG/KG
CHROMIUM	38.0	J	MG/KG
COBALT	0.70		MG/KG
LEAD	3.2	J	MG/KG
NICKEL	10.7		MG/KG
SELENIUM	2.8		MG/KG
VANADIUM	26.1		MG/KG
ZINC	28.5	J	MG/KG

LEGEND

- Subsurface Soil Detect
- (4-6 FT) Sample Depth
- Site Boundary
- — ··· — Intermittent Streams
- — 10 — Contour Interval - 1 foot
- Wooded Area
- Estimated Groundwater Flow Direction

100 0 100 Feet

NO.	DATE	REVISIONS

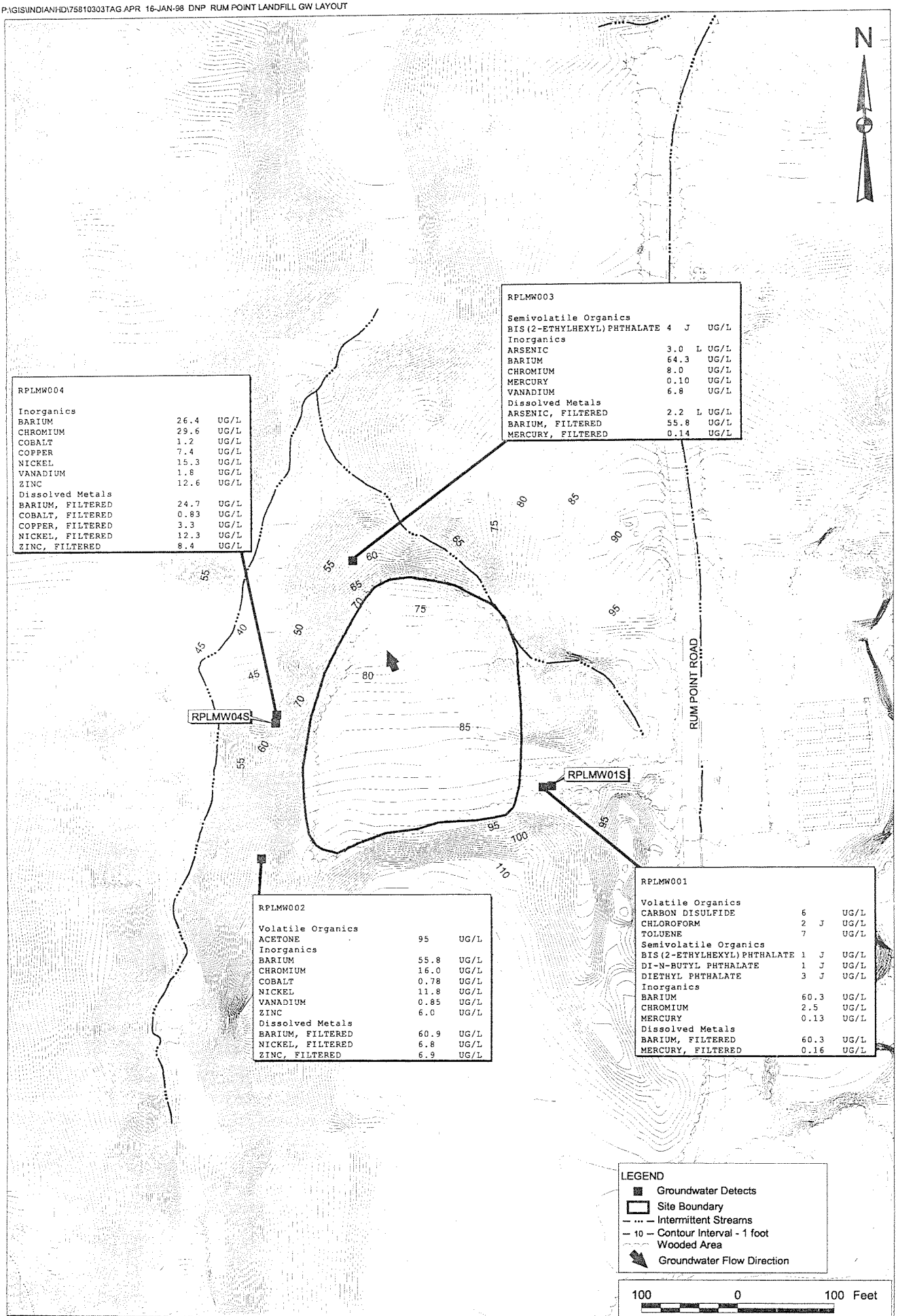
DRAWN BY: D. PERRY	DATE: 16-JAN-98
CHECKED BY: DPP	DATE: 1/16/98
COST/SCHED-AREA	
SCALE: AS NOTED	

Brown & Root Environmental

SUBSURFACE SOIL DETECTS
SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581	OWNER NO.
APPROVED BY	DATE
APPROVED BY	DATE 1/16/98
DRAWING NO. FIGURE 6-8	REV. 0

P:\GIS\INDIANHD\75810303TAG.APR 16-JAN-98 DNP RUM POINT LANDFILL GW LAYOUT



NO.	DATE	REVISIONS	DRAWN BY	DATE	Brown & Root Environmental	CONTRACT NO.	OWNER NO.
			D. PERRY	16-JAN-98		7581	
			CHECKED BY	DATE	GROUNDWATER DETECTS SWMU 1 - RUM POINT LANDFILL RCRA FACILITY INVESTIGATION/ VERIFICATION INVESTIGATION REPORT STUMP NECK ANNEX, INDIAN HEAD DIVISION NSWC INDIAN HEAD, MARYLAND	APPROVED BY	DATE
						APPROVED BY	DATE 1-16-98
			COST/SCHED-AREA			DRAWING NO. FIGURE 6-9	REV. 0
			SCALE AS NOTED				

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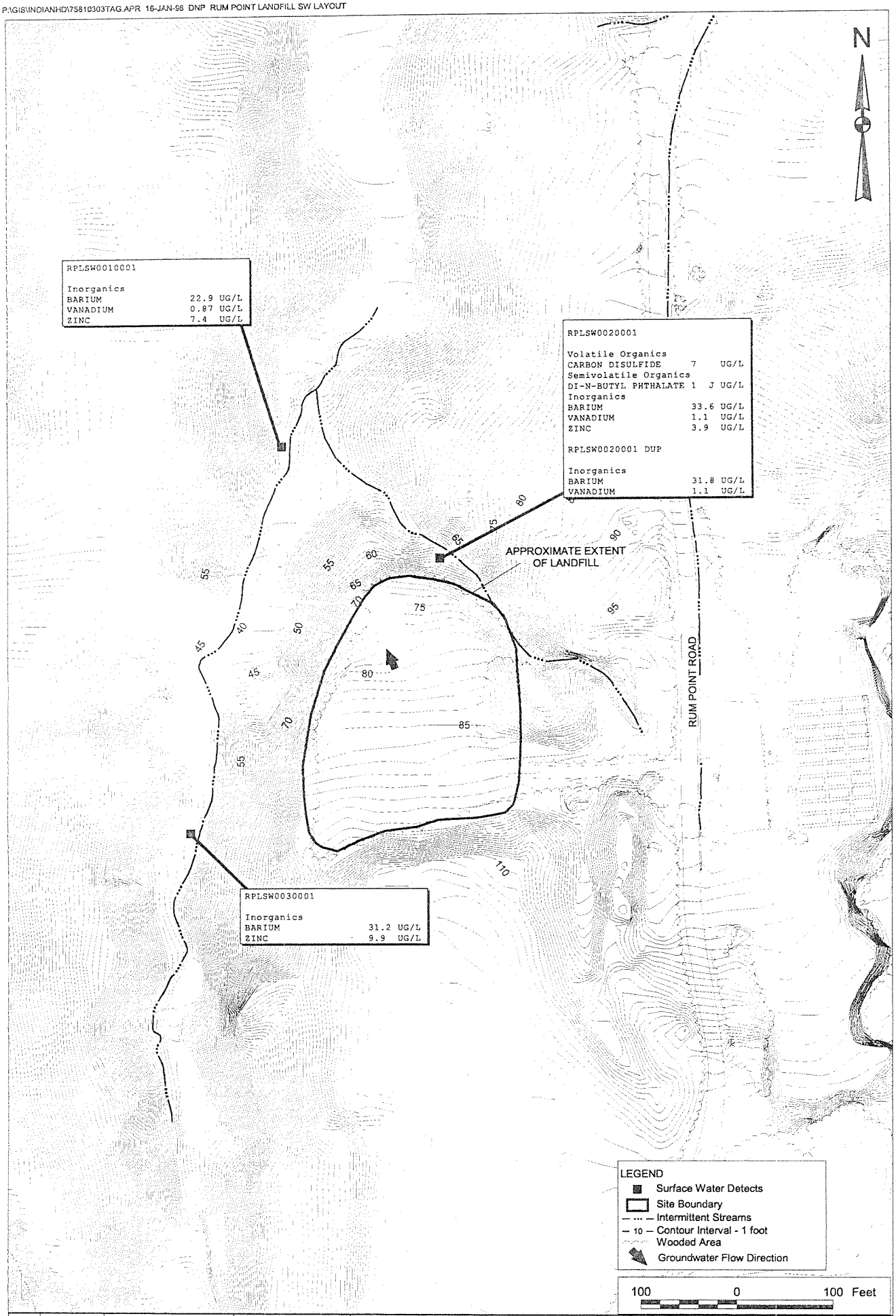


NO.	DATE	REVISIONS

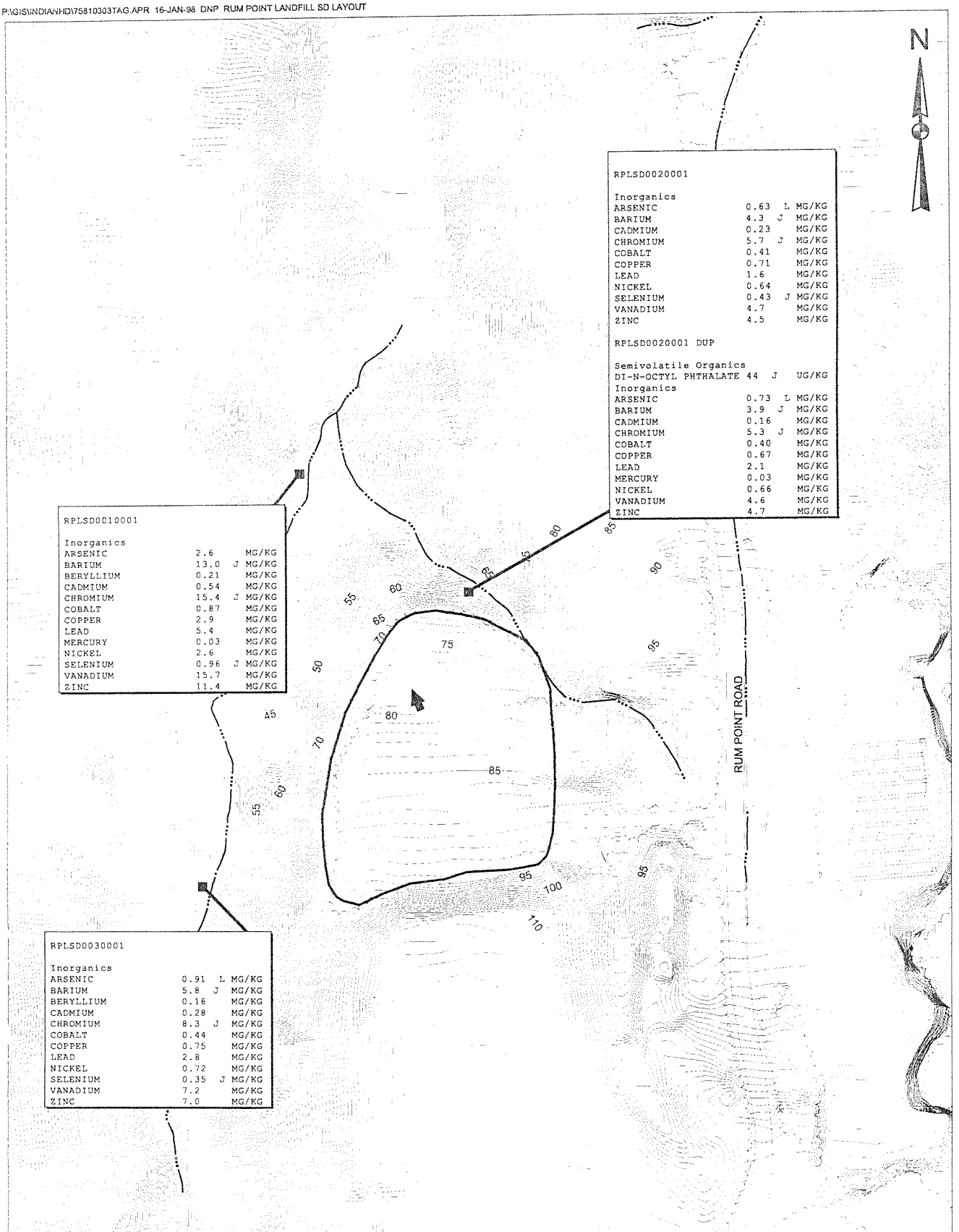
DRAWN BY / DATE	D. PERRY 16-JAN-98
CHECKED BY / DATE	DCF 4/16/98
COST/SCHED-AREA	
SCALE	AS NOTED

Brown & Root Environmental

SURFACE WATER DETECTS
SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO.	7581
OWNER NO.	
APPROVED BY / DATE	
APPROVED BY / DATE	1-16-98
DRAWING NO.	FIGURE 6-10
REV.	0

P:\GIS\INDIANHD\75810303TAG.APR 16-JAN-98 DNP RUM POINT LANDFILL SD LAYOUT



NO.	DATE	REVISIONS	DRAWN BY / DATE		CONTRACT NO.	OWNER NO.
			D. PERRY	16-JAN-98	7581	
			CHECKED BY / DATE		APPROVED BY / DATE	
			COST/SCHED-AREA		APPROVED BY / DATE	1-16-98
			SCALE	AS NOTED	DRAWING NO	FIGURE 6-11
						REV. 0

Brown & Root Environmental

SEDIMENT DETECTS
SWMU 1 - RUM POINT LANDFILL
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

7.0 SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B

Section 7 provides a brief description and history of Chicamuxen Creek's Edge Dump Site B (SWMU 4) and summarizes the scope and results of the environmental investigations and baseline risk assessments conducted for the RFI/VI.

7.1 SITE DESCRIPTION AND HISTORY

7.1.1 Site Description

Chicamuxen Creek's Edge Dump Site B (Dump Site B) is an unlined landfill located adjacent to Chicamuxen Creek near the end of Porter Road, which bisects the site. The site terrain is very flat and grass-covered, giving the impression that it is a man-made fill area. This flat area drops off slightly to Chicamuxen Creek to the south and to marshy areas to the north and east. The west is bounded by a slightly rising wooded area. This site falls within the safety zone of the Range 3 Burn Point, so access from Archer Avenue is controlled by the same gate north of the site that closes when Range 3 Burn Point is "hot" or when operations are being conducted. A lone structure, Building 2107 - "the hypervelocity building", stands on the eastern end of the site. The location and general features of Dump Site B are displayed in Figure 7-1.

7.1.2 Site History

It is not known when waste was first deposited at Dump Site B, and little is known about its history. The Old Demolition Range (SWMU 23) existed in the immediate vicinity of this site and in 1962 was used for EOD training similar to that which was conducted at Range 6. Site representatives are uncertain as to the exact nature of the materials disposed at Dump Site B.

7.2 VI FIELD INVESTIGATION

This section discusses the field activities performed at Dump Site B during the VI. These activities consisted of a field screening (magnetometer geophysical survey and field test-kit sample analysis) and sampling of surface soil, subsurface soil, and groundwater. Soil field test-kit sample analysis data are provided in Appendix C. Sample log sheets are provided in Appendices D through G. Table 7-1 provides a summary of the sampling and analytical program for the fixed-base lab samples. Table 7-2 presents a summary of monitoring well construction and groundwater level data

7.2.1 Field Screening

A reference grid consisting of 76 grid nodes spaced at 50-foot centers covering an area of approximately 137,500 sq. feet was established for the site. The grid was used for a magnetometer geophysical survey and to select field test-kit sampling locations. The magnetometer survey readings were collected on 50-foot centers, and surface soil samples for the field test-kit analyses were collected at 100-foot centers total of 18 surface soil samples.

The magnetometer survey was conducted as detailed in Section 2.1.3. An error in the preliminary results was discovered during final processing of the data set and the final quality assurance review of the results. The initial inaccurate preliminary total magnetic field map had been used to assist in the selection of soil borings locations for the subsequent field investigation. When the corrected total field magnetic map (shown on Figure 7-2) was overlain onto the since completed boring locations, it was shown that samples were collected at or in the immediate vicinity of all but one of the magnetic anomalies. The only uninvestigated total field magnetic anomaly is located approximately 100 feet north of Building 2107, the "hypervelocity building". This anomaly will be further investigated in an upcoming field mobilization, and findings will be incorporated into the draft final version of this report.

The grid established for the magnetometer survey was also used to select sampling locations for field test-kit screening of soils for TNT and RDX. Surface soil samples from 18 locations were collected at a depth of 0 to 1 foot bgs and analyzed in an attempt to locate contaminated soils for additional sampling and subsequent fixed base laboratory analysis. Additional information on these field test-kits is found in Section 2.1.4. The field test-kit sample locations are shown on Figure 7-3, and results are summarized in Table 7-3.

7.2.2 Soil Investigation

Ten surface soil samples and twelve subsurface soil samples were collected at the site to characterize the soil. The sampling locations and the general areas of the magnetic anomalies are shown on Figure 7-4. The general locations were established in the B&R Environmental Work Plan Addenda (May 1997). The actual locations were selected based on the preliminary results of the magnetometer geophysical survey (not shown on Figure 7-4). Monitoring well borings DSBSB01 through DSBSB04 were placed such that three of the wells were downgradient and one was upgradient of two large magnetic anomalies. The remaining soil borings DSBSB05 through DSBSB10 were placed in areas within and adjacent to these magnetic anomalies. DSBSB01 through DSBSB04 were completed using hollow-stem auger and split-spoon sampling techniques. DSBSB05 through DSBSB10 were installed using hand augering techniques. One surface soil sample was collected at each soil boring location. Twelve subsurface soil samples were collected from the ten soil

borings. The samples were obtained over 2-foot intervals ranging from beginning depths of 2 to 10 feet. All samples were collected for Appendix IX metals, Appendix IX VOA, Appendix IX SVOA, and explosives. Table 7-1 provides a summary of the analytical program for each sample collected. Figure 7-9 provides the specific sampling depths for each sample collected.

7.2.3 Groundwater Investigation

Four monitoring wells (DSBMW01 through DSBMW04) were installed and sampled at the site to investigate whether the groundwater beneath the site has been affected by site activities. The well locations were based on the results of the magnetometer geophysical survey. Well locations are shown on Figure 7-4. The samples were analyzed for the following parameters; Appendix IX metals, Appendix IX VOA, Appendix IX SVOA, and explosives. Table 7-1 presents a summary of the sample analyses. Table 7-2 presents a summary of monitoring well construction and groundwater-level data.

Groundwater-level measurements were obtained from all the wells at the site. The results are discussed in Section 7.3.2 and presented on a potentiometric surface map (Figure 7-5).

7.2.4 Surface water and Sediment Investigation

No surface water and sediment samples were collected at the site.

7.2.5 Summary of Environmental Investigation

The field investigation activities included field screening of soils using field test-kits sensitive to the presence of TNT and RDX (18 samples), a geophysical magnetometer survey, and soil borings/well installations. Four groundwater samples, ten surface soil samples, and twelve subsurface soil samples were collected for fixed-base laboratory analyses to characterize the site.

7.3 SITE CHARACTERISTICS

This section discusses the site-specific geology and hydrogeology of the site.

7.3.1 Geology

Subsurface conditions at the site were investigated through the drilling and logging of four soil borings. No waste material was encountered at the site during the subsurface investigation. The cross-section locations are shown on Figure 7-4. Cross-section profiles A-A' and B-B', shown on Figures 7-6 and 7-7, respectively, were generated to illustrate the subsurface materials encountered beneath the site.

Cross Section A-A'

Cross section A-A' traverses the northwest corner to the central portion of the site from well DSBMW04 to well DSBMW02. The materials encountered at well DSBMW04 consist of a 10 foot thick surficial layer of brown silt and sand with a trace of clay underlain in descending order by an approximately 2-foot-thick layer of brown silt and clay, a 3-foot-thick layer of medium to coarse sand, then yellow-orange sand and gravel to the bottom of the boring at a depth of 22.4 feet bgs. The same materials extend to well DSBMW02, approximately 180 feet to the east. However, the surficial brown silt and sand layer thins to approximately 4 feet at the ground surface, and the underlying layer is more clayey than at DSBMW04.

Cross Section B-B'

Cross section B-B' traverses west to east across the site from well DSBMW03 to well DSBMW01. The materials encountered at well DSBMW03 consist of a surficial 10 foot thick layer of brown silt and sand, underlain in descending order by an approximately 5-foot-thick layer of yellow-brown, medium to coarse sand, than by yellow-orange sand and gravel to the bottom of the boring at a depth of 22.5 feet bgs. These units extend approximately 170 feet to the east to well DSBMW02, however, a 2.5-foot-thick lens of orange-brown clay with some sand was encountered within the top portion of the yellow-brown, medium to coarse sand. The surficial layer of brown silt and sand thins in this area to approximately 4 feet. At well DSBMW01, farther to the east, the materials encountered consisted of a surficial 8 foot thick layer of yellow-brown, fine sand (probably reworked natural material). The natural, reworked material is underlain by yellow-brown, medium and coarse sand and by yellow-orange sand and gravel to the bottom of the boring at a depth of 16.0 feet bgs.

Summary

The subsurface materials were relatively consistent across the study area, both vertically and horizontally. The surficial deposits generally consisted of yellow and brown silt, sand, and clay mixtures and ranged in thickness from 6 to 12 feet. These surface materials were underlain by a coarsening-downward sequence of medium to coarse sand and gravel to the bottom of the well borings. No waste materials were encountered in the subsurface. There were areas of scattered surface debris observed, however, probably wash from Chicamuxen Creek and residual fill from the graded area around well DSBMW01.

7.3.2 Hydrogeology

Hydrogeologic conditions at the site have been interpreted from data obtained during the field investigation activities. The groundwater beneath the site occurs primarily under locally semiconfining and unconfined (water table) conditions. The water table aquifer consists primarily of yellow-brown sand. Shallow groundwater is presumed to be flowing to the south toward and discharging into Chicamuxen Creek. The creek is tidal and during high tide, losing stream conditions occur which cause the water table to be slightly elevated near the stream (bank storage). As a result, the groundwater appears to be flowing to the north away from Chicamuxen Creek at times. Groundwater is recharged by downward migration of precipitation through the unsaturated zone to the water table. In addition, a source of recharge to groundwater along the edge of the steam occurs as a result of the losing stream conditions during high tide.

Four monitoring wells were installed to characterize the site. DSBMW04 was installed in the upgradient portion of the site. Wells DSBMW01, DSBMW02, and DSBMW03 were installed in the downgradient areas of the study area. At wells DSBMW01 and DSBMW04, groundwater was encountered at 8 feet and 14 feet bgs, respectively, and water levels stablilized at the encountered depths. At wells DSBMW02 and DSBMW03, the groundwater was encountered at 4 feet and 12 feet bgs, respectively. Once wells DSBMW02 and DSBMW03 were installed and water levels stabilized, measured depths to the groundwater adjusted from the initial depths encountered during the drilling process, to 2.3 feet and 6.88 feet bgs, respectively. This is an indication that semiconfining conditions are present at well locations DSBMW02 and DSBMW03.

Synoptic groundwater-level measurements were taken at the site. The resulting depths to groundwater, groundwater elevations, and well construction details are presented on Table 7-2. The groundwater elevation data were used to generate a potentiometric surface map (Figure 7-5). The potentiometric surface contours, which are labeled in elevation (feet above msl), illustrate the estimated groundwater flow pattern across the site. Groundwater flows to the northwest away from Chicamuxen Creek, as indicated by the water-level data. The groundwater flow pattern at the site, however is not static. During high-tide conditions, Chicamuxen Creek becomes a losing stream, which causes a temporary increase in elevation of the water table near the stream. The result is a flow pattern similar to that shown on Figure 7-5, where groundwater flows northwest. During low-tide conditions however, Chicamuxen Creek becomes a gaining stream which causes a decrease in elevation of the water table near the stream. The result is a flow pattern that would show groundwater flowing south toward and discharging into Chicamuxen Creek. The average horizontal hydraulic gradient across the site has not been calculated because of the

instability of the groundwater pattern and because no tidal data are available for Chicamuxen Creek at the study area.

7.4 NATURE AND EXTENT OF CONTAMINATION

This section presents the results of the sampling and analysis of environmental samples collected at Dump Site B as described in Sections 2.0 and 7.2. The location of Dump Site B is shown on Figure 7-1. The results of the field screening for TNT and RDX are summarized in Table 7-3; field screening sampling locations are identified on Figure 7-3. Table 7-1 provided a summary of the sampling and analytical program for environmental samples collected by B&RE and analyzed by General Physics Environmental Services (GP), according to the methods specified in Section 2.0. Analytical results provided by GP are summarized in Tables 7-4 through 7-6 and are presented in detail in Appendix M.

All data generated by GP were validated according to EPA National and Region III guidelines. The data validation was performed by B&RE validation chemists, who routinely validate data from numerous laboratories producing data under the EPA Contract Laboratory Program (CLP). A copy of the validation packages is available to the Navy, the State of Maryland Department of Environment, and EPA Region III upon request. Additionally, data validation memorandum summarizing the results of the data validation are presented in Appendix N.

7.4.1 Surface and Subsurface Soil

Surface and subsurface soil samples were collected at Dump Site B during the field investigation conducted to investigate for the presence of site-related contamination. Summarizing from Section 7.2, the field investigation included field screening for TNT and RDX at 18 locations. The field investigation also consisted of the collection of 10 surface and 12 subsurface soil samples at 10 locations. Analytical results for any parameter detected at least once in surface and subsurface soil samples sent to GP for analysis are presented in Tables 7-4 and 7-5, respectively. Table 7-7 provides a comparison of the chemical concentration detected in surface and subsurface soil samples. Additionally, descriptive statistics (i.e., frequency of detection, range of detection, arithmetic mean of positive detections, location of maximum positive detection) are summarized in Tables 7-8 through 7-9, the COPC selection tables for Dump Site B soil. The location of the positive detections are depicted in Figures 7-8 and 7-9.

7.4.1.1 Surface Soil Characterization

The results of the analysis of Dump Site B surface soils indicate that historic activities at Dump Site B have not resulted in significant contamination on the surface soils. No explosives, components of

explosives, or degradation by-products of explosives were detected in Dump Site B surface soil samples. Acetone was reported in one sample at a concentration of 5,000 µg/kg and was the only volatile organic compound detected in surface soil samples. Bis(2-ethylhexyl)phthalate (C_{max} = 1,400 µg/kg) in three samples and di-n-butyl phthalate (C_{max} = 340 µg/kg) in five samples were the only semivolatile organic compounds detected in surface soil. Acetone, bis(2-ethylhexyl)phthalate, and di-n-butyl phthalate are common laboratory contaminants, however, it should be noted that the detections were not qualified as possible "blank contamination" during the validation process. Acetone and bis(2-ethylhexyl)phthalate were also detected in background soils samples collected for the Indian Head facility. The maximum concentrations of all organics were less than their respective EPA Region III RBCs (Table 7-8). The detected concentrations of organics were less than the EPA SSLs for migration of compounds from soil to groundwater (Table 7-10).

Several inorganic compounds were detected in Dump Site B surface soil samples at maximum concentrations exceeding the 95 percent upper tolerance limits (UTL95%) calculated for the background soil dataset:

Metal	Maximum Concentration (mg/kg)	$UTL_{95\% BACKGROUND}$ (mg/kg)	Eastern United States (mg/kg)	State of Maryland Soils[2]
Antimony	0.69	Not detected	<1 - 8.8	NA
Arsenic	5.1	4.25	<0.1 - 73	1.1 - 7.1
Beryllium	1.1	0.905	<1 - 7	ND - 3
Cadmium	0.42	0.26	NA	<0.01 - 5.6
Copper	26.1	18.7	<1 - 700	5 - 70
Selenium	1.5	1.09	<0.1 - 3.9	<0.1 - 0.5
Zinc	45.2	38.1	<5 - 2900	8 - 113

1 Shacklette and Boerngen, 1984.
2 Dragun, 1991.
NA - Not available

However, all of these metals were detected at maximum concentrations within the range of soil concentrations reported for soils of the Eastern United States. With the exception of selenium, all of these metals were also detected at concentrations with the range reported for soils of the State of Maryland. The maximum arsenic concentration exceeded the EPA Region III RBC for industrial exposures (Table 7-8). The maximum concentrations of arsenic and beryllium exceeded the EPA Region III RBCs for residential exposures. The detected concentrations of inorganics were less than the EPA SSLs for migration of compounds from soil to groundwater (Table 7-10).

7.4.1.2 Subsurface Soil Characterization

In overview, the target analytes detected in subsurface soil mirror those detected in surface soil (Table 7-7). Inorganic and organic concentrations reported are similar to those reported for the facility background dataset.

No explosives, components of explosives, or degradation by-products of explosives were noted in Dump Site B subsurface soil samples. Acetone in two samples (C_{max} = 1,200 µg/kg) was the only volatile organic compound detected. Bis(2-ethylhexyl)phthalate in one sample (C_{max} = 110 µg/kg) and di-n-butyl phthalate (C_{max} = 200 µg/kg) in four samples were the only semivolatile organic compounds detected. Acetone and bis(2-ethylhexyl)phthalate were also noted in background soil samples collected for the facility. The concentrations of acetone, bis(2-ethylhexyl)phthalate, and di-n-butyl phthalate were less in subsurface soil samples as compared to surface soil samples. The maximum concentrations of all organics were less than their respective EPA Region III RBCs (Table 7-9) and the EPA SSLs for migration of compounds from soil to groundwater (Table 7-10).

The following inorganic compounds were detected in Dump Site B subsurface soil samples:

Metal	Maximum Concentration (mg/kg)	$UTL_{95\% \text{ BACKGROUND}}$ (mg/kg)
Antimony	0.66	3.6
Arsenic	7.4	24.4
Barium	131	191
Beryllium	1.2	2.46
Cadmium	0.40	0.38
Chromium	20.6	101
Cobalt	19.4	90.9
Copper	16.5	56.5
Lead	11.2	37.5
Mercury	0.07	0.13
Nickel	12.1	22.1
Selenium	1.4	8.93
Vanadium	36.1	133
Zinc	37.6	79.5

Concentrations of metals in subsurface soil were comparable to those in surface soil. Maximum concentrations of all inorganics were similar to or within the range of concentrations reported for background soil samples collected at the facility. The maximum arsenic concentration exceeded the EPA Region III RBCs for industrial exposures (Table 7-9). The maximum concentrations of arsenic and

beryllium exceeded the EPA Region III RBCs for residential exposures. The detected concentrations of inorganics were less than the EPA SSLs for migration of compounds from soil to groundwater (Table 7-10).

7.4.2 Groundwater

Unfiltered and filtered groundwater samples were collected from the following monitoring wells located at Dump Site B.

Monitoring Well	Screened Interval (feet below ground surface)	Turbidity Reading Unfiltered Sample
DSBMW001	6 to 16	35
DSBMW002	4 to 14	4
DSBMW003	12 to 22	4
DSBMW004	12.4 to 22.2	33

The results of the groundwater sampling and analysis are presented in Table 7-6 and displayed in Figure 7-10. Additionally, descriptive statistics (i.e., frequency of detection, concentration range detected, arithmetic mean of positive detections, location of maximum positive detection) are summarized in Table 7-11, the COPC selection tables for Dump Site B groundwater.

Explosive Compounds

RDX, the only explosive compound noted in groundwater samples collected at Dump Site B, was detected in two of four wells sampled. Monitoring wells DSBMW02 (RDX = 3.8 µg/L) and DSBMW01 (RDX = 7.4 µg/L) were located in the hypervelocity test range and old demolition range, respectively. The detected concentrations of RDX exceeded the EPA Region III RBC for tap water ingestion (Table 7-11). However, it should be noted that RDX was also detected in background groundwater samples collected for the facility (C_{max} = 1.2 µg/L). Explosive compounds were not detected in fixed-base lab or field screening soil samples collected at Dump Site B.

Volatile and Semi-volatile Organic Compounds

The following volatile organic compounds were detected in the groundwater sample collected form monitoring well DSBMWO3:

- Chloroform (4 µg/L)
- 1,1,1-Trichloroethane (2 µg/L)

Volatile organic compounds were not detected in samples from other site monitoring wells. Additionally, chloroform and 1,1,1-trichloroethane were not detected in soil samples at Dump Site B. The detected concentration of chloroform exceeds the EPA Region III RBC for tap water ingestion (Table 7-11); but is less than the current SDWA MCL for trihalomethane compounds.

Semi-volatile organic compounds were detected sporadically and at maximum concentrations less than 10 µg/L. Three plasticizers (bis[2-ethylhexyl]phthalate, di-n-butyl phthalate, and diethyl phthalate) were detected in the groundwater sample from DSBMW03. Phenanthrene was detected in samples from two groundwater monitoring wells (DSBMW02 and DSBMW03). No other semi-volatile organic compounds were detected in groundwater samples. Phenanthrene was not detected in soil samples associated with monitoring wells DSBMW02 and DSBMW03. Di-n-butyl phthalate, and diethyl phthalate were not detected in soil samples associated with monitoring well DSBMW03. Bis(2-ethylhexyl)phthalate was detected in the surface soil sample associated with monitoring well DSBMW03 but was not detected in subsurface soil. No organic compounds were detected in the groundwater samples from well DSBMW04 which is located down gradient of Dump Site B. The detected concentrations of semi-volatile organic compounds in groundwater samples were less than the EPA Region III RBCs for tap water ingestion (Table 7-11).

Metals

The following metals were detected in groundwater at Dump Site B:

Metal	Maximum Concentration (µg/L) Unfiltered samples
Barium	61.8
Cadmium	1.9
Chromium	4.8
Cobalt	33.4
Copper	5.2
Lead	1.5
Mercury	0.2
Nickel	11.2
Selenium	1.2
Silver	0.86 (filtered)
Vanadium	4.6
Zinc	31.2

Lead and mercury were the only inorganics detected in unfiltered groundwater samples at concentrations exceeding those reported for the basewide background dataset. Neither metal was noted in soils at

concentrations exceeding background. Inorganic concentrations were highest in the samples from well DSBMW03 which is located in the eastern portion of Dump Site B. Concentrations of inorganics in unfiltered groundwater samples were comparable to filter samples with the exception of selenium and vanadium (Table 7-6). The maximum concentrations of all inorganics were similar to or less than the EPA Region III RBCs for tap water ingestion (Table 7-11).

7.5 CONTAMINANT FATE AND TRANSPORT

The data indicate that no significant migration of chemicals from Dump Site B into the surrounding area is occurring. No areas of significant contamination have been identified in the Dump Site B area. Acetone in one surface soil and one subsurface soil sample was the only volatile organic compound detected in site soil. Bis(2-ethylhexyl)phthalate and di-n-butyl phthalate were the only semi-volatile organics detected in surface and subsurface soil at Dump Site B. Volatile organics are typically not persistent compounds in the environment whereas phthalates typically are fairly immobile chemicals in the environment. In addition, these chemicals are common laboratory contaminants and their presence in soil samples may not be site related.

Low levels of organic compounds were detected in groundwater samples collected at Dump Site B, but these same compounds typically were not detected in soil samples associated with the monitoring wells. RDX was detected in two groundwater samples, but was not detected in soil. RDX is not considered to be persistent in the environment since RDX has a relatively high water solubility and does not strongly adhere to soil. Volatiles (chloroform and 1,1,1-trichloroethane) and semivolatiles (PAHs and phthalates) were detected in two groundwater samples. Volatile organics typically are not persistent compounds in the environment due to high vapor pressures, high water solubilities, and low organic carbon partition coefficients. PAHs and phthalates with high organic carbon partition coefficients and low water solubilities are typically fairly immobile chemicals in the environment.

Concentrations of metals in surface soil samples exceeded basewide background concentrations but were within the range of literature values for the State of Maryland. Concentrations of metals in groundwater samples were within the range of basewide background concentrations with the exception of lead and mercury in unfiltered groundwater samples. Metals typically are not considered to be mobile contaminants in the environment. Metals do not degrade via any of the identified fate processes (e.g., hydrolysis, photolysis, etc.) although under acidic soil conditions, metals may be solubilized and transported with infiltrating precipitation and groundwater migration.

7.6 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section contains the site-specific risk assessment for the identified exposure scenarios for Dump Site B. The risk assessment methodology was described in Section 2.5, and detailed calculations are contained in Appendix P.

7.6.1 Data Evaluation/Selection of Chemicals of Potential Concern

7.6.1.1 Data Evaluation SWMU 4 - Chicamuxen Creek's Edge Dump Site B

All field samples collected for fixed-base laboratory analysis for the RFI/VI at NSWC Indian Head underwent the data validation process as described in Section 2.3. This section summarizes the SWMU-specific data validation results for Dump Site B. Analytical data for samples collected from Dump Site B are contained in SDGs 9708042, 9708020, 9708030, 9707065, 9707124, and 9707119.

Some positive analytical results for acetone, methylene chloride, bis(2-ethylhexyl)phthalate, silver, thallium, tin, and antimony associated with Dump Site B soils were flagged "B" during data validation indicating that they are false positives attributable to field/laboratory blank contamination. Additionally, some positive results reported for beryllium, nickel, silver, tin, vanadium, barium, lead, and zinc in Dump Site B groundwater samples were flagged "B" during data validation indicating that they are false positives attributable to field/laboratory blank contamination.

Nondetected results for the organic compounds: 2-butanone, acrolein, acrylonitrile, acetonitrile, propionitrile, isobutyl alcohol, vinyl acetate, 4-nitroquinoline-1-oxide, famphur, and kepone, in most soil and groundwater samples were qualified as rejected, "UR," during data validation. No positive results were reported for any of the noted compounds. The rejection of results for the noted compounds were a result of extremely low (0.050 unitless) initial and continuing calibration relative response factors. These low response factors indicate that the laboratory's instruments could not achieve satisfactory sensitivity for the aforementioned compounds which severely compromises the associated positive and nondetected results.

The method of analysis for the determination of these volatile and semivolatile organic compounds utilizes Gas Chromatography/Mass Spectrometry (GC/MS). Isobutyl alcohol and 2-butanone are soluble in water and are difficult to purge effectively. There are technical adjustments the laboratory could have made that would have improved the responses for isobutyl alcohol and 2-butanone. Vinyl acetate may react under certain chromatographic conditions, thus yielding a poor instrument response. Kepone is best analyzed by GC using an Electron Capture Detector (ECD). Acrolein and Acrylonitrile, chemically, are more suited

for analysis by High Performance Liquid Chromatography (HPLC). Acetonitrile may be analyzed using GC with a Nitrogen-Phosphorus Detector (NPD). The chemical properties of propionitrile, 4-nitroquinoline-1-oxide, and famphur may restrict these compounds from yielding satisfactory chromatographic response regardless of the analytical method of detection. However, the substitution of alternative analytical methods would be cost prohibitive in comparison to the value they would add to the final data. Therefore, the poor response of the aforementioned compounds is attributable to both the specific chemical properties and the use of GC/MS as an all encompassing method of analysis in an attempt to eliminate a variety of complex alternatives. Furthermore, the rejection of results for these compounds in environmental matrices does not create any significant data gaps that would warrant resampling.

No inorganic analyte results were rejected during the data validation process.

7.6.1.2 Selection of Chemicals of Potential Concern

Chemicals of potential concern at this site were selected using the risk-based COPC screening levels (i.e., the Section 2.0 benchmarks) described in Section 2.5.1. COPC summary screening tables for all media are presented in Tables 7-8 through 7-11. The list of COPCs for Dump Site B is summarized in Table 7-12.

Maximum chemical concentrations in soil were compared to EPA Region III RBCs and basewide background levels. Additionally, maximum concentrations in soil were compared to EPA SSLs for transfers from soil to air and for migration to groundwater to justify the exclusion of the inhalation pathway and to provide a cursory evaluation of the potential transport of soil chemicals to groundwater. Since the current and expected future site use is nonresidential only those compounds with concentrations exceeding nonresidential RBCs will be retained as COPCs.

A discussion of the chemicals identified as COPCs and the rationale for their selection is provided in the following subsections.

Surface Soil

One VOC, 2 SVOCs (phthalates), and 13 inorganics were detected in surface soil samples (0 to 2 feet bgs) at Dump Site B. A comparison of the maximum detected soil concentrations to EPA Region III RBCs and EPA SSLs for soil to air is presented in Table 7-8. No VOCs or SVOCs were present in surface soil at concentrations in excess of the RBCs or SSLs. Arsenic was the only inorganic in surface soil which exceeded the RBCs for industrial exposures. Maximum concentrations of arsenic and beryllium exceeded

the RBCs for residential exposures. Future site use is anticipated to be nonresidential so only those compounds exceeding nonresidential RBCs will be retained as COPCs. Therefore, only arsenic was selected as a COPC for surface soil.

Maximum surface soil concentrations were also compared to EPA SSLs for migration to groundwater (Table 7-10). There were no exceedances of the SSLs in surface soil.

Surface/Subsurface Soil

One VOC, 2 SVOCs (phthalates), and 14 inorganics were detected in surface/subsurface soil (0 to >10 feet bgs) at Dump Site B. A comparison of the maximum detected soil concentrations to EPA Region III RBCs and EPA SSLs for soil to air is presented in Table 7-9. No VOCs or SVOCs were present in surface/subsurface soil at concentrations in excess of the RBCs or SSLs. Arsenic was the only inorganic which exceeded the RBCs for industrial exposures. Maximum concentrations of arsenic and beryllium in surface/subsurface soil exceeded the RBCs for residential exposures. Future site use is anticipated to be nonresidential so only those compounds exceeding nonresidential RBCs will be retained as COPCs. Therefore, only arsenic was selected as a COPC for surface/subsurface soil.

Maximum surface/subsurface soil concentrations were also compared to EPA SSLs for migration to groundwater (Table 7-10). There were no exceedances of the SSLs in surface/subsurface soil.

Groundwater

Two VOCs, 4 SVOCs (PAHs and phthalates), one explosive, and 11 inorganics were detected in unfiltered groundwater samples collected at Dump Site B. Nine inorganics were found in the filtered groundwater samples. A comparison of the maximum detected groundwater concentrations to EPA Region III RBCs is presented in Table 7-11. The maximum detected concentrations of chloroform, RDX, and cadmium in unfiltered groundwater samples exceeded the RBCs for tap water ingestion. The maximum detected cadmium concentration of 1.9 µg/L exceeded its RBC of 1.8 µg/L but was below the basewide background concentration of 2.8 µg/L, consequently cadmium will not be retained as a COPC. Therefore, only chloroform and RDX were retained as COPCs for groundwater.

7.6.2 Exposure Assessment

Dump Site B is an unlined landfill located adjacent to Chicamuxen Creek as shown on Figure 7-1. As discussed in Section 7.2.1 the Old Demolition Range existed in the immediate vicinity of this site and was

used for training similar to that which was conducted at Range 6. It is anticipated that future use of the site will remain nonresidential. Potential receptors for Dump Site B include current/future maintenance workers, current/future full-time employees, and future construction workers. Access to Dump Site B is restricted by a gate located north of the site, therefore civilian trespassers were not considered as potential human receptors.

Maintenance workers and full-time employees are assumed to enter the site to conduct maintenance (such as mowing) and related activities. The only medium of concern for these workers would be surface soil (0 to 2 feet bgs). Exposure to subsurface soil is expected to be limited to ground-intrusive activities. Although no major construction projects are planned for the site or the surrounding areas, construction workers are evaluated as potential receptors to assess future exposure to subsurface soil (assumed to be exposed to surface and subsurface soil to an estimated maximum depth of 10 feet bgs or greater).

The primary routes of exposure for potential human receptors at Dump Site B are incidental ingestion of soil and dermal contact with soil. Exposure routes associated with soil contact are evaluated for maintenance workers/full-time employees and future construction workers. Other potential exposure routes included incidental dermal contact with groundwater by construction workers.

Ingestion of groundwater, inhalation of volatile emissions, and ingestion of wildlife were not considered for the following reasons:

- The shallow aquifer at NSWC Stump Neck is not used as a potable water supply either on base or in surrounding off-base areas. Shallow groundwater at the site is tidally influenced and the source of potable water is the deeper aquifers. The deeper aquifers are not believed to be impacted by the surficial aquifer. Thus, groundwater exposures by base personnel are eliminated.

- Potential exposure to volatile emissions from Dump Site B soil is considered to be minimal, thereby eliminating the need for quantitative evaluation of this exposure pathway. As shown in Tables 7-8 and 7-9 all reported surface and subsurface soil concentrations are less than the EPA SSLs for transfers from soil to air (USEPA, 1996a).

- Ingestion of wildlife by hunters and their families was eliminated as a significant exposure pathway. The large size of the home ranges for game species at NSWC Stump Neck relative to the size of Dump Site B is not expected to result in significant foraging at the site. Moreover, the restrictive nature of the site would limit access both to the game species and to human receptors.

Exposure assumptions for these receptors are presented in Table 2-14. Table 7-12 presents a summary of the COPCs and exposure point concentrations for Dump Site B. A summary of the potentially significant exposures identified for quantitative evaluation for Dump Site B is provided in Table 7-13. The dose-response factors (RfDs and CSFs) for COPCs at Dump Site B were presented in Tables 2-10 and 2-11. Appendix P contains the toxicological profiles for the COPCs.

7.6.3 Risk Characterization

Potential cancer risks and hazard indices were calculated for maintenance workers, full-time employees, and construction workers (future land use) using the methodology presented in Section 2.0. Both RME and CTE exposure scenarios were evaluated. Table 7-14 contains a summary of the estimated risks for Dump Site B. All spreadsheets containing the detailed, chemical-specific risks for the site are included in Appendix P. The following text presents a summary of the results of the risk characterization.

7.6.3.1 Carcinogenic Effects

All estimated cancer risks for exposures to surface and subsurface soil were within or below EPA's target risk range of 10^{-4} to 10^{-6}. The estimated cancer risk for maintenance workers based on RME and CTE exposures to surface soil were 6.0×10^{-7} and 8.5×10^{-8}, respectively. The estimated cancer risk for full-time employees based on RME and CTE exposures to surface soil were 3.0×10^{-6} and 8.5×10^{-7}, respectively. The estimated cancer risk for construction workers based on RME and CTE exposures to surface and subsurface soil were 1.7×10^{-8} and 1.1×10^{-8}, respectively.

The estimated cancer risks for construction workers exposed to groundwater were below EPA's target risk range of 10^{-4} to 10^{-6}. The cancer risk for construction workers exposed to groundwater was 8.2×10^{-10} for RME exposures and 4.5×10^{-10} for CTE exposures.

The combined cancer risk for construction workers exposed to both soil and groundwater were below EPA's target risk range of 10^{-4} to 10^{-6}. The cancer risk for construction workers exposed to both soil and groundwater was 1.8×10^{-8} for RME exposures and 1.1×10^{-8} for CTE exposures.

7.6.3.2 Noncarcinogenic Effects

All estimated hazard indices were below 1.0 indicating that no toxic effects are anticipated for these receptors under the defined exposure scenarios. The hazard indices for maintenance workers exposed to surface soil were 0.0037 for RME exposures and 0.00061 for CTE exposures. The hazard indices for full-time employees exposed to surface soil were 0.019 for RME exposures and 0.0061 for CTE exposures.

The hazard indices for construction workers exposed to surface and subsurface soil was 0.0027 for RME exposures and 0.00092 for CTE exposures.

The hazard indices for construction workers exposed to groundwater were less than the acceptable level of 1.0. The hazard index for construction workers exposed to groundwater was 0.0028 for RME exposures and 0.0018 for CTE exposures.

The combined hazard index for construction workers exposed to both soil and groundwater was less than the acceptable level of 1.0. The hazard index for construction workers exposed to both soil and groundwater was 0.003 for RME exposures and 0.0011 for CTE exposures.

7.6.4.3 Qualitative Evaluation of Groundwater

Because site groundwater from surficial aquifers is not currently used or expected to be used in the future as a potable water supply and since potential exposure to this medium is not quantitatively addressed in the human health risk assessment (i.e., future residential use is not considered), a brief qualitative assessment of groundwater is included in this section. Table 7-15 contains a summary of the qualitative assessment of this medium.

Maximum detected concentrations in unfiltered and filtered groundwater samples collected at Dump Site B were compared to EPA MCLs, SMCLs, and EPA Region III RBCs for tap water. As previously indicated, the shallow aquifer at the site is not used as a source of drinking water either on- or off-base. Therefore, the comparison of site concentrations to primary MCLs, SMCLs, and RBCs serves as a conservative assessment of potential risks.

Chloroform and RDX were the only organic compounds detected in unfiltered groundwater samples at concentrations which exceeded RBCs. Chloroform was detected in only one of four groundwater samples and was not detected in soil at Dump Site B. In addition chloroform is a common laboratory contaminant. Consequently, the presence of chloroform in one groundwater sample at Dump Site B is not believed to be site related. Cadmium was the only inorganic compound detected in unfiltered groundwater samples at concentrations exceeding RBCs. The maximum detected cadmium concentration of 1.9 µg/L slightly exceeds the RBC of 1.8 µg/L. Concentrations of all compounds in unfiltered groundwater samples were below MCLs and SMCLs. Concentrations of all compounds in filtered groundwater samples were below RBCS, MCLs, and SMCLs.

7.6.3 Uncertainty Analysis

A detailed discussion of uncertainties associated with the various aspects of risk assessment in general was provided in Section 2.8. There are no site-specific uncertainties for Dump Site B.

7.6.4 Summary of Risk Assessment

The following items summarize the human health risk assessment for Dump Site B.

- The human health risk assessment for Dump Site B considered exposures to maintenance workers, full-time employees, and construction workers. Potential exposure pathways for direct contact with soil for all receptors included incidental ingestion and dermal contact with soil. Inhalation of fugitive dust and volatiles from soil were not considered since concentrations of all COPCs in soil were less than the EPA soil to air SSLs. In additional dermal contact with groundwater and inhalation of volatiles from groundwater were evaluated for construction workers.

- Incremental lifetime cancer risks for all receptors were within or below EPA's target risk range of 10^{-4} to 10^{-6}.

- Noncarcinogenic risk estimates (HIs) for all receptors were less than 1.0 indicating that no toxic effects are anticipated for these receptors under the defined exposure scenarios.

7.7 ECOLOGICAL ISSUES

This section presents the ERA, ecological risk management, ERA/risk management summary for Dump Site B and site-specific uncertainties.

7.7.1 Ecological Risk Assessment

This section presents the results of the ecological risk assessment performed at Dump Site B, and consists of a discussion of the preliminary problem formulation, effects characterization, exposure assessment, and risk characterization.

7.7.1.1 Preliminary Problem Formulation

This section includes a discussion of available habitats, ecological receptors, contaminant sources, release mechanisms, migration pathways, exposure routes, selection of preliminary contaminants of potential concern (PCOCs), assessment and measurement endpoints and the conceptual site model.

Habitat Types and Ecological Receptors

Dump Site B is located at the end of Porter Road, immediately adjacent to the Old Demolition Range (SWMU 23). A small peninsula is located at the terminus of Porter Road (Figure 7-4). The terminus of the road circles around Building 2107, the "hypervelocity building." Most of this peninsula is covered with turfgrass. At the time of the ecological site inspection, the entire perimeter of the peninsula had recently been cleared of a strip of trees and brush approximately 10 to 15 feet wide for the resumption of base activities at the site; only a few immature trees were left standing. A large marsh is located to the east and northeast of the site, and Chicamuxen Creek is located to the west and south. The western section of the site, located along Chicamuxen Creek, is comprised of a heavily wooded hillside. This area is dominated by tulip poplar (*Liriodendron tulipera*), red maple (*Acer rubrum*) and willow oak (*Quercus phellos*). Some beech trees (*Fagus grandifolia*) and hickories (*Carya* spp.) are also present. The subcanopy is dominated by pawpaw (*Asimina tribola*) and American holly (*Ilex opaca*).

The wooded hillside is part of the area designated as the Porter Woods Protection Area by the Maryland Natural Heritage Program (MDNHP, 1992). Two rare plant species were observed in this area during MDNHP surveys is 1991-1992. A small population of the State threatened large-seed forget-me-not (*Myosotis macrosperma*) occurs in the woods at the edge of the Creek less than 15 feet from the mean high water line. Approximately 30 plants were observed, although the actual population size cannot be ascertained without several years of observations. The wildflower *Nemophylla aphylla*, was also observed during the MDNHP surveys, and is ranked as rare by MDNHP. This species was observed near the Creek's edge, but extends into the wooded area over 300 feet from the water. Thousands of individuals were observed in sunny openings created by dead trees. MDNHP suggests that the presence of these two species, as well as adder's tongue fern (*Ophioglossum* sp.), in this area indicates that there may be shell deposits in the soil since these species typically grow in soil that is much less acidic than is usually found in the Coastal plain.

MDNHP documented the presence of three bird species in the Porter Woods area considered forest interior dwelling (FID) species: the red-eyed vireo (*Vireo olivaceus*), northern parula (*Parula americana*), and the scarlet tanager (*Pirangea olivacea*). The red-eyed vireo and scarlet tanager may be breeding successfully in the 20 acre woodland, but northern parulas require a minimum 250 acre floodplain to sustain a breeding population. Thus, MDNHP speculates that the long-term survival of the northern parula at Porter Woods is doubtful.

A bald eagle (*Haliaeetus leucocephalus*) nest is located in the wooded area a few hundred feet west of the base of the peninsula. This species is listed as both State and Federally threatened. One or two eagles were fledged each year from 1988 to 1991, but the nest was not used in 1992 (MDNHP, 1992). The following nesting activity has been observed since 1992: failed breeding attempt, 1993; 1 young fledged in 1994; 2 young fledged in 1995; 1 young fledged in 1996; and 2 young fledged in 1997 (Therres, 1997).

The freshwater tidal marsh to the east and northeast of the site is part of the Chicamuxen Creek Marsh Protection area, as designated by MDNHP (1992). Since the marsh and adjacent areas are of important regional ecological significance, the Chicamuxen Creek Natural Heritage Area was classified under the State Threatened and Endangered Species regulations (COMAR 07.03.08.10). These areas receive regulatory protection under the State Critical Area Regulations (COMAR 14.15.09). According to MDNHP, the Chicamuxen Creek Natural Heritage Area includes the area referred to as Chicamuxen Creek Marsh (on Navy property), and the contiguous wetlands and uplands under Navy and private ownership. This marsh system encompasses approximately 150 acres in two sections, separated by a large oxbow of Chicamuxen Creek. SWMU 6, the Air Blast Pond, is also located near this marsh system (Section 8.0).

The marshes are primarily dominated by cattail (*Typha* spp.), but also include tall cordgrass (*Spartina cynosuroides*), wild rice (*Zizania aquatica*), three-square bulrush (*Scirpus pungens*), and common reed (*Phragmites australis*) in the upper elevations. Although common reed is invasive and has been targeted for removal, the marshes are remarkably free of non-native vegetation and contain high diversity and abundance of plant life (MDNHP, 1992). Over 125 plant species have been recorded in the marsh area by MDNHP.

MDNHP has identified at least three rare animals and six rare plant species in the Chicamuxen Creek marsh complex. Two bird species listed as State species in need of conservation, the least bittern (*Ixobrychus exilis*) and American bittern (*Botarus lentiginosus*) were observed on the south side of Chicamuxen Creek in the central section of the marsh. These identifications were outside of Navy property, but MDNHP believes that several pairs of the two bittern species regularly nest in and utilize the marsh. Several stands of the State endangered red-berried greenbriar (*Smilax walteri*) are present in swamps in and along the perimeter of the marsh. This is the largest known population of this species in Maryland (MDNHP, 1992).

A State endangered and Federally threatened plant, the sensitive joint-vetch, was collected from a marsh at the mouth of Reeder Road in 1951, which is 0.5 miles south of the Navy portion of Chicamuxen Creek Marsh. This plant was not observed during recent MDNHP surveys in this area, but the species is an annual with long-term seed viability and may persist along Chicamuxen Creek in the seed bank or when

conditions are favorable (MDNHP, 1992). The State threatened giant cane (*Arundinaria gigantea*) occurs along Chicamuxen Creek less than 0.5 miles south of the Navy portion of Chicamuxen Creek Marsh, but has not been found in Chicamuxen Creek Marsh.

Most of the peninsula is flat and covered with turfgrass and weeds. As a result, precipitation on that portion of the site infiltrates and probably does not flow into the Creek and marsh. No drainage swales are evident in this area. Since the edge of the peninsula is higher in elevation that the Creek and most of the brush and trees have been cleared from the perimeter, runoff from those areas flows into the Creek and marsh. Runoff from the Porter Woods area most likely flows into Chicamuxen Creek since it is located on hilly terrain, although long stretches of the woods adjacent to the Creek are lower in elevation than the shoreline area. Communication between shallow groundwater and Chicamuxen Creek and the marsh probably occurs at the site.

Contaminant Sources, Release Mechanisms, and Migration Pathways

The major potential contaminant source at Dump Site B is residual soil contamination from historical landfilling activities, and to a lesser extent, from historical demolition activities at SWMU 23. The contaminant release pathways from this area include overland runoff and infiltration of contaminants. Air transport is unlikely since the site is heavily vegetated.

Precipitation runoff can carry contaminants via overland runoff to Chicamuxen Creek, mainly along the sloping banks around the peninsula and in the wooded area to the south. The heavily wooded areas that are higher in elevation than Chicamuxen Creek may trap surface runoff. Also, infiltrating precipitation can cause the potential contamination of subsurface soil and groundwater, which probably is a major contaminant transport mechanism because most of the peninsula is flat and water in low lying areas from precipitation will tend to pond and infiltrate. Contaminants can be deposited subsequently in sediment or surface water, and can potentially accumulate in the tissues of aquatic organisms in Chicamuxen Creek.

Exposure Routes

Terrestrial animals at Dump Site B can be exposed to soil contaminants through the ingestion of contaminated food items. In addition, animals can incidentally ingest soil while grooming fur, preening feathers, digging, grazing close to the soil, or feeding on items that are covered with soil (such as roots and tubers). Terrestrial vegetation can be exposed to contaminants through direct aerial deposition and root translocation, although aerial deposition is probably minuscule since the site is heavily vegetated, thus reducing fugitive dust. Terrestrial receptors can also come into contact with contaminants in surface

water in Chicamuxen Creek by using it for drinking, although this exposure route generally represents a negligible portion of total exposure for most receptors. Aquatic and semi-aquatic organisms can be exposed to contaminants through direct contact with surface water and sediments in Chicamuxen Creek, incidental ingestion of surface water and sediments in the Chicamuxen Creek, and consumption of contaminated food items. Exposure to contaminants in the soil via dermal contact can occur but is unlikely to represent a major exposure pathway because fur, feathers, and chitinous exoskeletons minimize the transfer of contaminants across dermal tissue.

Volatilization and soil-bound contaminant airborne suspension are not relevant at the site since the site is heavily vegetated. In addition, inhalation does not represent a significant exposure pathway because this investigation assumes that air contaminant concentrations are quite low, even for burrowing wildlife. Furthermore, inhalation ecotoxicity data for chronic exposure are lacking. Hence, the air pathway was not considered for ecological receptors.

Selection of Preliminary Contaminants of Concern (PCOCs)

The PCOC selection process for this ERA is described in Section 2.6.

Assessment and Measurement Endpoints

A description of assessment and measurement endpoints for this ERA is presented in Section 2.6.

Conceptual Site Model

Figure 7-11 shows the conceptual model for Dump Site B. Although aquatic exposure routes are presented (for Chicamuxen Creek), no surface water or sediment data were available, precluding the assessment of potential risks to aquatic and semi-aquatic receptors near the site.

7.7.1.2 Ecological Effects Characterization

Ecologically-based screening levels (concentrations of contaminants in various media protective of ecological receptors) were compared to exposure point concentrations of detected analytes in surface water, sediment, and surface soil to determine if they should be retained as ecological PCOCs at Dump Site B. The thresholds were USEPA Region III BTAG screening levels (EPA, 1995), although AWQC were used for groundwater. The derivation of toxicity reference values (TRVs) for Dump Site B foodchain modeling is also described in Section 2.6, as well as the selection of representative receptors. Briefly, the

short-tailed shrew, red-tailed hawk, red fox, meadow vole, and woodcock were selected as representative ecological receptors for the foodchain modeling at Dump Site B.

7.7.1.3 Exposure Assessment

This section presents the ecological exposure assessment for Dump Site B and includes a discussion of exposure point contaminant concentrations.

Exposure Point Contaminant Concentrations

The maximum detected contaminant concentrations in groundwater and soil were used as exposure point concentrations for screening against USEPA Region III BTAG screening levels and AWQC. The maximum and mean concentrations of contaminants detected in Dump Site B media were used in the foodchain modeling.

7.7.1.4 Risk Characterization

This section presents the results of the ERA for Dump Site B.

Results - Ecological Screening Assessment

Antimony, beryllium, chromium, copper, lead, mercury, nickel and zinc had maximum surface soil concentrations in excess of BTAG screening levels and were retained as inorganic PCOCs (Table 7-16). Two phthalates, bis(2-ethylhexyl)phthalate and di-n-butylphthalate, and acetone were retained as surface soil PCOCs since no BTAG screening levels were available (Table 7-16).

Barium, cadmium, cobalt, mercury, and silver had maximum groundwater concentrations in excess of AWQC (Table 7-17) and was retained as groundwater PCOCs.

Results - Foodchain Modeling

Antimony, beryllium, chromium, copper, lead, mercury and zinc were retained as inorganic surface soil PCOCs because at least one of the EEI values developed using maximum concentrations exceeded 1.0 (Table 7-18). Di-n-butyl phthalate was retained as a surface soil PCOC because at least one of its EEI values exceeded 1.0. All EEI values calculated using mean concentrations for beryllium and di-n-butyl phthalate were less than 1.0 (Table 7-19).

7.7.2 Risk Management

Risk management considerations for contaminants in Dump Site B surface soils and groundwater are discussed below.

7.7.2.1 Surface Soils

Antimony, beryllium, chromium, copper, lead, mercury and zinc were retained as PCOCs after the terrestrial foodchain modeling.

Antimony was detected in 2 of 10 samples and its maximum concentration (0.69 mg/kg) was within the range of regional background concentrations (<1-1 mg/kg; Boerngen and Shacklette, 1981). No alternate guideline was available for this metal.

Beryllium's maximum concentration (1.1 mg/kg) was greater than the average basewide background concentration (0.4 mg/kg; Table 7-20), but within the range of regional background concentrations (<1-7 mg/kg; Boerngen and Shacklette, 1981). Beryllium's average concentration (0.58 mg/kg) was slightly higher than the average basewide background concentration (0.4 mg/kg). Also, all EEI values for beryllium derived using mean concentrations for beryllium were less than 1.0.

Chromium's average concentration (21 mg/kg) was approximately equal to the maximum concentration in the basewide background (20.8 mg/kg) and approximately two times the average basewide background concentration (12 mg/kg). In addition, chromium's maximum concentration was slightly higher than the range of regional background concentrations (15-20 mg/kg; Boerngen and Shacklette, 1981).

Copper's maximum concentration (26.1 mg/kg) was greater than the range of basewide background concentrations, as well as the range of regional concentrations (7-10 mg/kg). It should be noted that the copper concentrations were within the range of background concentration reported as additional reference for the State of Maryland (Dragun 1991). The maximum concentration of copper was less than both of the alternate guidelines presented, which are ORNL values indicative of toxicity to soil organisms. Copper's average concentration (14.1 mg/kg) was less than the BTAG screening level.

Lead's maximum concentration was less than the average basewide background concentration (17.9 mg/kg), and slightly higher than the range of regional background concentrations (10-15 mg/kg; Boerngen and Shacklette, 1981). It was also much less than the ORNL alternate guidelines (Table 7-20),

indicative of toxicity to soil organisms. The average concentration of lead in Dump Site B surface soils (11.5 mg/kg) was within the range of regional background.

Mercury's maximum concentration (0.07 mg/kg) was slightly higher than the average basewide background concentration (0.04 mg/kg) and equal to the upper end of the range of regional concentrations (0.04-0.07 mg/kg; Boerngen and Shacklette, 1981). Mercury's average concentration (0.04 mg/kg) was equal to the average basewide concentration.

Zinc's maximum concentration (45.2 mg/kg) was higher than the average basewide background concentration (18.1 mg/kg) and higher than the range of regional background concentrations (15-26 mg/kg; Boerngen and Shacklette, 1981). Yet, zinc's maximum concentration was an order of magnitude lower than the ORNL alternate guidelines (Table 7-5), indicative of toxicity to soil organisms. Only the EEI (1.3) for the woodcock, derived using a mean concentration and comparing to a NOAEL, was greater than 1.0. It should be noted that the zinc concentrations noted were within the background range reported in an additional reference for the State of Maryland (Dragun, 1991).

Di-n-butyl phthalate, a common laboratory contaminant, was retained as a surface soil PCOC after the terrestrial foodchain modeling. This compound was detected in 5 of 10 samples at a maximum of 340 µg/kg. No BTAG screening level was available, but the maximum concentration was an order of magnitude lower than the alternate guideline (Table 7-20) which is a Dutch value (3005 µg/kg) indicative of potential risks to ecological receptors. All EEI values derived using mean concentrations were less than 1.0.

In summary, antimony, beryllium, chromium, lead and mercury maximum concentrations in surface soil were comparable to basewide background concentrations and regional background concentrations. Copper and zinc maximum concentrations were elevated relative to basewide and regional background concentrations. However, they were within the same order of magnitude as regional ranges. Also, the maximum concentrations of copper and zinc were an order of magnitude lower than alternate guidelines. The maximum concentrations of copper and zinc in subsurface soils, 16.5 and 37.6, respectively, are less than the maximum concentrations in surface soils.

Metals in soils at hazardous waste sites are typically in poorly available forms (Will and Suter, 1995), although the site-specific bioavailability of metals in Dump Site B soils is not known. Dump Site B, in particular the wooded area west of the turfgrass field, supports a diverse and abundant canopy and understory typical of similar habitats on the base and in the region. No evidence of stressed vegetation is apparent. The maximum concentration of copper was collected in a surface soil sample in the wooded

area (SS02; Figure 7-4). Although the maximum concentration of zinc was in a sample collected from the grassy area (SS06), several detections of zinc that were slightly elevated relative to background were present in samples collected in the wooded area. For these reasons, although the maximum concentrations of copper and zinc are somewhat elevated relative to background, no final inorganic PCOCs were retained for Dump Site B.

Di-n-butyl phthalate was detected in half of the surface soil samples, but its maximum concentration was an order of magnitude less than the alternate guideline. Because phthalates are common laboratory contaminants and its maximum concentration was less than a guideline, this compound will not be retained as a final organic PCOC in Dump Site B surface soils.

Although contaminants in site surface soils may not pose a significant risk to terrestrial receptors, contaminant migration to the adjacent Chicamuxen Creek is possible. However, the concentrations of contaminants in surface soils, particularly copper and zinc, do not appear to be high enough to qualitatively indicate the potential for significant migration via overland runoff. The site is heavily vegetated, precluding significant erosion of surface soils. Also, the top of the bank along Chicamuxen Creek is slightly higher in elevation than most of the wooded area behind it. As a result, it appears that most of the rainwater will tend to pond and infiltrate.

Groundwater to surface water migration of contaminants is possible. Several metals and a few organics were detected in groundwater. Nonetheless, without surface water or sediment data in Chicamuxen Creek adjacent to the site only, qualitative inferences regarding groundwater to surface water and sediment migration can be made. For the most part, the concentrations of contaminants in subsurface soils are lower than those in surface soils, suggesting that leaching of metals, if possible, may not result in significant subsurface soil to groundwater contaminant migration.

7.7.3 ERA and Risk Management Summary and Conclusions

The maximum detected concentrations of contaminants detected in Dump Site B surface soils and groundwater were compared to BTAG screening levels. All contaminants with maximum concentrations that exceeded BTAG screening levels were retained as PCOCs and were included in terrestrial foodchain modeling at the site for several representative ecological receptors. Contaminants that had at least one EEI greater than 1.0 in the foodchain modeling (for all representative receptors) using maximum concentrations were retained as PCOCs. Finally, those PCOCs were assessed using risk management considerations to develop a list of final PCOCs. As a result of these analyses, the following conclusions are drawn.

- The maximum concentrations of most metals in surface soils that were retained as PCOCs after the foodchain modeling were comparable to basewide and regional background concentrations.

- Copper and zinc were present in surface soils at maximum concentrations which may be elevated relative to basewide and regional background concentrations.

- No stressed vegetation is present on the site. The site supports a diverse and abundant flora typical of similar habitats on the base and in the region.

- The bald eagle's nest located near the site has successfully produced young for several years, suggesting that site- and base-related contaminants were not resulting in obvious reproductive effects to this contaminant-sensitive, federally-threatened species. The eagle's foraging range, up to 1,830 hectares (EPA, 1993), is much larger than all of the sites investigated in this ERA combined.

- Despite elevated copper and zinc in site surface soils, remediation does not appear to be desirable due to the presence of an apparently healthy flora with several large, mature trees, and the presence of the bald eagle's nest. The area is part of the Porter Woods Protection Area and disturbance of this area and its rare flora and fauna should be avoided.

- Since no surface water and sediment data in Chicamuxen Creek were available near the site, contaminant impacts from Dump Site B to Chicamuxen Creek cannot be quantitatively assessed. However, the surface soil data, subsurface soil data, and topography did not indicate that significant overland migration of surface soil contaminants are likely.

7.7.4 Site-specific Uncertainties

The following items summarize site-specific uncertainties for the ERA at Dump Site B:

- No BTAG screening level was available for Di-n-butyl phthalate, and no alternate guidelines were available for the inorganics antimony and beryllium. Although these metals do not appear to be elevated relative to background, the general lack of toxicity data for these metals precludes a thorough toxicological evaluation of their presence in site sediments.

- The maximum concentrations of several metals, mainly copper and zinc, in surface soils did not appear to be significantly elevated relative to background and were much less than alternate

guidelines. As mentioned earlier, metals at hazardous waste sites are usually in poorly available forms (Will and Suter, 1995). However, the lack of site-specific bioavailability data introduces uncertainty into the ERA.

- Surface water and sediment data for Chicamuxen Creek near Dump Site B were not available. Therefore potential risks to aquatic and semi-aquatic receptors could not be assessed. This lack of aquatic data also precludes the assessment of potential contaminant migration from Dump Site B to Chicamuxen Creek.

7.8 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Section 7.8 summarizes the environmental investigations conducted to date, the nature and extent of the chemicals detected in the environmental media, and the results of the baseline risk assessment. Conclusions and recommendations are provided.

The following items summarize the investigative work conducted to date:

1. The field investigation included the field screening of 18 shallow soil samples for TNT and RDX and a magnetometer survey covering a 137,500 square foot area to identify potential contaminant "hot spots".

2. Surface and subsurface soil samples were collected from 10 locations and submitted to a fixed-base laboratory (GP) for analysis. In total, 10 surface and 12 subsurface soil samples were collected.

3. Four monitoring wells were installed. One round of synoptic water level measurements were recorded.

4. Environmental samples collected for analysis by the fixed-base laboratory were analyzed for a comprehensive suite of analytes including volatile organic and semivolatile organic compounds, metals, and explosives.

The following items summarize the environmental conditions at Dump Site B:

1. The subsurface soil materials were relatively consistent across the study area both vertically and horizontally. The surficial deposits generally consist of yellow and brown silt, sand, and clay

mixtures and range in thickness from 6 to 12 feet. These surface materials were underlain by a coarsening downward sequence of medium to coarse sand and gravel to the bottom of the well borings. No waste materials were encountered in the subsurface. There were areas of scattered surface debris observed however, probably as a result of wash from Chicamuxen Creek and residual fill from the graded area around well DSBMW01.

2. The groundwater beneath the site occurs primarily under locally semiconfining and unconfined (water table) conditions. The water table aquifer consists primarily of yellow-brown sand. Based on topography, shallow groundwater is presumed to be flowing to the south toward and discharging into Chicamuxen Creek. However, the creek is tidal and during high tide, losing stream conditions occur which cause the water table to be slightly elevated near the stream (bank storage). As a result, the groundwater appears to be flowing to the north away from Chicamuxen Creek. The groundwater flow pattern at the site is not static. During low-tide conditions, Chicamuxen Creek becomes a gaining stream which causes a decrease in the elevation of the water table near the stream and would result in a groundwater flow pattern to the south.

3. The groundwater resource is probably recharged by downward migration of precipitation through the unsaturated zone to the water table. In addition, groundwater along the edge of the stream is also recharged as a result of the losing stream conditions during high tide.

4. The results of the analysis of surface and subsurface soil samples from Dump Site B suggest that historic activities have not resulted in significant contamination of the soils. No explosives were detected. Acetone, the only volatile organic chemical noted, was reported at a maximum concentration similar to or less than those reported for the background soil dataset. Three phthalate compounds were the only semi-volatile organics detected in soils. Site-related as well as non-site-related activities may have contributed to the presence of these compounds in the environmental media. Concentrations reported in site samples are similar to those reported in the background dataset. With a few exceptions, metals concentrations reported in the surface and subsurface soils samples appear to reflect background conditions.

5. Two volatile organics (chloroform and 1,1,1-trichloroethane), three phthalate compounds (e.g., bis[2-ethylhexyl]phthalate), and phenanthrene were sporadically detected in groundwater samples collected at Dump Site B. The maximum concentrations detected (less than 10 ug/L) suggest that a significant subsurface groundwater contaminant source is not present at Dump Site B.

6. With few exceptions, metals concentrations in groundwater appear to reflect background conditions. Maximum concentrations reported do not exceed EPA Region III RBCs or SDWA MCLs.

The following items summarize the baseline human health risk assessment conducted for Dump Site B:

1. The human health risk assessment for Dump Site B considered exposures to maintenance workers, full-time employees, and construction workers. Potential exposure pathways for direct contact with soil for all receptors included incidental ingestion and dermal contact with soil. Inhalation of fugitive dust and volatiles from soil were not considered since concentrations of all COPCs in soil were less than the SSLs developed by the EPA for the migration of contaminants from soil to air. In addition, dermal contact with groundwater was evaluated for construction workers.

2. Arsenic was the only COPC selected for the evaluation of exposures to soil. Chloroform and RDX were the only COPCs selected for the evaluation of exposures to groundwater.

3. Incremental lifetime cancer risk estimates for all receptors hypothetically exposed to COPCs in soil and groundwater were within or less than the EPA's target risk range of 10^{-4} to 10^{-6}.

4. Noncarcinogenic risk estimates (HIs) calculated for all receptors were less than unity indicating that adverse noncarcinogenic health effects are not anticipated under the conditions established in the exposure assessment.

The following items summarize the baseline ecological risk assessment conducted for Dump Site B:

1. The maximum concentrations of most metals in surface soils that were retained as PCOCs after the foodchain modeling were comparable to basewide and regional background concentrations.

2. Copper and zinc were present in surface soils at maximum concentrations which may be elevated relative to basewide and regional background concentrations.

3. No stressed vegetation is present on the site. The site supports a diverse and abundant flora typical of similar habitats on the base and in the region.

4. The bald eagle's nest located near the site has successfully produced offspring for several years, suggesting that site- and base-related contaminants were not resulting in obvious reproductive effects to this contaminant-sensitive, federally-threatened species. The eagle's foraging range, up to 1,830 hectares (EPA, 1993), is much larger than all of the sites investigated in this ERA combined.

5. Despite elevated copper and zinc in site surface soils, remediation does not appear to be desirable due to the presence of an apparently healthy flora with several large, mature trees, and the presence of the bald eagle's nest. The area is part of the Porter Woods Protection Area and disturbance of this area and its rare flora and fauna should be avoided.

6. Since no surface water and sediment data in Chicamuxen Creek were available near the site, contaminant impacts from Dump Site B to the Creek cannot be quantitatively assessed. However, the surface soil data, subsurface soil data, and topography indicate that significant overland migration of surface soil contaminants is not likely.

Recommendations are not presented because field investigations are on-going for this site.

TABLE 7-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM FOR SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE	MEDIA	Explosives SW846 8330	APP IX Metals SW846 6010A/7000	APP IX SVOA SW846 8270B	APP IX VOA SW846 8240B	TOC SW846 9060	TOX SW846 9020B	Miscellaneous
DSBMW001F001	Groundwater		X					
DSBMW001F001	Groundwater							
DSBMW001U001	Groundwater	X	X	X	X			
DSBMW002F001	Groundwater		X					
DSBMW002U001	Groundwater	X	X	X	X			
DSBMW003F001	Groundwater		X					
DSBMW003F001-D	Groundwater		X					
DSBMW003U001	Groundwater	X	X	X	X			
DSBMW003U001-D	Groundwater	X	X	X	X			
DSBMW004F001	Groundwater		X					
DSBMW004U001	Groundwater	X	X	X	X			
DSBSB0010101	Subsurface soil	X	X	X	X			
DSBSB0020101	Subsurface soil	X	X	X	X			
DSBSB0030101	Subsurface soil	X	X	X	X			
DSBSB0030201	Subsurface soil	X	X	X	X			
DSBSB0040101	Subsurface soil	X	X	X	X			
DSBSB0040201	Subsurface soil	X	X	X	X			
DSBSB0050101	Subsurface soil	X	X	X	X			
DSBSB0050101-D	Subsurface soil	X	X	X	X			
DSBSB0060101	Subsurface soil	X	X	X	X			
DSBSB0070101	Subsurface soil	X	X	X	X			
DSBSB0080101	Subsurface soil	X	X	X	X			
DSBSB0090101	Subsurface soil	X	X	X	X			
DSBSB0100101	Subsurface soil	X	X	X	X			
DSBSS0010101	Surface Soil	X	X	X	X			
DSBSS0020101	Surface Soil	X	X	X	X			
DSBSS0030101	Surface Soil	X	X	X	X			

TABLE 7-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM FOR SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE	MEDIA	Explosives SW846 8330	APP IX Metals SW846 6010A/7000	APP IX SVOA SW846 8270B	APP IX VOA SW846 8240B	TOC SW846 9060	TOX SW846 9020B	Miscellaneous
DSBSS0040101	Surface Soil	X	X	X	X			
DSBSS0050101	Surface Soil	X	X	X	X			
DSBSS0050101-D	Surface Soil	X	X	X	X			
DSBSS0060101	Surface Soil	X	X	X	X			
DSBSS0070101	Surface Soil	X	X	X	X			
DSBSS0080101	Surface Soil	X	X	X	X			
DSBSS0090101	Surface Soil	X	X	X	X			
DSBSS0090101-D	Surface Soil	X	X	X	X			
DSBSS0100101	Surface Soil	X	X	X	X			

APP IX - Appendix IX
VOA - Volatile organic analyte
SVOA - Semi-volatile organic analyte
TOC - Total organic carbon
TOH - Total organic halides
Miscellaneous - Parmeters include ammonia and nitrate/nitrite.

TABLE 7-2

WELL CONSTRUCTION SUMMARY FOR SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Well Number	Ground Elevation (Ft. msl)	Top of Riser Elevation (Ft. ml)	Total Well Depth (Ft. bgs)	Monitored Interval (Ft. bgs)	Depth to Groundwater (Ft. tor)	Depth to Groundwater (Ft. bgs)	Groundwater Elevation (Ft. msl)
DSBMW10	9.52	11.73	16	6-16	10.49	8.28	1.24
DSBMW02	3.54	5.93	14.5	4-14	4.69	2.3	1.24
DWBMW03	8.01	10.4	22.5	12-22	9.27	6.88	1.13
DSBMW04	14.93	16.83	22.4	12.4-22.4	15.83	13.93	1

* Water levels measured 8/17/97.

Ft. msl - Feet above mean sea level.
Ft. bgs - Feet below ground surface.
Ft. tor - Feet below top of riser.

TABLE 7-3

FIELD TEST KIT RESULTS FOR SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Grid Location Identification	Laboratory Sample Identification	TNT Result (mg/kg)	RDX Result (mg/kg)
DSBFT01	DSBFT0010101	ND	ND
DSBFT02	DSBFT0020101	ND	ND
DSBFT03	DSBFT0030101	ND	ND
DSBFT04	DSBFT0040101	ND	ND
DSBFT05	DSBFT0050101	ND	ND
DSBFT06	DSBFT0060101	ND	ND
DSBFT07	DSBFT0070101	ND	ND
DSBFT08	DSBFT0080101	ND	ND
DSBFT09	DSBFT0090101	ND	ND
DSBFT10	DSBFT0100101	ND	ND
DSBFT11	DSBFT0110101	ND	ND
DSBFT12	DSBFT0120101	ND	ND
DSBFT13	DSBFT0130101	ND	ND
DSBFT14	DSBFT0140101	ND	ND
DSBFT15	DSBFT0150101	ND	ND
DSBFT16	DSBFT0160101	ND	ND
DSBFT17	DSBFT0170101	ND	ND
DSBFT18	DSBFT0180101	ND	ND

ND = Not Detected
TNT = 2,4,6-Trinitrotoluene
RDX = Cyclo-1,3,5-trimethylene-2,4,6-trinitramine
Published detection limit is 0.7 mg/kg for TNT and 0.8 mg/kg for RDX

TABLE 7-4
SUMMARY OF POSITIVE DETECTIONS IN SURFACE SOIL FOR SMWU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	DSBSS0010101	DSBSS0020101	DSBSS0030101	DSBSS0040101	DSBSS0050101	DSBSS0050101-D	DSBSS0060101
SAMPLE DATE:	07/10/97	07/23/97	07/22/97	07/21/97	08/02/97	08/02/97	08/02/97
LOCATION:	DSBSS0010101	DSBSS0020101	DSBSS0030101	DSBSS0040101	DSBSS0050101	DSBDUP014	DSBSS0060101
FIELD DUPLICATE OF:						DSBSS0050101	
VOLATILES (µg/kg)							
ACETONE				5000			
SEMIVOLATILES (µg/kg)							
BIS(2-ETHYLHEXYL)PHTHALATE		280 J	1400 J				
DI-N-BUTYL PHTHALATE	53 J					190 J	
METALS (mg/kg)							
ANTIMONY	0.52 L			0.69 L			
ARSENIC	3.6	3.1	3.3	5.1	4.9 L	4.3 L	3.4 L
BARIUM	46.7	67.2	31.0 J	59.1 J	44.5 J	45.8 J	48.1 J
BERYLLIUM	0.44	0.48 K	0.37	0.64	0.45 J	0.38 J	1.1 J
CADMIUM	0.42 K	0.12 K					
CHROMIUM	13.7	13.9	14.2 J	20.5 J	20.8 J	21.0 J	21.0 J
COBALT	6.2 J	9.6	5.2	22.4	4.2 J	4.0 J	7.6 J
COPPER	10.5	26.1	8.2	11.8	24.5	25.8	17.8
LEAD	10.1	14.3 K	11.2 J	12.4 J	17.9 J	16.4 J	9.4 J
MERCURY		0.06	0.05	0.07	0.04 L	0.03 L	
NICKEL	8.8	6.2	5.6	9.6	9.0 J	9.2 J	13.5 J
SELENIUM	1.2	0.60 L	0.90	1.5	0.83 J	0.79 J	1.5 J
VANADIUM	24.1	20.2	22.5	29.6	32.6	30.9	35.9
ZINC	36.2	24.8	22.0 J	35.6 J	37.5 J	36.5 J	45.2 J

TABLE 7-4
SUMMARY OF POSITIVE DETECTIONS IN SURFACE SOIL FOR SMWU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	DSBSS0070101	DSBSS0080101	DSBSS0090101	DSBSS0090101-D	DSBSS0100101		
SAMPLE DATE:	08/02/97	08/02/97	08/02/97	08/02/97	08/02/97	/ /	/ /
LOCATION:	DSBSS0070101	DSBSS0080101	DSBSS0090101	DSBDUP016	DSBSS0100101		
FIELD DUPLICATE OF:				DSBSS0090101			
SEMIVOLATILES (µg/kg)							
BIS(2-ETHYLHEXYL)PHTHALATE			160 J				
DI-N-BUTYL PHTHALATE	150 J		160 J	340 J	160 J		
METALS (mg/kg)							
ARSENIC	2.5 L	2.6 L	2.7 L	2.5 L	3.9 L		
BARIUM	48.3 J	76.6 J	54.6 J	57.2 J	44.3 J		
BERYLLIUM	0.78 J	0.55 J	0.56 J	0.58 J	0.47 J		
CHROMIUM	21.0 J	15.2 J	15.1 J	15.6 J	16.2 J		
COBALT	7.8 J	10.6 J	11.0 J	10.9 J	13.1 J		
COPPER	16.9	7.5	7.9	7.3	9.8		
LEAD	11.3 J	8.9 J	9.0 J	8.8 J	11.1 J		
MERCURY	0.02 L	0.03 L	0.04 L	0.04 L	0.07 L		
NICKEL	12.0 J	7.8 J	8.7 J	8.1 J	9.0 J		
SELENIUM	0.57 J	0.52 J	0.54 J	0.45 J	0.80 J		
VANADIUM	39.1	22.8	25.4	24.6	26.3		
ZINC	39.1 J	27.9 J	31.1 J	29.5 J	30.6 J		

TABLE 7-5
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SMWU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	DSBSB0010101	DSBSB0020101	DSBSB0030101	DSBSB0030201	DSBSB0040101	DSBSB0040201	DSBSB0050101
SAMPLE DATE:	07/10/97	07/23/97	07/22/97	07/22/97	07/21/97	07/21/97	08/02/97
LOCATION:	DSBSB0010101	DSBSB0020101	DSBSB0030101	DSBSB0030201	DSBSB0040101	DSBSB0040201	DSBSB0050101
FIELD DUPLICATE OF:							
VOLATILES (µg/kg)							
ACETONE			220			1200	
SEMIVOLATILES (µg/kg)							
BIS(2-ETHYLHEXYL)PHTHALATE		110 J					
METALS (mg/kg)							
ANTIMONY	0.40 L		0.43 L		0.66 L	0.45 L	
ARSENIC	1.7	3.4	4.1	3.2	2.7	3.0	1.8 L
BARIUM	31.5	131	50.8 J	57.9	35.2 J	49.5 J	65.2 J
BERYLLIUM	0.58	1.2	0.68	0.61 K	0.67	0.68	0.41 J
CADMIUM	0.40 K			0.14 K			
CHROMIUM	15.9	16.0	20.6 J	15.2	15.0 J	14.3 J	13.7 J
COBALT	8.5 J	19.4	10.8	6.8	4.5	10.5	5.3 J
COPPER	14.3	6.9	12.5	10.1	16.0	15.1	7.5
LEAD	9.3	11.2 K	9.2 J	7.6 K	10.3 J	9.6 J	9.1 J
MERCURY		0.07	0.02	0.02		0.02	0.04 L
NICKEL	7.6	10.2	12.0	9.0	10.1	12.1	7.5 J
SELENIUM	1.0	0.75 L	1.1	0.78 L	1.4	0.98	0.49 J
VANADIUM	32.3	26.0	36.1	22.5	29.2	31.0	21.8
ZINC	27.4	36.7	37.2 J	33.2	33.4 J	37.6 J	27.9 J

TABLE 7-5
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SMWU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	DSBSB0050101-D	DSBSB0060101	DSBSB0070101	DSBSB0080101	DSBSB0090101	DSBSB0100101	
SAMPLE DATE:	08/02/97	08/02/97	08/02/97	08/02/97	08/02/97	08/02/97	/ /
LOCATION:	DSBDUP015	DSBSB0060101	DSBSB0070101	DSBSB0080101	DSBSB0090101	DSBSB0100101	
FIELD DUPLICATE OF:	DSBSB0050101						
SEMIVOLATILES (µg/kg)							
DI-N-BUTYL PHTHALATE	160 J		100 J		200 J	180 J	
METALS (mg/kg)							
ARSENIC	3.7 L	2.7 L	2.9 L	3.8 L	7.4 L	1.9 L	
BARIUM	61.8 J	34.2 J	27.0 J	42.9 J	37.2 J	36.9 J	
BERYLLIUM	0.57 J	0.78 J	0.87 J	0.47 J	0.71 J	0.46 J	
CHROMIUM	18.3 J	15.0 J	17.4 J	17.6 J	18.0 J	15.0 J	
COBALT	4.9 J	5.0 J	8.3 J	10.7 J	5.1 J	5.9 J	
COPPER	6.0	10.9	11.6	10.5	16.5	14.7	
LEAD	9.0 J	6.7 J	7.2 J	9.7 J	10.7 J	9.9 J	
MERCURY	0.04 L	0.01 L	0.01 L	0.05 L	0.02 L	0.02 L	
NICKEL	7.9 J	8.6 J	8.5 J	9.5 J	10.5 J	10.9 J	
SELENIUM	0.59 J	0.55 J	0.98 J	0.70 J	0.95 J	0.76 J	
VANADIUM	27.0	26.2	29.3	31.9	32.3	28.7	
ZINC	28.8 J	28.2 J	31.8 J	31.3 J	33.7 J	33.2 J	

TABLE 7-6
SUMMARY OF POSITIVE DETECTIONS IN GROUNDWATER FOR SMWU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	DSBMW001U001	DSBMW001F001	DSBMW002U001	DSBMW002F001	DSBMW003U001	DSBMW003U001-D	DSBMW003F001
SAMPLE DATE:	08/05/97	08/05/97	08/06/97	08/06/97	08/05/97	08/05/97	08/05/97
LOCATION:	DSBMW001U001	DSBMW001F001	DSBMW002U001	DSBMW002F001	DSBMW003U001	DSBDUP003	DSBMW003F001
FIELD DUPLICATE OF:						DSBMW003U001	
VOLATILES (µg/L)							
1,1,1-TRICHLOROETHANE						2 J	
CHLOROFORM					2 J	4 J	
SEMIVOLATILES (µg/L)							
BIS(2-ETHYLHEXYL)PHTHALATE					1 J		
DI-N-BUTYL PHTHALATE					2 J	2 J	
DIETHYL PHTHALATE					2 J	2 J	
PHENANTHRENE			1 J		2 J	2 J	
ENERGETICS (µg/L)							
RDX	7.4		3.8				
METALS (µg/L)							
BARIUM	7.7	7.0			57.4	61.8	53.6
CADMIUM					1.7	1.8	1.8
CHROMIUM	2.1				4.4	4.8	2.3
COBALT	28.7	25.3	6.6	6.2	32.0	33.4	32.9
COPPER					4.6	5.2	4.1
LEAD	1.3				1.5	1.5	
MERCURY	0.10	0.13	0.13	0.10	0.20	0.18	0.18
NICKEL					11.2	10.5	10.3
VANADIUM						4.6	
ZINC	5.5	5.9			28.6	31.2	27.8

TABLE 7-6
SUMMARY OF POSITIVE DETECTIONS IN GROUNDWATER FOR SMWU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	DSBMW003F001-D	DSBMW004U001	DSBMW004F001				
SAMPLE DATE:	08/05/97	08/05/97	08/05/97	/ /	/ /	/ /	/ /
LOCATION:	DSBDUP003-F	DSBMW004U001	DSBMW004F001				
FIELD DUPLICATE OF:	DSBMW003F001						
METALS (µg/L)							
BARIUM	52.1	12.5	11.3				
CADMIUM	1.8	1.9	1.6				
CHROMIUM	2.1						
COBALT	30.9	29.7	28.7				
COPPER	4.0	4.2	3.6				
MERCURY	0.18	0.15	0.12				
NICKEL	10.2						
SILVER	0.86	1.2	0.81				
ZINC	25.1	7.5	6.9				

TABLE 7-7

COMPARISON OF SURFACE SOIL AND SUBSURFACE SOIL DATA FOR SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	SURFACE SOIL				SUBSURFACE SOIL			
	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum
VOLATILE ORGANIC COMPOUNDS (µg/kg)								
Acetone	1/10	5000	5000.00	DSBSS0040101	2/12	220-1200	710.00	DSBSB0040201
SEMIVOLTILE ORGANIC COMPOUNDS (µg/kg)								
Bis(2-ethylhexyl)phthalate	3/10	160-1400	613.33	DSBSS0030101	1/12	110	110.00	DSBSB0020101
Di-n-butyl phthalate	5/10	53-340	160.60	DSBSS0090101-D	4/12	100-200	160.00	DSBSB0090101
INORGANICS (mg/kg)								
Antimony	2/10	0.52-0.69	0.61	DSBSS0040101	4/12	0.40-0.66	0.48	DSBSB0040101
Arsenic	10/10	2.5-5.1	3.47	DSBSS0040101	12/12	1.7-7.4	3.30	DSBSB0090101
Barium	10/10	31-76.6	52.24	DSBSS0080101	12/12	27-131	49.80	DSBSB0020101
Beryllium	10/10	0.37-1.1	0.58	DSBSS0060101	12/12	0.46-1.2	0.68	DSBSB0020101
Cadmium	2/10	0.12-0.42	0.27	DSBSS0010101	2/12	0.14-0.40	0.27	DSBSB0010101
Chromium	10/10	13.7-21	17.20	DSBSS0050101-D, DSBSS0060101, DSBSS0070101	12/12	14.3-20.6	16.33	DSBSB0030101
Cobalt	10/10	4-22.4	9.76	DSBSS0040101	12/12	4.5-19.4	8.38	DSBSB0020101
Copper	10/10	7.3-26.1	14.14	DSBSS0020101	12/12	6.75-16.5	12.15	DSBSB0090101
Lead	10/10	8.8-17.9	11.48	DSBSS0050101	12/12	6.7-11.2	9.20	DSBSB0020101
Mercury	8/10	0.02-0.07	0.05	DSBSS0100101, DSBSS0040101	10/12	0.01-0.07	0.03	DSBSB0020101
Nickel	10/10	5.6-13.5	9.00	DSBSS0060101	12/12	7.6-12.1	9.72	DSBSB0040201
Selenium	10/10	0.45-1.5	0.89	DSBSS0040101, DSBSS0060101	12/12	0.54-1.4	0.87	DSBSB0040101
Vanadium	10/10	20.2-39.1	27.73	DSBSS0070101	12/12	22.5-36.1	29.16	DSBSB0030101
Zinc	10/10	22-45.2	32.87	DSBSS0060101	12/12	27.4-37.6	32.67	DSBSB0040201

* Screening levels exceeded by maximum site concentrations have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.

TABLE 7-8

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT FOR SURFACE SOIL (0 TO 2 FEET)
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGAITON/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tol. Limit for Background	Greater Than Background?	SSL Transfer from Soil to Air (5)	Selected as COPC?
					Industrial	Residential					
VOLATILE ORGANIC COMPOUNDS (µg/kg)											
Acetone	1/10	5000	5000.00	DSBSS0040101	20000000	780000	N	13000	No	100000000	No
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)											
Bis(2-ethylhexyl)phthalate	3/10	160-1400	613.33	DSBSS0030101	410000	46000	C	640	Yes	31000000	No
Di-n-butyl phthalate	5/10	53-340	160.60	DSBSS0090101-D	20000000	780000	N	ND (6)	Yes (7)	2300000	No
INORGANICS (mg/kg)											
Antimony	2/10	0.52-0.69	0.61	DSBSS0040101	82	3.1	N	ND	Yes (7)	(8)	No
Arsenic	10/10	2.5-5.1	3.47	DSBSS0040101	**3.8***	**0.43**	C	4.25	Yes	750	Yes
Barium	10/10	31-76.6	52.24	DSBSS0080101	14000	550	N	144	No	690000	No
Beryllium	10/10	0.37-1.1	0.58	DSBSS0060101	1.3	**0.15**	C	0.905	Yes	1300	No
Cadmium	2/10	0.12-0.42	0.27	DSBSS0010101	100	3.9	N	0.26	Yes	1800	No
Chromium (9)	10/10	13.7-21	17.20	DSBSS0050101-D, DSBSS0060101, DSBSS0070101	1000	39	N	24.2	No	270	No
Cobalt	10/10	4-22.4	9.76	DSBSS0040101	12000	470	N	39.7	No	-	No
Copper	10/10	7.3-26.1	14.14	DSBSS0020101	8200	310	N	18.7	Yes	-	No
Lead	10/10	8.8-17.9	11.48	DSBSS0050101	2000 (10)	400 (10)	N	149	No	-	No
Mercury	8/10	0.02-0.07	0.05	DSBSS0100101, DSBSS0040101	61	2.3	N	0.087	No	10	No
Nickel	10/10	5.6-13.5	9.00	DSBSS0060101	4100	160	N	18.2	No	13000	No
Selenium	10/10	0.45-1.5	0.89	DSBSS0040101, DSBSS0060101	1000	39	N	1.09	Yes	-	No
Vanadium	10/10	20.2-39.1	27.73	DSBSS0070101	1400	55	N	53.5	No	-	No
Zinc	10/10	22-45.2	32.87	DSBSS0060101	61000	2300	N	38.1	Yes	-	No

* Screening levels exceeded by maximum site concentrations have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 Soil Screening Levels (SSLs) for transfers from soil to air (USEPA, 1996) included for qualitative evaluation only.
6 ND = not detected; NA = not applicable.
7 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
Organic background data presented for information purposes, but not for COPC selection.
8 Data not available.
9 Considered as hexavalent chromium.
10 OSWER screening level for lead in soil (USEPA, 1993).

TABLE 7-9

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT FOR ALL SOIL
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICAITON INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tolerance Limit for Background		Greater Than Background?	SSL Transfer from Soil to Air (5)	Selected as COPC?
					Industrial	Residential		Surface	Subsurface			
VOLATILE ORGANIC COMPOUNDS (µg/kg)												
Acetone	3/22	220-5000	2140.00	DSBSS0040101	20000000	780000	N	13000	1800	No	100000000	No
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)												
Bis(2-ethylhexyl)phthalate	4/22	110-1400	487.50	DSBSS0030101	410000	46000	C	640	ND (6)	Yes	31000000	No
Di-n-butyl phthalate	9/22	53-340	160.33	DSBSS0090101-D	20000000	780000	N	ND	ND	Yes (7)	2300000	No
INORGANICS (mg/kg)												
Antimony	6/22	0.4-0.69	0.53	DSBSS0040101	82	3.1	N	ND	3.6	No	(8)	No
Arsenic	22/22	1.7-7.4	3.38	DSBSB0090101	**3.8***	**0.43**	C	4.25	24.4	Yes	750	Yes
Barium	22/22	27-131	50.91	DSBSB0020101	14000	550	N	144	191	No	690000	No
Beryllium	22/22	0.37-1.2	0.64	DSBSB0020101	1.3	**0.15**	C	0.905	2.46	Yes	1300	No
Cadmium	4/22	0.12-0.42	0.27	DSBSS0010101	100	3.9	N	0.26	0.388	Yes	1800	No
Chromium (9)	22/22	13.7-21	16.73	BSS0050101-D,. DSBSS0060101, DSBSS0070	1000	39	N	24.2	101	No	270	No
Cobalt	22/22	4-22.4	9.01	DSBSS0040101	12000	470	N	39.7	133	No	-	No
Copper	22/22	6-26.1	13.05	DSBSS0020101	8200	310	N	18.7	56.5	Yes	-	No
Lead	22/22	6.7-17.9	10.24	DSBSS0050101	2000 (10)	400 (10)	N	149	37.5	No	-	No
Mercury	18/22	0.01-0.07	0.04	SBSB0020101, DSBSS0040101, DSBSS01001	61	2.3	N	0.087	0.13	No	10	No
Nickel	22/22	5.6-13.5	9.40	DSBSS0060101	4100	160	N	18.2	22.1	No	13000	No
Selenium	22/22	0.45-1.5	0.88	DSBSS0040101, DSBSS0060101	1000	39	N	1.09	8.93	Yes	-	No
Vanadium	22/22	20.2-39.1	28.51	DSBSS0070101	1400	55	N	53.5	133	No	-	No
Zinc	22/22	22-45.2	32.76	DSBSS0060101	61000	2300	N	38.1	79.5	Yes	-	No

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 Soil Screening Levels (SSLs) for transfers from soil to air (USEPA, 1996) included for qualitative evaluation only.
6 ND = not detected; NA = not applicable.
7 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
Organic background data presented for information purposes, but not for COPC selection.
8 Data not available.
9 Considered as hexavalent chromium.
10 OSWER screening level for lead in soil (USEPA, 1993).

TABLE 7-10

SOIL CONCENTRATION VERSUS SOIL SCREENING LEVELS (SSLs) FOR PROTECTION OF GROUNDWATER
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Upper Tolerance Limit for Background		Greater Than Background?	SSL Transfer from Soil to GW-20DAF(3)
					Surface	Subsurface		
VOLATILE ORGANIC COMPOUNDS (µg/kg)								
Acetone	3/22	220-5000	2140.00	DSBSS0040101	13000	1800	No	16000
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)								
Bis(2-ethylhexyl)phthalate	4/22	110-1400	487.50	DSBSS0030101	640	ND (4)	Yes	3600000
Di-n-butyl phthalate	9/22	53-340	160.33	DSBSS0090101-D	ND	ND	Yes (5)	2300000
INORGANICS (mg/kg)								
Antimony	6/22	0.4-0.69	0.53	DSBSS0040101	ND	3.6	No	5
Arsenic	22/22	1.7-7.4	3.38	DSBSB0090101	4.25	24.4	Yes	29
Barium	22/22	27-131	50.91	DSBSB0020101	144	191	No	1600
Beryllium	22/22	0.37-1.2	0.64	DSBSB0020101	0.905	2.46	Yes	63
Cadmium	4/22	0.12-0.42	0.27	DSBSS0010101	0.26	0.388	Yes	8
Chromium (7)	22/22	13.7-21	16.73	DSBSS0050101-D,. DSBSS0060101, DSBSS0070101	24.2	101	No	38
Cobalt	22/22	4-22.4	9.01	DSBSS0040101	39.7	133	No	(6)
Copper	22/22	6-26.1	13.05	DSBSS0020101	18.7	56.5	Yes	-
Lead	22/22	6.7-17.9	10.24	DSBSS0050101	149	37.5	No	-
Mercury	18/22	0.01-0.07	0.04	DSBSB0020101, DSBSS0040101, DSBSS0100101	0.087	0.13	No	2
Nickel	22/22	5.6-13.5	9.40	DSBSS0060101	18.2	22.1	No	130
Selenium	22/22	0.45-1.5	0.88	DSBSS0040101, DSBSS0060101	1.09	8.93	Yes	5
Vanadium	22/22	20.2-39.1	28.51	DSBSS0070101	53.5	133	No	6000
Zinc	22/22	22-45.2	32.76	DSBSS0060101	38.1	79.5	Yes	12000

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Soil Screening Levels (SSLs) for migration from soil to groundwater (USEPA, 1996) corresponding to a dilution and attenuation factor (DAF) of 20.
4 ND = not detected; NA = not applicable.
5 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
Organic background data presented for information purposes, but not for COPC selection.
6 Data not available.
7 Considered as hexavalent chromium.

TABLE 7-11A

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT FOR GROUNDWATER - UNFILTERED SAMPLES
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGAITON REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	UTL for Background (5)	Greater Than Background?	Selected as COPC?
VOLATILE ORGANIC COMPOUNDS (µg/L)									
1,1,1-Trichloroethane	1/4	2	2	DSBMW003U001-D	54	N	ND (6)	Yes (7)	No
Chloroform	1/4	2-4	3	DSBMW003U001-D	**0.15***	C	2	Yes	Yes
SEMIVOLATILE ORGANIC COMPOUNDS (µg/L)									
Bis(2-ethylhexyl)phthalate	1/4	1	1.00	DSBMW003U001	4.8	C	1	No	No
Di-n-butyl phthalate	1/4	2	2.00	DSBMW003U001, DSBMW003U001-D	370	N	1	Yes	No
Diethyl phthalate	1/4	2	2.00	DSBMW003U001, DSBMW003U001-D	2900	N	3	No	No
Phenanthrene	2/4	1-2	1.50	DSBMW003U001, DSBMW003U001-D	(8)	-	ND	Yes (7)	No (9)
EXPLOSIVES (µg/L)									
RDX (9)	2/4	3.8-7.4	5.60	DSBMW001U001	**0.61**	C	1.2	Yes	Yes
INORGANICS (µg/L)									
Barium	3/4	7.7-61.8	26.60	DSBMW003U001-D	260	N	253.5	No	No
Cadmium	2/4	1.7-1.9	1.83	DSBMW004U001	1.8	N	2.8	No	No
Chromium (11)	2/4	2.1-4.8	3.35	DSBMW003U001-D	18	N	20.9	No	No
Cobalt	4/4	6.6-33.4	24.43	DSBMW003U001-D	220	N	39.6	No	No
Copper	2/4	4.2-5.2	4.55	DSBMW003U001-D	150	N	22.4	No	No
Lead	2/4	1.3-1.5	1.40	DSBMW003U001, DSBMW003U001-D	15 (12)	N	ND	Yes (7)	No
Mercury	4/4	0.1-0.2	0.14	DSBMW003U001	1.1	N	0.13	Yes	No
Nickel	1/4	10.5-11.2	10.85	DSBMW003U001	73	N	39	No	No
Silver	1/4	1.2	1.2	DSBMW004U001	18	N	ND	Yes (7)	No
Vanadium	1/4	4.6	4.00	DSBMW003U001-D	26	N	24.1	No	No
Zinc	3/4	5.5-31.2	14.30	DSBMW003U001-D	1100	N	45.2	No	No

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 Only nonturbid background samples included.
6 ND = not detected; NA = not applicable.
7 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
Organic background data presented for information purposes, but not for COPC selection.
8 Data not available.
9 Sufficient toxicity criteria not available; maximum concentration below screening levels of related chemicals (naphthalene, fluoranthene,fluorene).
10 RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine.
11 Considered as hexavalent chromium.
12 Safe Drinking Water Act Action Level.

TABLE 7-11B

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT FOR GROUNDWATER - FILTERED SAMPLES
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP STIE B
RCRA FACILITY INVESTIGATION/VERIFICAITON INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	Upper Tol. Limit for Background	Greater Than Background?
Inorganics (µg/L)								
Barium, Filtered	3/4	7-53.6	23.72	DSBMW003F001	260	N	114	No
Cadmium, Filtered	2/4	1.6-1.8	1.70	DSBMW003F001, DSBMW003F001-D	1.8	N	2.9	No
Chromium, Filtered (5)	1/4	2.1-2.3	2.20	DSBMW003F001	18	N	ND (6)	Yes (7)
Cobalt, Filtered	4/4	6.2-32.9	23.03	DSBMW003F001	220	N	13	Yes
Copper, Filtered	2/4	3.6-4.1	3.83	DSBMW003F001	150	N	3.8	Yes
Mercury, Filtered	4/4	0.1-0.18	0.13	DSBMW003F001, DSBMW003F001-D	1.1	N	0.16	Yes
Nickel, Filtered	1/4	10.2-10.3	10.25	DSBMW003F001	73	N	41.4	No
Silver, Filtered	1/4	0.86	0.86	DSBMW003F001-D	18	N	ND	Yes (7)
Vanadium, Filtered	2/4	0.81-0.86	0.90	DSBMW003F001-D	26	N	ND	Yes (7)
Zinc, Filtered	3/4	5.9-27.8	13.08	DSBMW003F001	1100	N	10.3	Yes

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6. or a target cancer risk of 1E-6. Unfiltered data and screening levels presented only for qualitative analysis, not for COPC selection.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 Considered as hexavalent chromium.
6 ND = not detected; NA = not applicable.
7 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.

TABLE 7-12

CHEMICALS OF POTENTIAL CONCERN AND EXPOSURE CONCENTRATIONS
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC, INDIAN HEAD, MARYLAND

Medium	Organics		Inorganics	
	Chemical	Exposure Point Concentration[1]	Chemical	Exposure Point Concentration[1]
Surface Soil	None[2]	-	Arsenic	4.06 mg/kg
All Soil (Surface/ Subsurface Soil)	None[2]	-	Arsenic	0.37 mg/kg
Sediments	None[3]	-	None[3]	-
Groundwater (Unfiltered)	Chloroform RDX[4]	3.00 µg/L (max.) 7.40 µg/L (max.) 5.60 µg/L (ave.)	None[3]	-
Surface Water/Fish Tissue	None[3]	-	None[3]	-

1 95 Percent UCLs of the arithmetic mean were used as exposure point concentrations for RME and CTE, unless they exceeded the maximum concentration or fewer than 10 sample were analyzed. In these instances, the maximum concentrations were used for the RME. The mean of positive detects for data sets with fewer than 10 samples (if less than the maximum) were used for the CTE. Statistics for distribution of data sets and 95 percent UCLs are presented in Appendix I.
2 No maximum analyte concentrations exceeded screening levels and\or background concentrations.
3 No sediment or surface water samples were collected.
4 RDX = hexahydro-1,3,5-trinitro-1,3,5,-triazine.

TABLE 7-13

SUMMARY OF EXPOSURE SCENARIOS
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Medium	Receptor	Exposure Route
Current Scenario		
Surface Soil[1]	Maintenance Worker/ Full-Time Employee	Incidental Ingestion Dermal Contact
Future Scenario		
Surface Soil	Maintenance Worker/ Full-Time Employee	Incidental Ingestion Dermal Contact
Surface/Subsurface Soil[2]	Construction Worker	Incidental Ingestion Dermal Contact
Groundwater	Construction Worker	Dermal Contact Inhalation of Volatiles

1 Surface soil is defined as soil collected from depths of 0 to 2 feet bgs.

2 Surface soil/subsurface soil is defined as soil collected from depths of 0 to >10 feet bgs.

TABLE 7-14

SUMMARY OF CANCER RISKS AND HAZARD INDICES [1]
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

EXPOSURE ROUTE	MAINTENANCE WORKER [2]		FULL-TIME EMPLOYEE [2]		CONSTRUCTION WORKER [3]	
	RME [4]	CTE [5]	RME	CTE	RME	CTE
INCREMENTAL CANCER RISK						
Soil						
Incidental Ingestion of Soil	2.6E-07	2.3E-08	1.3E-06	2.3E-07	1.1E-08	4.7E-09
Dermal Contact with Soil	3.4E-07	6.2E-08	1.7E-06	6.2E-07	6.3E-09	6.3E-09
Total Risk - Soil	**6.0E-07**	**8.5E-08**	**3.0E-06**	**8.5E-07**	**1.7E-08**	**1.1E-08**
Groundwater						
Dermal Contact with Groundwater	NA	NA	NA	NA	6.9E-10	3.8E-10
Inhalation of volatiles	NA	NA	NA	NA	1.3E-10	6.7E-11
Total Risk - Groundwater	**NA**	**NA**	**NA**	**NA**	**8.2E-10**	**4.5E-10**
Cumulative Risk	**6.0E-07**	**8.5E-08**	**3.0E-06**	**8.5E-07**	**1.8E-08**	**1.1E-08**
HAZARD INDEX						
Soil						
Incidental Ingestion of Soil	0.0016	0.0004	0.0079	0.004	0.0017	0.00072
Dermal Contact with Soil	0.0021	0.00021	0.011	0.0021	0.00098	0.0002
Total Hazard Index - Soil	**0.0037**	**0.00061**	**0.019**	**0.0061**	**0.0027**	**0.00092**
Groundwater						
Dermal Contact with Groundwater	NA	NA	NA	NA	0.0003	0.00018
Inhalation of volatiles	NA	NA	NA	NA	NA	NA
Total Hazard Index - Groundwate	**NA**	**NA**	**NA**	**NA**	**0.0003**	**0.00018**
Total Hazard Index	**0.0037**	**0.00061**	**0.019**	**0.0061**	**0.0030**	**0.0011**

Notes:
1 - Chemical specific risks present in Appendix ?
2 - Adolescent trespasser, maintenance worker, and full-time employee are exposed to surface soil.
3 - Construction worker is exposed to surface/subsurface soil and groundwater.
4 - Reasonable Maximum Exposures
5 - Central Tendency Exposures
NA - Not applicable, exposure route not evaluated for this receptor.

TABLE 7-15A

QUALITATIVE EVALUATION OF GROUNDWATER - UNFILTERED SAMPLES
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	EPA Drinking Water Standard		EPA Drinking Water Health Advisories	
						MCL	MCLG	Value	Receptor
Volatile Organic Compounds (µg/L)									
1,1,1-Trichloroethane	1/4	2	2	54	N	200	200	200	LIFETIME, 70-KG ADULT
Chloroform	1/4	2-4	3	**0.15***	C	100/80	0	100	LONG-TERM 10-KG CHILD
Semivolatile Organic Compounds (µg/L)									
Bis(2-ethylhexyl)phthalate	1/4	1	1.00	4.8	C	6	0	700	DWEL, 70-KG ADULT
Di-n-butyl phthalate	1/4	2	2.00	370	N	NA	NA	4000	DWEL, 70-KG ADULT
Diethyl phthalate	1/4	2	2.00	2900	N	NA	NA	5000	LIFETIME, 70-KG ADULT
Phenanthrene	2/4	1-2	1.50	NA	-	NA	NA	NA	NA
Explosives (µg/L)									
RDX (5)	2/4	3.8-7.4	5.60	**0.61**	C	NA	NA	2	LIFETIME, 70-KG ADULT
Inorganics (µg/L)									
Barium	3/4	7.7-61.8	26.60	260	N	2000	2000	2000	LIFETIME, 70-KG ADULT
Cadmium	2/4	1.7-1.9	1.83	**1.8**	N	5	5	5	LIFETIME, 70-KG ADULT
Chromium (6)	2/4	2.1-4.8	3.35	18	N	100	100	100	LIFETIME, 70-KG ADULT
Cobalt	4/4	6.6-33.4	24.43	220	N	NA	NA	NA	NA
Copper	2/4	4.2-5.2	4.55	150	N	1300	1300	NA	NA
Lead	2/4	1.3-1.5	1.40	15 (7)	N	15	0	NA	NA
Mercury	4/4	0.1-0.2	0.14	1.1	N	2	2	2	LIFETIME, 70-KG ADULT
Nickel	1/4	10.5-11.2	10.85	73	N	100	100	100	LIFETIME, 70-KG ADULT
Silver	1/4	1.2	1.2	18	N	100	NA	100	LIFETIME, 70-KG ADULT
Vanadium	1/4	4.6	4.00	26	N	NA	NA	NA	NA
Zinc	3/4	5.5-31.2	14.30	1100	N	5000	NA	2000	LIFETIME, 70-KG ADULT

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
Organic background data presented for information purposes, but not for COPC selection.
5 RDX = hexahydro-1,3,5-trinitro-1,3,5-triazine.
6 Considered as hexavalent chromium.
7 Safe Drinking Water Act Action Level.
NA - Data not available.

TABLE 7-15B

QUALITATIVE EVALUTION OF GROUNDWATER - FILTERED SAMPLES
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Risk-Based COPC Screening Level Tap Water (3)	Basis (4)	EPA Drinking Water Standard		EPA Drinking Water Health Advisories	
						MCL	MCLG	Value	Receptor
Inorganics (µg/L)									
Barium, Filtered	3/4	7-53.6	23.72	260	N	2000	2000	2000	LIFETIME, 70-KG ADULT
Cadmium, Filtered	2/4	1.6-1.8	1.70	1.8	N	5	5	5	LIFETIME, 70-KG ADULT
Chromium, Filtered (5)	1/4	2.1-2.3	2.20	18	N	100	100	100	LIFETIME, 70-KG ADULT
Cobalt, Filtered	4/4	6.2-32.9	23.03	220	N	NA	NA	NA	NA
Copper, Filtered	2/4	3.6-4.1	3.83	150	N	1300	1300	NA	NA
Mercury, Filtered	4/4	0.1-0.18	0.13	1.1	N	2	2	2	LIFETIME, 70-KG ADULT
Nickel, Filtered	1/4	10.2-10.3	10.25	73	N	100	100	100	LIFETIME, 70-KG ADULT
Silver, Filtered	1/4	0.86	0.86	18	N	100	NA	100	LIFETIME, 70-KG ADULT
Vanadium, Filtered	2/4	0.81-0.86	0.90	26	N	NA	NA	NA	NA
Zinc, Filtered	3/4	5.9-27.8	13.08	1100	N	5000	NA	2000	LIFETIME, 70-KG ADULT

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
Unfiltered data and screening levels presented only for qualitative analysis, not for COPC selection.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 Considered as hexavalent chromium.
ND = not detected; NA = data not available

TABLE 7-16

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN - SURFACE SOIL
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Frequency of Detection	Range of Detections		Location of Maximum	BTAG Screening Level	EEQ (unitless)	Retained as PCOC?
		Min.	Max.				
INORGANICS (mg/kg)							
Antimony	2/10	0.52	0.69	DSBSS0040101	0.48	1.44	Y
Arsenic	10/10	2.5	5.1	DSBSS0040101	328	0.02	N
Barium	10/10	31	76.6	DSBSS0080101	440	0.17	N
Beryllium	10/10	0.37	1.1	DSBSS0060101	0.02	55.00	Y
Cadmium	2/10	0.12	0.42	DSBSS0010101	2.5	0.17	N
Chromium	10/10	13.7	21	DSBSS0050101-D, DSBSS0060101, DSBSS0070101	0.0075	2800.00	Y
Cobalt	10/10	4	22.4	DSBSS0040101	200	0.11	N
Copper	10/10	7.3	26.1	DSBSS0020101	15	1.74	Y
Lead	10/10	8.8	17.9	DSBSS0050101	0.01	1790.00	Y
Mercury	8/10	0.02	0.07	DSBSS0100101, DSBSS0040101	0.058	1.21	Y
Nickel	10/10	5.6	13.5	DSBSS0060101	2	6.75	Y
Selenium	10/10	0.45	1.5	DSBSS0040101, DSBSS0060101	1.8	0.83	N
Vanadium	10/10	20.2	39.1	DSBSS0070101	58	0.67	N
Zinc	10/10	22	45.2	DSBSS0060101	10	4.52	Y
Semivolatile Organic Compounds (µg/kg)							
Bis(2-ethylhexyl)phthalate	3/10	160	1400	DSBSS0030101	NA	NA	Y
Di-n-butyl phthalate	5/10	53	340	DSBSS0090101-D	NA	NA	Y
Volatile Organic Compounds (µg/kg)							
Acetone	1/10	5000	5000	DSBSS0040101	NA	NA	Y

EEQ = Ecological Effects Quotient
NA = Not Available

TABLE 7-17

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN - GROUNDWATER
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	AWQC	Hazard Quotient (unitless)	Retained as PCOC?
		Min.	Max.				
INORGANICS (mg/kg)							
Barium	3/4	7	53.6	DSBMW003F001	3.9	13.74	Y
Cadmium	2/4	1.6	1.8	DSBMW003F001, DSBMW003F001-D	1	1.80	Y
Chromium	1/4	2.1	2.3	DSBMW003F001	10	0.23	N
Cobalt	4/4	6.2	32.9	DSBMW003F001	3	10.97	Y
Copper	2/4	3.6	4.1	DSBMW003F001	11	0.37	N
Mercury	4/4	0.1	0.18	DSBMW003F001, DSBMW003F001-D	0.003	60.00	Y
Nickel	1/4	10.2	10.3	DSBMW003F001	160	0.06	N
Silver	2/4	0.81	0.86	DSBMW003F001-D	0.12	7.17	Y
Zinc	3/4	5.9	27.8	DSBMW003F001	100	0.28	N

NA = Not Available
EEQ = Ecological Effects Quotient

TABLE 7-18

RESULTS OF TERRESTRIAL FOODCHAIN MODELING FOR MAXIMUM CONCENTRATIONS
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Potential Concern	Shrew		Hawk		Fox		Vole		Woodcock	
	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI
INORGANICS										
Antimony	3.78	0.38	NA	NA	0.74	0.07	1.98	0.20	NA	NA
Beryllium	1.39	0.14	NA	NA	0.27	0.03	0.73	0.07	NA	NA
Chromium	84.55	8.46	88.39	8.84	16.53	1.65	44.27	4.43	115.18	1.15
Copper	17.86	1.79	4.67	0.47	3.49	0.35	9.35	0.94	6.09	0.61
Lead	81.68	8.17	25.11	2.51	15.97	1.60	42.77	4.28	32.73	3.27
Mercury	0.96	0.10	2.95	0.29	0.94	0.09	0.50	0.05	3.20	0.32
Nickel	0.15	0.01	0.07	0.05	0.03	0.00	0.08	0.00	0.10	0.07
Zinc	1.24	0.12	1.37	0.14	0.24	0.02	0.65	0.06	1.78	0.18
Semivolatile Organic Compounds										
Bis(2-ethylhexyl)phthalate	0.05	0.00	NA	NA	0.01	0.00	0.03	0.00	NA	NA
Di-n-butyl phthalate	0.00	0.00	1.30	0.13	0.00	0.00	0.00	0.00	1.70	0.17
Volatile Organic Compounds										
Acetone	0.34	0.07	NA	NA	0.07	0.01	0.18	0.04	NA	NA

NA = Not Available
EEI = Ecological Effects Index

TABLE 7-19

RESULTS OF TERRESTRIAL FOODCHAIN MODELING FOR MEAN CONCENTRATIONS
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Potential Concern	Shrew		Hawk		Fox		Vole		Woodcock	
	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI
INORGANICS										
Antimony	2.23	0.22	NA	NA	0.44	0.04	1.17	0.12	NA	NA
Beryllium	0.74	0.07	NA	NA	0.14	0.01	0.39	0.04	NA	NA
Chromium	69.23	6.92	72.37	7.24	13.53	1.35	36.25	3.63	94.31	0.94
Copper	9.68	0.97	2.53	0.25	1.89	0.19	5.07	0.51	3.30	0.33
Lead	52.36	5.24	16.10	1.61	10.23	1.02	27.42	2.74	20.98	2.10
Mercury	0.54	0.05	1.66	0.17	0.53	0.05	0.28	0.03	1.81	0.18
Nickel	0.10	0.00	0.05	0.04	0.02	0.00	0.05	0.00	0.06	0.05
Zinc	0.90	0.09	1.00	0.10	0.18	0.02	0.47	0.05	1.30	0.13
Semivolatile Organic Compounds										
Bis(2-ethylhexyl)phthalate	0.01	0.00	NA	NA	0.00	0.00	0.00	0.00	NA	NA
Di-n-butyl phthalate	0.00	0.00	0.65	0.07	0.00	0.00	0.00	0.00	0.85	0.09
Volatile Organic Compounds										
Acetone	0.04	0.00	NA	NA	0.00	0.00	0.02	0.00	NA	NA

NA = Not Available
EEI = Ecological Effects Index

TABLE 7-20

RISK MANAGEMENT CONSIDERATIONS FOR SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Frequency of Detection	Range of Detections		Location of Maximum	Mean Concentration	BTAG Screening Level	Alternate Guideline(s)1	Max/Mean Background	Retained as Final PCOC?
		Minimum	Maximum						
SURFACE SOIL[2]									
Antimony	2/10	0.52	0.69	DSBSS0040101	0.41	0.48	NA	ND	N
Beryllium	10/10	0.37	1.1	DSBSS0060101	0.58	0.02	NA	0.61/0.4	N
Chromium	10/10	13.7	21	DSBSS0050101-D, DSBSS0060101, DSBSS0070101	17.2	0.0075	0.4/10	20.8/12	N
Copper	10/10	7.3	26.1	DSBSS0020101	14.1	15	50/100	17.3/5.15	N
Lead	10/10	8.8	17.9	DSBSS0050101	11.5	0.01	500/900	149/20	N
Mercury	8/10	0.02	0.07	DSBSS0100101, DSBSS0040101	0.04	0.058	0.1/30	0.08/0.04	N
Zinc	10/10	22	45.2	DSBSS0060101	32.9	10	200/100	30.8/18.1	N
Di-n-butyl phthalate	5/10	53	340	DSBSS0090101-D	170	NA	3005	ND	N

1 Alternate guidelines are as follows: soil = ORNL screening levels for earthworms/soil microbes (when 2 values are present) (Will and Suter, 1995) or Dutch guidelines (when one value is present) (NMHSP&E, 1994)
2 Inorganics = mg/kg, organics = ug/kg
NA = Not Available
ND = Not Detected

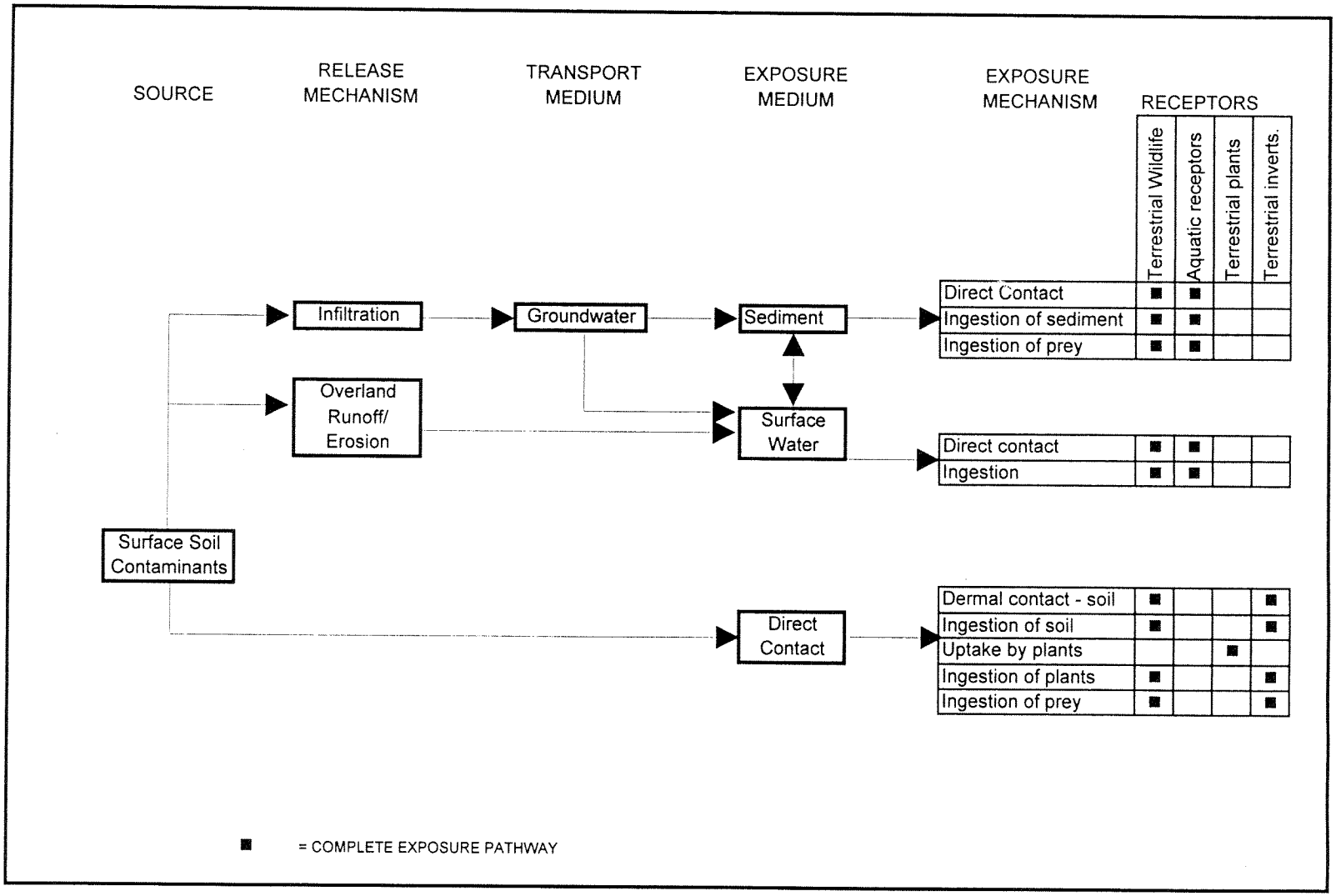
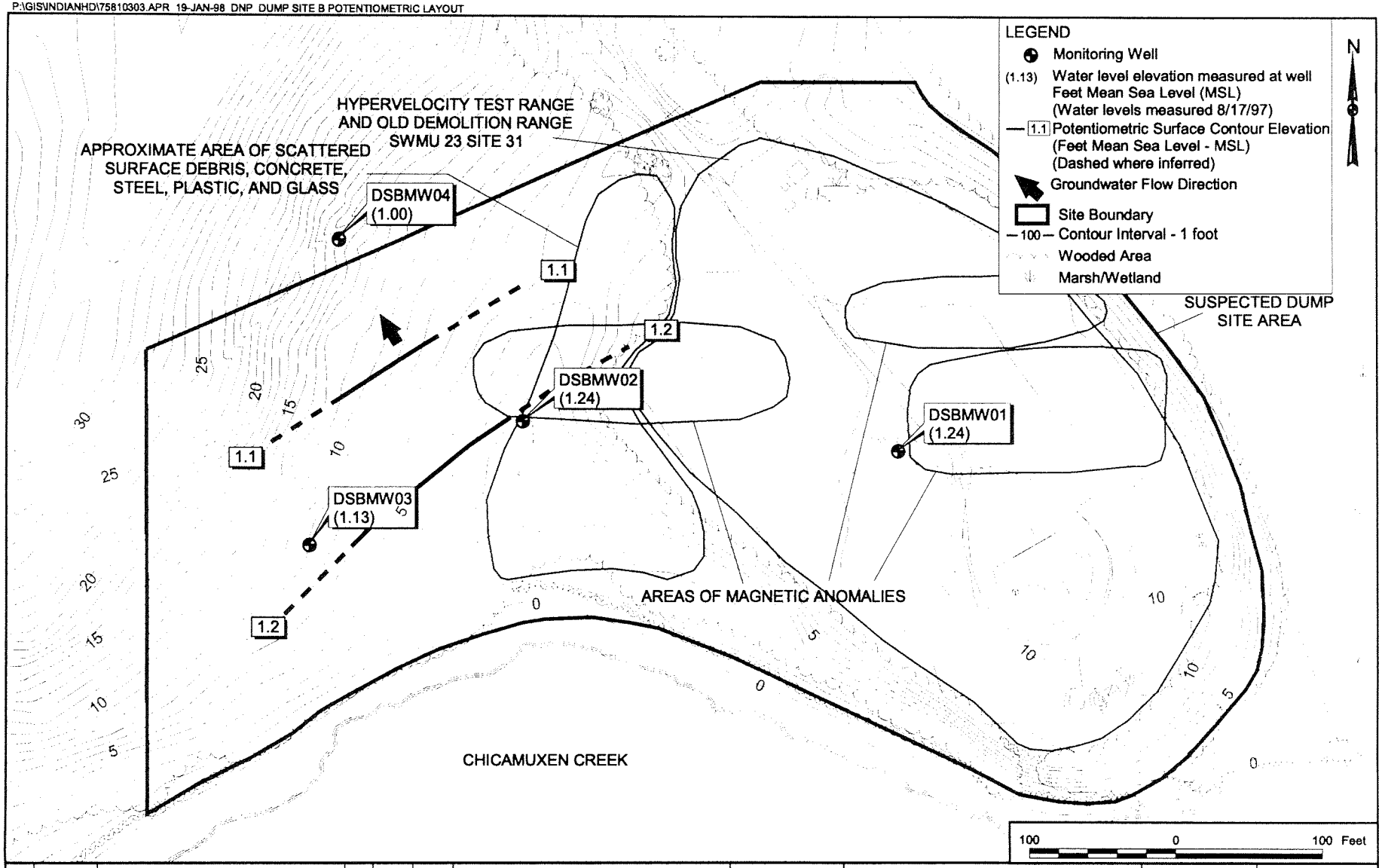


FIGURE 7-11

CONCEPTUAL SITE MODEL - SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

P:\GIS\INDIANHD\75810303.APR 19-JAN-98 DNP DUMP SITE B POTENTIOMETRIC LAYOUT



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

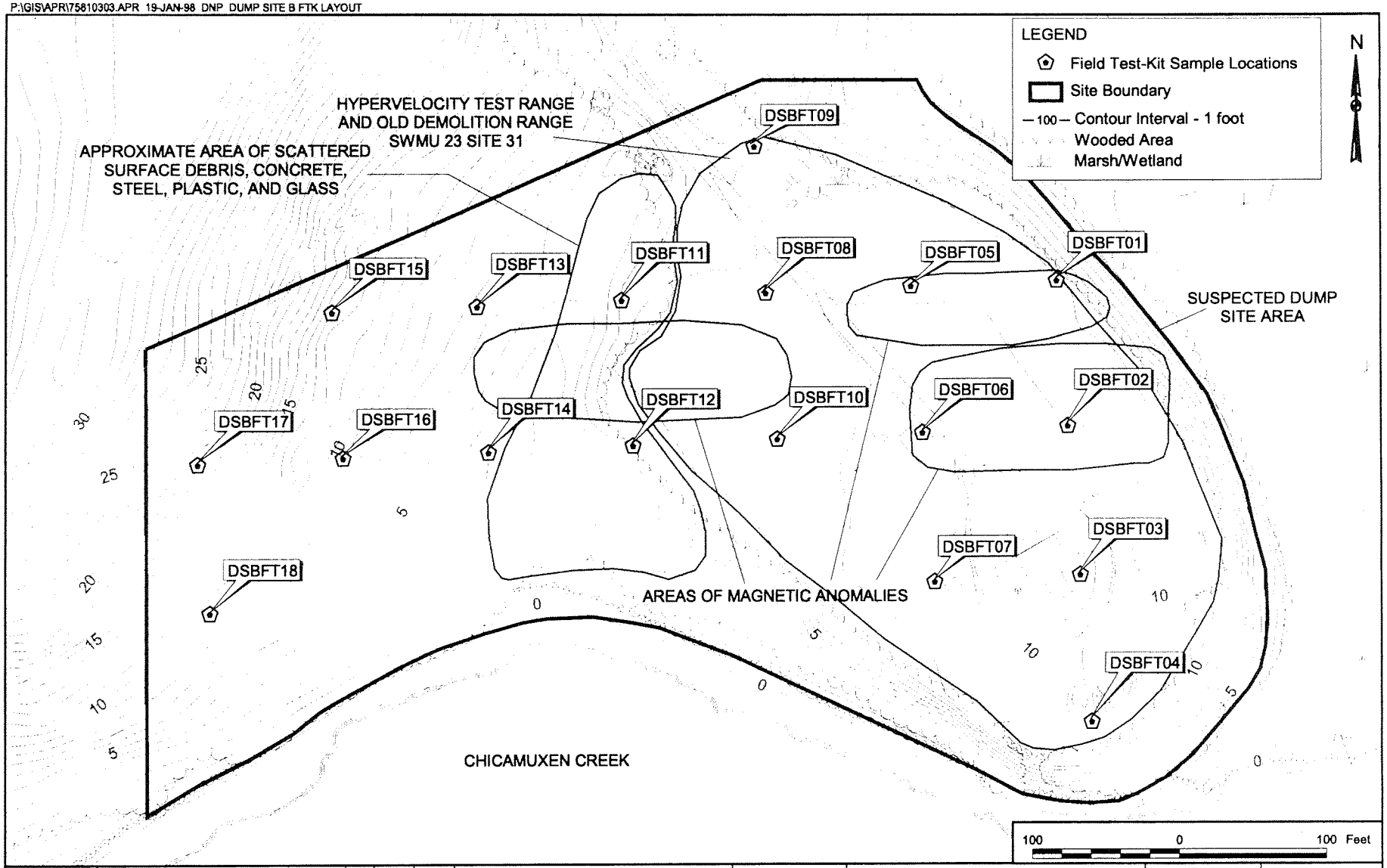
DRAWN BY D. PERRY DATE 19-JAN-98
CHECKED BY ____ DATE ____
COST/SCHED-AREA
SCALE AS NOTED

Brown & Root Environmental

POTENTIOMETRIC SURFACE CONTOUR FIGURE
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581
OWNER NO. ____
APPROVED BY PUR DATE 1-20-98
APPROVED BY ____ DATE 1-23-98
DRAWING NO. FIGURE 7-5
REV 0

P:\GIS\APR\75810303.APR 19-JAN-98 DNP DUMP SITE B FTK LAYOUT



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY / DATE	D. PERRY 19-JAN-98
CHECKED BY / DATE	
COST/SCHED-AREA	
SCALE	AS NOTED

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FIELD TEST-KIT SAMPLE LOCATIONS
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO.	7851
OWNER NO.	
APPROVED BY / DATE	1-20-98
APPROVED BY / DATE	1-20-98
DRAWING NO.	FIGURE 7-3
REV.	0

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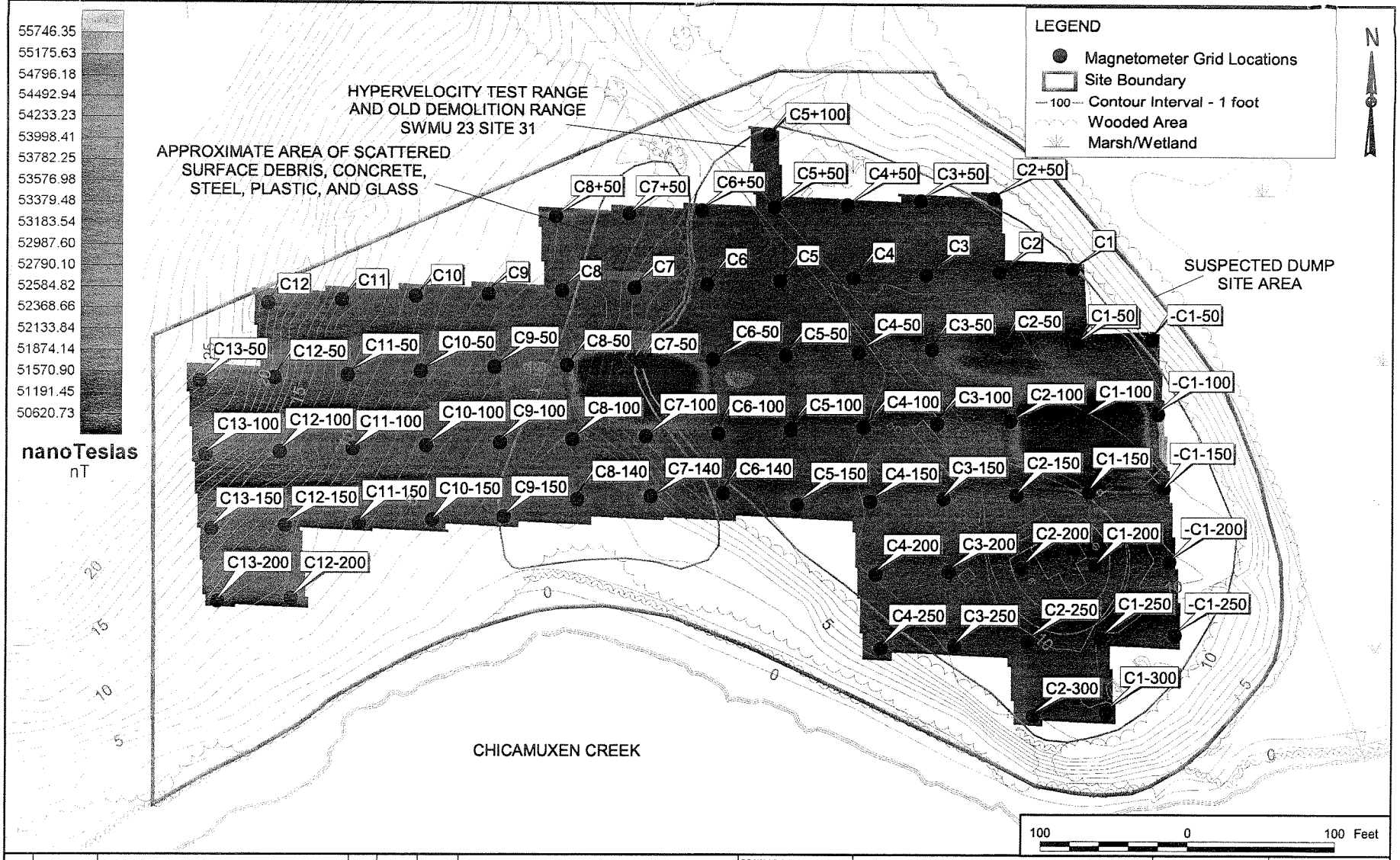

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY D. PERRY DATE 23-JAN-98
CHECKED BY DATE
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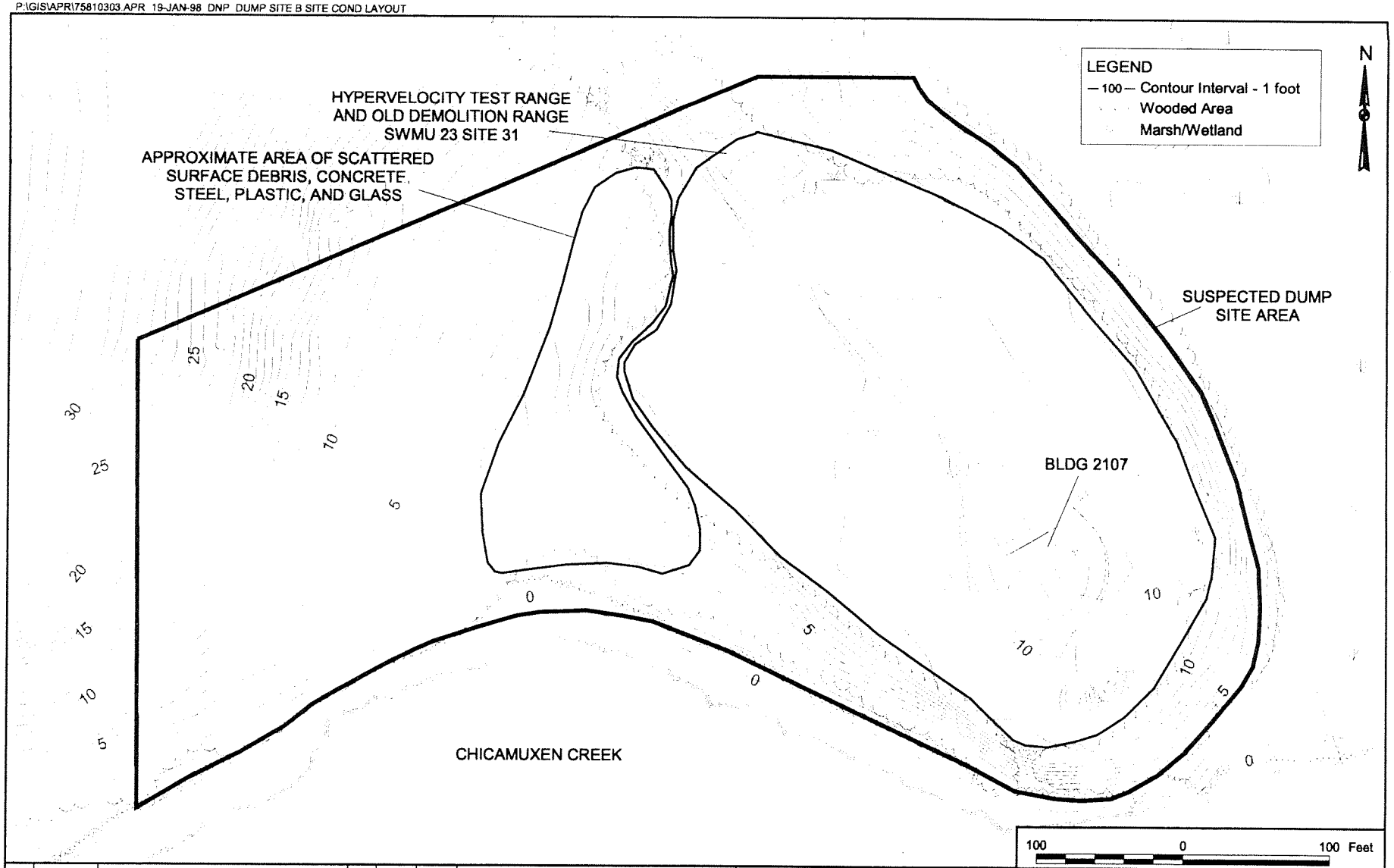
TOTAL FIELD MAGNETIC RESULTS
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7851
OWNER NO.
APPROVED BY DATE 1-23-98
APPROVED BY DATE 1-23-98
DRAWING NO. FIGURE 7-2
REV. 0

P:\GIS\APR\75810303.APR 19-JAN-98 DNP DUMP SITE B SITE COND LAYOUT



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY D. PERRY DATE 19-JAN-98
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

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SITE CONDITIONS FIGURE
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581
OWNER NO.
APPROVED BY [signature] DATE 1-20-98
APPROVED BY [signature] DATE 1-20-98
DRAWING NO. FIGURE 7-1
REV. 0

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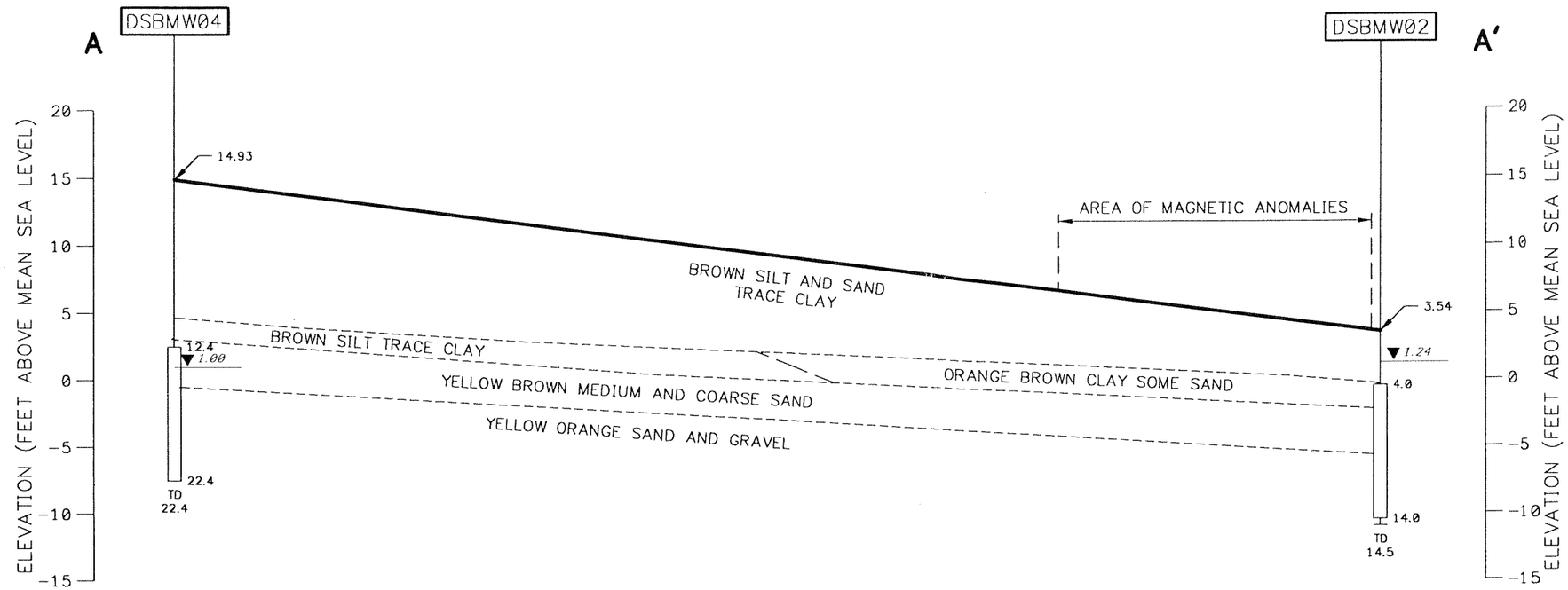
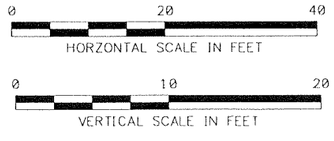
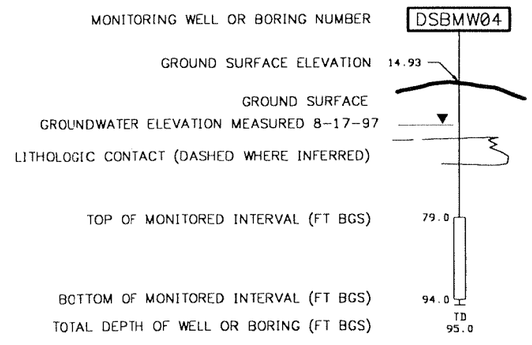




LEGEND



NOTE: ELEVATIONS IN FEET
ABOVE MEAN SEA LEVEL (FT AMSL)

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 10/29/97
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

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GENERALIZED GEOLOGIC CROSS SECTION A-A'
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RFI/VI REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581
OWNER NO. 0287
APPROVED BY DATE 1-16-98
APPROVED BY DATE 1-16-98
DRAWING NO. FIGURE 7-6
REV. 0

FORM CADD NO. SOUTH_BH.DGN - REV 0 - 02/11/97

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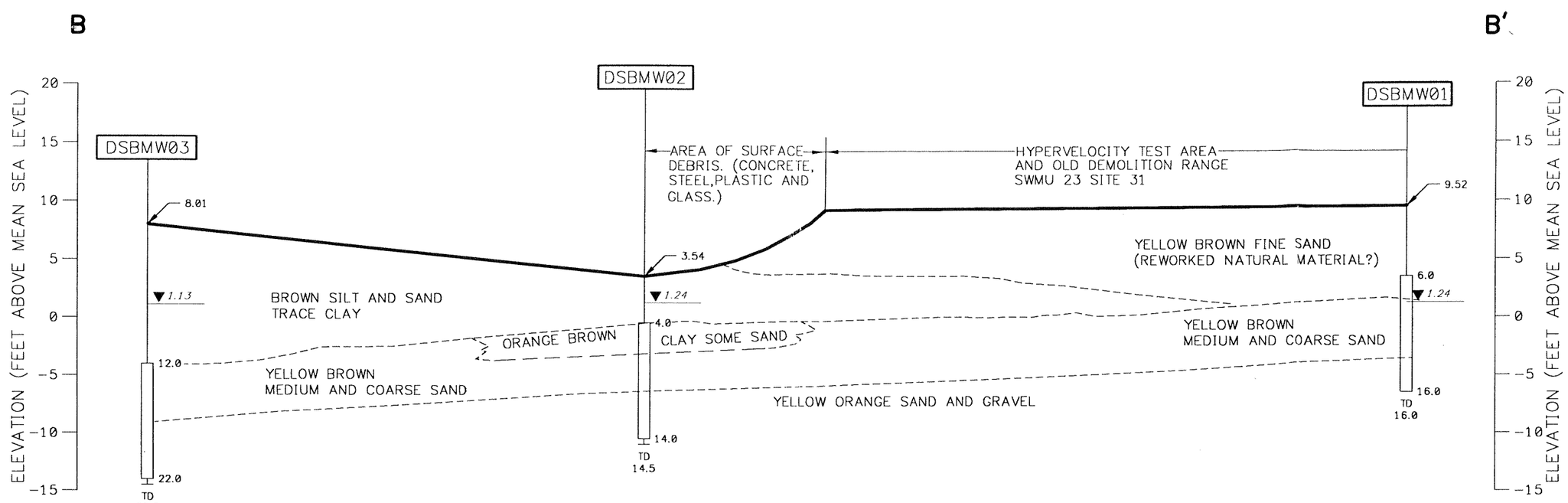
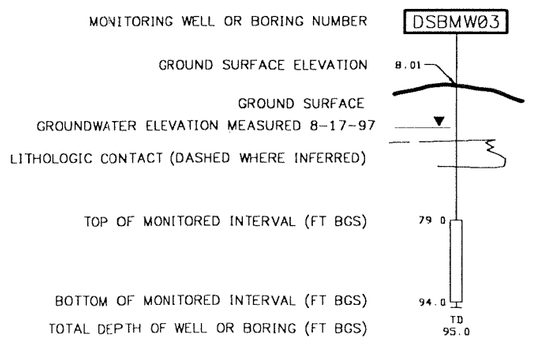


0 40 80
HORIZONTAL SCALE IN FEET

0 10 20
VERTICAL SCALE IN FEET

LEGEND



NOTE: ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL (FT AMSL)

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 10/30/97
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

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GENERALIZED GEOLOGIC CROSS SECTION B-B'
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RFI/VI REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581
OWNER NO. 0287
APPROVED BY SWR DATE 1-16-98
APPROVED BY DATE 1-16-98
DRAWING NO. FIGURE 7-7
REV. 0

FORM CADD NO. SOUTH_BH.DGN - REV 0 - 02/11/97

P:\GIS\INDIANHD\75810303TAG.APR 16-JAN-98 DNP DUMP SITE B SS LAYOUT

N

DSBSS0090101

Semivolatile Organics			
BIS(2-ETHYLHEXYL)PHTHALATE	160	J	UG/KG
DI-N-BUTYL PHTHALATE	160	J	UG/KG
Metals			
ARSENIC	2.7	L	MG/KG
BARIUM	54.6	J	MG/KG
BERYLLIUM	0.56	J	MG/KG
CHROMIUM	15.1	J	MG/KG
COBALT	11.0	J	MG/KG
COPPER	7.9		MG/KG
LEAD	9.0	J	MG/KG
MERCURY	0.04	L	MG/KG
NICKEL	8.7	J	MG/KG
SELENIUM	0.54	J	MG/KG
VANADIUM	25.4		MG/KG
ZINC	31.1	J	MG/KG

DSBSS0090101 DUP

Semivolatile Organics			
DI-N-BUTYL PHTHALATE	340	J	UG/KG
Metals			
ARSENIC	2.5	L	MG/KG
BARIUM	57.2	J	MG/KG
BERYLLIUM	0.58	J	MG/KG
CHROMIUM	15.6	J	MG/KG
COBALT	10.9	J	MG/KG
COPPER	7.3		MG/KG
LEAD	8.8	J	MG/KG
MERCURY	0.04	L	MG/KG
NICKEL	8.1	J	MG/KG
SELENIUM	0.45	J	MG/KG
VANADIUM	24.6		MG/KG
ZINC	29.5	J	MG/KG

DSBSS0040101

Volatile Organics			
ACETONE	5000		UG/KG
Metals			
ANTIMONY	0.69	L	MG/KG
ARSENIC	5.1		MG/KG
BARIUM	59.1	J	MG/KG
BERYLLIUM	0.64		MG/KG
CHROMIUM	20.5	J	MG/KG
COBALT	22.4		MG/KG
COPPER	11.8		MG/KG
LEAD	12.4	J	MG/KG
MERCURY	0.07		MG/KG
NICKEL	9.6		MG/KG
SELENIUM	1.5		MG/KG
VANADIUM	29.6		MG/KG
ZINC	35.6	J	MG/KG

DSBSS0050101

Metals			
ARSENIC	4.9	L	MG/KG
BARIUM	44.5	J	MG/KG
BERYLLIUM	0.45	J	MG/KG
CHROMIUM	20.8	J	MG/KG
COBALT	4.2	J	MG/KG
COPPER	24.5		MG/KG
LEAD	17.9	J	MG/KG
MERCURY	0.04	L	MG/KG
NICKEL	9.0	J	MG/KG
SELENIUM	0.83	J	MG/KG
VANADIUM	32.6		MG/KG
ZINC	37.5	J	MG/KG

DSBSS0050101 DUP

Semivolatile Organics			
DI-N-BUTYL PHTHALATE	190	J	UG/KG
Metals			
ARSENIC	4.3	L	MG/KG
BARIUM	45.8	J	MG/KG
BERYLLIUM	0.38	J	MG/KG
CHROMIUM	21.0	J	MG/KG
COBALT	4.0	J	MG/KG
COPPER	25.8		MG/KG
LEAD	16.4	J	MG/KG
MERCURY	0.03	L	MG/KG
NICKEL	9.2	J	MG/KG
SELENIUM	0.79	J	MG/KG
VANADIUM	30.9		MG/KG
ZINC	36.5	J	MG/KG

DSBSS0080101

Metals			
ARSENIC	2.6	L	MG/KG
BARIUM	76.6	J	MG/KG
BERYLLIUM	0.55	J	MG/KG
CHROMIUM	15.2	J	MG/KG
COBALT	10.6	J	MG/KG
COPPER	7.5		MG/KG
LEAD	8.9	J	MG/KG
MERCURY	0.03	L	MG/KG
NICKEL	7.8	J	MG/KG
SELENIUM	0.52	J	MG/KG
VANADIUM	22.8		MG/KG
ZINC	27.9	J	MG/KG

HYPERVELOCITY TEST RANGE
AND OLD DEMOLITION RANGE
SWMU 23 SITE 31

APPROXIMATE AREA OF SCATTERED
SURFACE DEBRIS, CONCRETE,
STEEL, PLASTIC, AND GLASS

DSBSS0060101

Metals			
ARSENIC	3.4	L	MG/KG
BARIUM	48.1	J	MG/KG
BERYLLIUM	1.1	J	MG/KG
CHROMIUM	21.0	J	MG/KG
COBALT	7.6	J	MG/KG
COPPER	17.8		MG/KG
LEAD	9.4	J	MG/KG
NICKEL	13.5	J	MG/KG
SELENIUM	1.5	J	MG/KG
VANADIUM	35.9		MG/KG
ZINC	45.2	J	MG/KG

SUSPECTED DUMP
SITE AREA

AREAS OF MAGNETIC ANOMALIES

CHICAMUXEN CREEK

DSBSS0030101

Semivolatile Organics			
BIS(2-ETHYLHEXYL)PHTHALATE	1400	J	UG/KG
Metals			
ARSENIC	3.3		MG/KG
BARIUM	31.0	J	MG/KG
BERYLLIUM	0.37		MG/KG
CHROMIUM	14.2	J	MG/KG
COBALT	5.2		MG/KG
COPPER	8.2		MG/KG
LEAD	11.2	J	MG/KG
MERCURY	0.05		MG/KG
NICKEL	5.6		MG/KG
SELENIUM	0.90		MG/KG
VANADIUM	22.5		MG/KG
ZINC	22.0	J	MG/KG

DSBSS0020101

Semivolatile Organics			
BIS(2-ETHYLHEXYL)PHTHALATE	280	J	UG/KG
Metals			
ARSENIC	3.1		MG/KG
BARIUM	67.2		MG/KG
BERYLLIUM	0.48	K	MG/KG
CADMIUM	0.12	K	MG/KG
CHROMIUM	13.9		MG/KG
COBALT	9.6		MG/KG
COPPER	26.1		MG/KG
LEAD	14.3	K	MG/KG
MERCURY	0.06		MG/KG
NICKEL	6.2		MG/KG
SELENIUM	0.60	L	MG/KG
VANADIUM	20.2		MG/KG
ZINC	24.8		MG/KG

DSBSS0010101

Semivolatile Organics			
DI-N-BUTYL PHTHALATE	53	J	UG/KG
Metals			
ANTIMONY	0.52	L	MG/KG
ARSENIC	3.6		MG/KG
BARIUM	46.7		MG/KG
BERYLLIUM	0.44		MG/KG
CADMIUM	0.42	K	MG/KG
CHROMIUM	13.7		MG/KG
COBALT	6.2	J	MG/KG
COPPER	10.5		MG/KG
LEAD	10.1		MG/KG
NICKEL	8.8		MG/KG
SELENIUM	1.2		MG/KG
VANADIUM	24.1		MG/KG
ZINC	36.2		MG/KG

DSBSS0100101

Semivolatile Organics			
DI-N-BUTYL PHTHALATE	160	J	UG/KG
Metals			
ARSENIC	3.9	L	MG/KG
BARIUM	44.3	J	MG/KG
BERYLLIUM	0.47	J	MG/KG
CHROMIUM	16.2	J	MG/KG
COBALT	13.1	J	MG/KG
COPPER	9.8		MG/KG
LEAD	11.1	J	MG/KG
MERCURY	0.07	L	MG/KG
NICKEL	9.0	J	MG/KG
SELENIUM	0.80	J	MG/KG
VANADIUM	26.3		MG/KG
ZINC	30.6	J	MG/KG

DSBSS0070101

Semivolatile Organics			
DI-N-BUTYL PHTHALATE	150	J	UG/KG
Metals			
ARSENIC	2.5	L	MG/KG
BARIUM	48.3	J	MG/KG
BERYLLIUM	0.78	J	MG/KG
CHROMIUM	21.0	J	MG/KG
COBALT	7.8	J	MG/KG
COPPER	16.9		MG/KG
LEAD	11.3	J	MG/KG
MERCURY	0.02	L	MG/KG
NICKEL	12.0	J	MG/KG
SELENIUM	0.57	J	MG/KG
VANADIUM	39.1		MG/KG
ZINC	39.1	J	MG/KG

LEGEND
- Surface Soil Detect
- Site Boundary
- — ··· — Intermittent Streams
- — 10 — Contour Interval - 1 foot
- Wooded Area
- Marsh/Wetland
- Groundwater Flow Direction

100 0 100 Feet

NO.	DATE	REVISIONS	DRAWN BY	DATE
			D. PERRY	16-JAN-98
			CHECKED BY	DATE
				1/16/98
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			SCALE	AS NOTED

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SURFACE SOIL DETECTS
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
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STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

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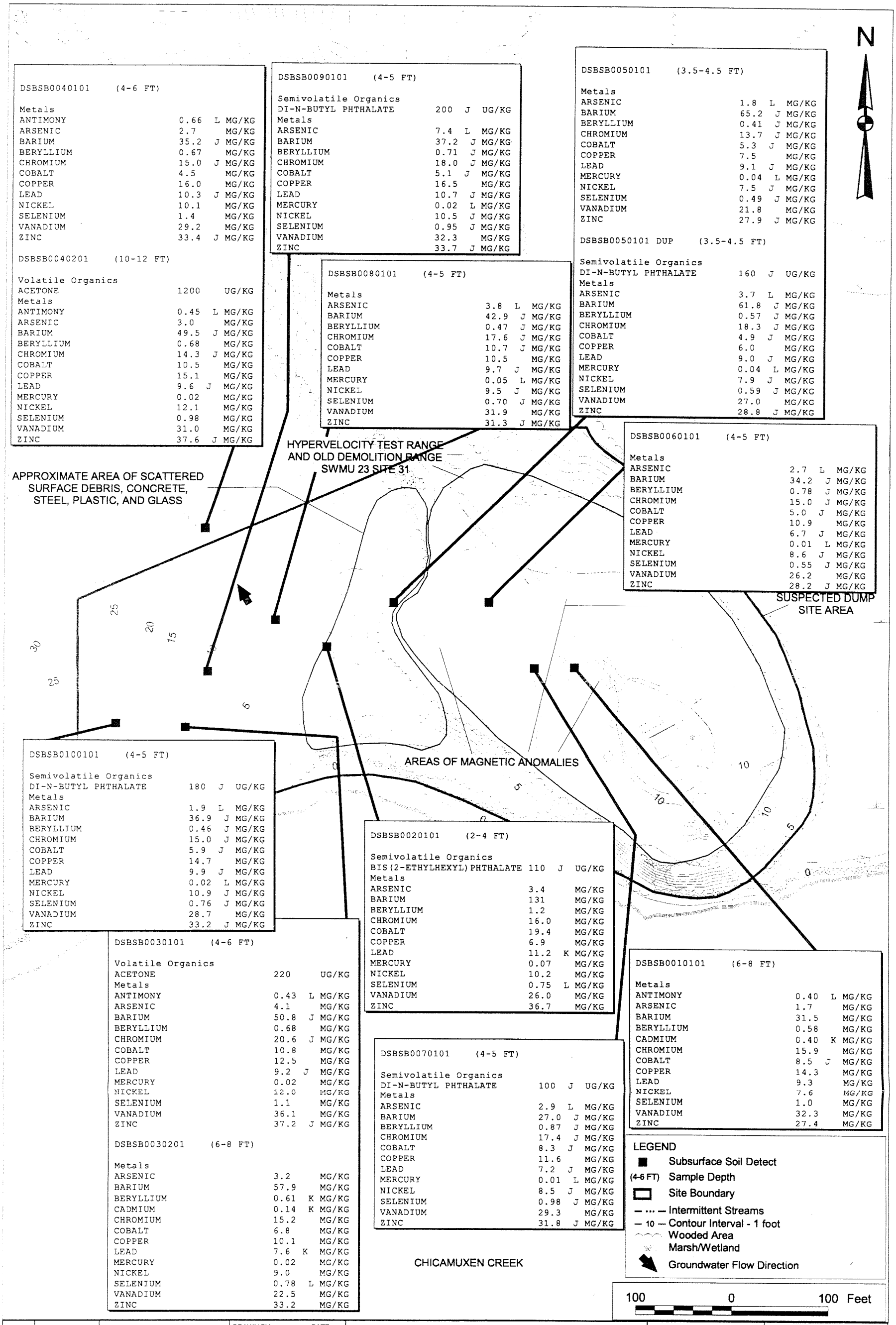
7581	
APPROVED BY	DATE
APPROVED BY	DATE 1-16-98
DRAWING NO. FIGURE 7-8	REV. 0

P:\GIS\INDIANHD\75810303TAG.APR 16-JAN-98 DNP DUMP SITE B SB LAYOUT



DSBSB0040101 (4-6 FT)

Metals			
ANTIMONY	0.66	L	MG/KG
ARSENIC	2.7		MG/KG
BARIUM	35.2	J	MG/KG
BERYLLIUM	0.67		MG/KG
CHROMIUM	15.0	J	MG/KG
COBALT	4.5		MG/KG
COPPER	16.0		MG/KG
LEAD	10.3	J	MG/KG
NICKEL	10.1		MG/KG
SELENIUM	1.4		MG/KG
VANADIUM	29.2		MG/KG
ZINC	33.4	J	MG/KG

DSBSB0040201 (10-12 FT)

Volatile Organics			
ACETONE	1200		UG/KG
Metals			
ANTIMONY	0.45	L	MG/KG
ARSENIC	3.0		MG/KG
BARIUM	49.5	J	MG/KG
BERYLLIUM	0.68		MG/KG
CHROMIUM	14.3	J	MG/KG
COBALT	10.5		MG/KG
COPPER	15.1		MG/KG
LEAD	9.6	J	MG/KG
MERCURY	0.02		MG/KG
NICKEL	12.1		MG/KG
SELENIUM	0.98		MG/KG
VANADIUM	31.0		MG/KG
ZINC	37.6	J	MG/KG

DSBSB0090101 (4-5 FT)

Semivolatile Organics			
DI-N-BUTYL PHTHALATE	200	J	UG/KG
Metals			
ARSENIC	7.4	L	MG/KG
BARIUM	37.2	J	MG/KG
BERYLLIUM	0.71	J	MG/KG
CHROMIUM	18.0	J	MG/KG
COBALT	5.1	J	MG/KG
COPPER	16.5		MG/KG
LEAD	10.7	J	MG/KG
MERCURY	0.02	L	MG/KG
NICKEL	10.5	J	MG/KG
SELENIUM	0.95	J	MG/KG
VANADIUM	32.3		MG/KG
ZINC	33.7	J	MG/KG

DSBSB0080101 (4-5 FT)

Metals			
ARSENIC	3.8	L	MG/KG
BARIUM	42.9	J	MG/KG
BERYLLIUM	0.47	J	MG/KG
CHROMIUM	17.6	J	MG/KG
COBALT	10.7	J	MG/KG
COPPER	10.5		MG/KG
LEAD	9.7	J	MG/KG
MERCURY	0.05	L	MG/KG
NICKEL	9.5	J	MG/KG
SELENIUM	0.70	J	MG/KG
VANADIUM	31.9		MG/KG
ZINC	31.3	J	MG/KG

DSBSB0050101 (3.5-4.5 FT)

Metals			
ARSENIC	1.8	L	MG/KG
BARIUM	65.2	J	MG/KG
BERYLLIUM	0.41	J	MG/KG
CHROMIUM	13.7	J	MG/KG
COBALT	5.3	J	MG/KG
COPPER	7.5		MG/KG
LEAD	9.1	J	MG/KG
MERCURY	0.04	L	MG/KG
NICKEL	7.5	J	MG/KG
SELENIUM	0.49	J	MG/KG
VANADIUM	21.8		MG/KG
ZINC	27.9	J	MG/KG

DSBSB0050101 DUP (3.5-4.5 FT)

Semivolatile Organics			
DI-N-BUTYL PHTHALATE	160	J	UG/KG
Metals			
ARSENIC	3.7	L	MG/KG
BARIUM	61.8	J	MG/KG
BERYLLIUM	0.57	J	MG/KG
CHROMIUM	18.3	J	MG/KG
COBALT	4.9	J	MG/KG
COPPER	6.0		MG/KG
LEAD	9.0	J	MG/KG
MERCURY	0.04	L	MG/KG
NICKEL	7.9	J	MG/KG
SELENIUM	0.59	J	MG/KG
VANADIUM	27.0		MG/KG
ZINC	28.8	J	MG/KG

DSBSB0060101 (4-5 FT)

Metals			
ARSENIC	2.7	L	MG/KG
BARIUM	34.2	J	MG/KG
BERYLLIUM	0.78	J	MG/KG
CHROMIUM	15.0	J	MG/KG
COBALT	5.0	J	MG/KG
COPPER	10.9		MG/KG
LEAD	6.7	J	MG/KG
MERCURY	0.01	L	MG/KG
NICKEL	8.6	J	MG/KG
SELENIUM	0.55	J	MG/KG
VANADIUM	26.2		MG/KG
ZINC	28.2	J	MG/KG

DSBSB0100101 (4-5 FT)

Semivolatile Organics			
DI-N-BUTYL PHTHALATE	180	J	UG/KG
Metals			
ARSENIC	1.9	L	MG/KG
BARIUM	36.9	J	MG/KG
BERYLLIUM	0.46	J	MG/KG
CHROMIUM	15.0	J	MG/KG
COBALT	5.9	J	MG/KG
COPPER	14.7		MG/KG
LEAD	9.9	J	MG/KG
MERCURY	0.02	L	MG/KG
NICKEL	10.9	J	MG/KG
SELENIUM	0.76	J	MG/KG
VANADIUM	28.7		MG/KG
ZINC	33.2	J	MG/KG

DSBSB0020101 (2-4 FT)

Semivolatile Organics			
BIS(2-ETHYLHEXYL)PHTHALATE	110	J	UG/KG
Metals			
ARSENIC	3.4		MG/KG
BARIUM	131		MG/KG
BERYLLIUM	1.2		MG/KG
CHROMIUM	16.0		MG/KG
COBALT	19.4		MG/KG
COPPER	6.9		MG/KG
LEAD	11.2	K	MG/KG
MERCURY	0.07		MG/KG
NICKEL	10.2		MG/KG
SELENIUM	0.75	L	MG/KG
VANADIUM	26.0		MG/KG
ZINC	36.7		MG/KG

DSBSB0030101 (4-6 FT)

Volatile Organics			
ACETONE	220		UG/KG
Metals			
ANTIMONY	0.43	L	MG/KG
ARSENIC	4.1		MG/KG
BARIUM	50.8	J	MG/KG
BERYLLIUM	0.68		MG/KG
CHROMIUM	20.6	J	MG/KG
COBALT	10.8		MG/KG
COPPER	12.5		MG/KG
LEAD	9.2	J	MG/KG
MERCURY	0.02		MG/KG
NICKEL	12.0		MG/KG
SELENIUM	1.1		MG/KG
VANADIUM	36.1		MG/KG
ZINC	37.2	J	MG/KG

DSBSB0030201 (6-8 FT)

Metals			
ARSENIC	3.2		MG/KG
BARIUM	57.9		MG/KG
BERYLLIUM	0.61	K	MG/KG
CADMIUM	0.14	K	MG/KG
CHROMIUM	15.2		MG/KG
COBALT	6.8		MG/KG
COPPER	10.1		MG/KG
LEAD	7.6	K	MG/KG
MERCURY	0.02		MG/KG
NICKEL	9.0		MG/KG
SELENIUM	0.78	L	MG/KG
VANADIUM	22.5		MG/KG
ZINC	33.2		MG/KG

DSBSB0070101 (4-5 FT)

Semivolatile Organics			
DI-N-BUTYL PHTHALATE	100	J	UG/KG
Metals			
ARSENIC	2.9	L	MG/KG
BARIUM	27.0	J	MG/KG
BERYLLIUM	0.87	J	MG/KG
CHROMIUM	17.4	J	MG/KG
COBALT	8.3	J	MG/KG
COPPER	11.6		MG/KG
LEAD	7.2	J	MG/KG
MERCURY	0.01	L	MG/KG
NICKEL	8.5	J	MG/KG
SELENIUM	0.98	J	MG/KG
VANADIUM	29.3		MG/KG
ZINC	31.8	J	MG/KG

DSBSB0010101 (6-8 FT)

Metals			
ANTIMONY	0.40	L	MG/KG
ARSENIC	1.7		MG/KG
BARIUM	31.5		MG/KG
BERYLLIUM	0.58		MG/KG
CADMIUM	0.40	K	MG/KG
CHROMIUM	15.9		MG/KG
COBALT	8.5	J	MG/KG
COPPER	14.3		MG/KG
LEAD	9.3		MG/KG
NICKEL	7.6		MG/KG
SELENIUM	1.0		MG/KG
VANADIUM	32.3		MG/KG
ZINC	27.4		MG/KG

LEGEND

- Subsurface Soil Detect
- (4-6 FT) Sample Depth
- Site Boundary
- — ··· — Intermittent Streams
- — 10 — Contour Interval - 1 foot
- Wooded Area
- Marsh/Wetland
- Groundwater Flow Direction

100 0 100 Feet

NO.	DATE	REVISIONS

DRAWN BY: D. PERRY	DATE: 16-JAN-98
CHECKED BY: D&T	DATE: 1/16/98
COST/SCHED-AREA	
SCALE: AS NOTED	

Brown & Root Environmental

SUBSURFACE SOIL DETECTS
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581	OWNER NO.
APPROVED BY	DATE
APPROVED BY	DATE 1-16-98
DRAWING NO. FIGURE 7-9	REV. 0

P:\GIS\INDIANHD\75810303TAG.APR 16-JAN-98 DNP DUMP SITE B GW LAYOUT

N

DSBMW004		
Metals		
BARIUM	12.5	UG/L
CADMIUM	1.9	UG/L
COBALT	29.7	UG/L
COPPER	4.2	UG/L
MERCURY	0.15	UG/L
SILVER	1.2	UG/L
ZINC	7.5	UG/L
Dissolved Metals		
BARIUM, FILTERED	11.3	UG/L
CADMIUM, FILTERED	1.6	UG/L
COBALT, FILTERED	28.7	UG/L
COPPER, FILTERED	3.6	UG/L
MERCURY, FILTERED	0.12	UG/L
SILVER, FILTERED	0.81	UG/L
ZINC, FILTERED	6.9	UG/L

DSBMW001		
Explosives		
RDX	7.4	UG/L
Metals		
BARIUM	7.7	UG/L
CHROMIUM	2.1	UG/L
COBALT	28.7	UG/L
LEAD	1.3	UG/L
MERCURY	0.10	UG/L
ZINC	5.5	UG/L
Dissolved Metals		
BARIUM, FILTERED	7.0	UG/L
COBALT, FILTERED	25.3	UG/L
MERCURY, FILTERED	0.13	UG/L
ZINC, FILTERED	5.9	UG/L

HYPERVELOCITY TEST RANGE
AND OLD DEMOLITION RANGE
SWMU 23 SITE 31

APPROXIMATE AREA OF SCATTERED
SURFACE DEBRIS, CONCRETE,
STEEL, PLASTIC, AND GLASS

SUSPECTED DUMP
SITE AREA

AREAS OF MAGNETIC ANOMALIES

CHICAMUXEN CREEK

DSBMW002		
Semivolatile Organics		
PHENANTHRENE	1 J	UG/L
Explosives		
RDX	3.8	UG/L
Metals		
COBALT	6.6	UG/L
MERCURY	0.13	UG/L
Dissolved Metals		
COBALT, FILTERED	6.2	UG/L
MERCURY, FILTERED	0.10	UG/L

DSBMW003			DSBMW003 DUP		
Volatile Organics			Volatile Organics		
CHLOROFORM	2 J	UG/L	1,1,1-TRICHLOROETHANE	2 J	UG/L
Semivolatile Organics			CHLOROFORM	4 J	UG/L
BIS(2-ETHYLHEXYL)PHTHALATE	1 J	UG/L	Semivolatile Organics		
DIETHYL PHTHALATE	2 J	UG/L	DIETHYL PHTHALATE	2 J	UG/L
DI-N-BUTYL PHTHALATE	2 J	UG/L	DI-N-BUTYL PHTHALATE	2 J	UG/L
PHENANTHRENE	2 J	UG/L	PHENANTHRENE	2 J	UG/L
Metals			Metals		
BARIUM	57.4	UG/L	BARIUM	61.8	UG/L
CADMIUM	1.7	UG/L	CADMIUM	1.8	UG/L
CHROMIUM	4.4	UG/L	CHROMIUM	4.8	UG/L
COBALT	32.0	UG/L	COBALT	33.4	UG/L
COPPER	4.6	UG/L	COPPER	5.2	UG/L
LEAD	1.5	UG/L	LEAD	1.5	UG/L
MERCURY	0.20	UG/L	MERCURY	0.18	UG/L
NICKEL	11.2	UG/L	NICKEL	10.5	UG/L
ZINC	28.6	UG/L	VANADIUM	4.6	UG/L
Dissolved Metals			ZINC	31.2	UG/L
BARIUM, FILTERED	53.6	UG/L	Dissolved Metals		
CADMIUM, FILTERED	1.8	UG/L	BARIUM, FILTERED	52.1	UG/L
CHROMIUM, FILTERED	2.3	UG/L	CADMIUM, FILTERED	1.8	UG/L
COBALT, FILTERED	32.9	UG/L	CHROMIUM, FILTERED	2.1	UG/L
COPPER, FILTERED	4.1	UG/L	COBALT, FILTERED	30.9	UG/L
MERCURY, FILTERED	0.18	UG/L	COPPER, FILTERED	4.0	UG/L
NICKEL, FILTERED	10.3	UG/L	MERCURY, FILTERED	0.18	UG/L
ZINC, FILTERED	27.8	UG/L	NICKEL, FILTERED	10.2	UG/L
			SILVER, FILTERED	0.86	UG/L
			ZINC, FILTERED	25.1	UG/L

LEGEND
- Groundwater Detect
- Site Boundary
- Intermittent Streams
- 10 Contour Interval - 1 foot
- Wooded Area
- Marsh/Wetland
- Groundwater Flow Direction

100 0 100 Feet

NO.	DATE	REVISIONS

DRAWN BY: D. PERRY — DATE: 16-JAN-98
CHECKED BY: SWT — DATE: 1/16/98
COST/SCHED-AREA:
SCALE: AS NOTED

Brown & Root Environmental

GROUNDWATER DETECTS
SWMU 4 - CHICAMUXEN CREEK'S EDGE DUMP SITE B
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO.: 7581 — OWNER NO.:
APPROVED BY: — DATE:
APPROVED BY: MP — DATE: 1-16-98
DRAWING NO.: FIGURE 7-10 — REV.: 0

8.0 SWMU 6 - AIR BLAST POND

Section 8 provides a brief description and history of the Air Blast Pond (SWMU 6), an inactive explosive test area, and summarizes the scope and results of the environmental investigations and baseline risk assessments conducted for the RFI/VI.

8.1 SITE DESCRIPTION AND HISTORY

8.1.1 Site Description

The Air Blast Pond (SWMU 6) is a former explosive testing area used from 1955 to 1975. It is located approximately 100 feet from Chicamuxen Creek and is accessed by an unpaved road that intersects Archer Avenue. The Air Blast Pond is an unlined earthen pit approximately 100 feet in diameter with a capacity of approximately 1.3 million gallons. The pit currently contains no water and is overgrown with grass, brier, and small trees. There are several rusted metal pipes standing upright on the earthen floor of the pit that were reportedly used to hold monitoring devices when the unit was operational. The area surrounding the Air Blast Pond is wooded on the north and west sides. Chicamuxen Creek is approximately 100 feet south of the unit with a wooded area containing scattered metal and wood surface debris between them. The unpaved access road and an open grass-covered field lie to the east of the site. An unnamed stream, which was not flowing at the time of the RFI/VI field investigation, runs along the northwestern edge of the pond and empties into Chicamuxen Creek. A smaller unnamed stream, which also was not flowing at the time of the RFI/VI field investigation, runs perpendicular to and intersects the aforementioned unnamed stream approximately 75 feet before it empties into Chicamuxen Creek. The location and general features of SWMU 6 - Air Blast Pond are displayed in Figure 8-1.

8.1.2 Site History

The Air Blast Pond was used as explosive testing area from approximately 1955 to 1975. The pond, constructed in 1956, was filled with water from Chicamuxen Creek by means of a 14-inch diameter pipe. Wire was strung across the pit to measure concussion factors of various explosives above the water. Water was periodically discharged through the same pipe, industrial outfall IW32, into Chicamuxen Creek. The pond was emptied and refilled two to three times per year. Reportedly, three to four detonation events (shots) were conducted per day, with an estimated 1,500 shots over the unit's active life. The explosives tested include Pentolite (a mixture of TNT and PETN (pentaerythrol tetranitrate)), HBX-1 (a mixture of RDX, TNT, and aluminum), HBX-2, H-6 (a mixture of RDX, TNT, and aluminum), and C4. Maximum charge weights were eight pounds per shot. The pond has not been in use since 1975.

8.2 VI FIELD INVESTIGATION

This section discusses the field activities performed at the Air Blast Pond during the VI. These activities consist of a field screening (using field test-kit sample analysis), and sampling of surface soil, subsurface soil, and sediment for fixed-base laboratory analysis. Field test-kit sample analysis data are provided in Appendix C. Sample log sheets are provided in Appendices D through G. Table 8-1 provides a summary of the sampling and analytical program for the fixed-base laboratory samples.

8.2.1 Field Screening

A reference grid was established at the site. The grid consisted of perpendicular lines spaced at 50-foot intervals covering an area of approximately 62,500 sq. feet. Soil samples collected at the grid points were analyzed using field test-kits. These field test-kits are sensitive to the explosives TNT and RDX. Additional information on these field test-kits is found in Section 2.1.4. Initially, five soil samples (two shallow-subsurface and three surface) were collected from three locations (ABPFT01, ABPFT02, and ABPFT03) within the pond, for field screening. ABPFT01 was located near the center of the pond around piping and other equipment apparently used for site activities. Three soil samples were collected from ABPFT01 at depths of 0 to 6 inches, 6 to 12 inches, and 12 to 24 inches bgs to determine whether any particular depth interval demonstrated higher levels of contaminants. None of these samples exhibited positive detections for explosives, so subsequent soil samples for test-kit analyses were collected from a depth of 0 to 6 inches. Sample ABPFT02 was located at a pipe culvert inside the pond that was used to drain the pond periodically. ABPFT03 was located at the western portion of the pond floor. None of these samples collected within the pond had positive detections for explosives. Therefore, the B&R Environmental project manager decided that only four samples were to be collected outside the pond from locations surrounding the pond (ABPFT04 through ABPFT07) for field test-kit analysis. The sampling locations are shown on Figure 8-2, and results are summarized on Table 8-2.

8.2.2 Soil Investigation

Seven surface soil samples and seven subsurface soil samples were collected at the site for fixed-base laboratory analysis to characterize the soil. The sampling locations are shown on Figure 8-3. The general locations were established in the B&R Environmental Work Plan Addenda (May 1997). The actual locations were selected by the field crew. Three surface soil samples, ABPSS01 through ABPSS03, were collected from locations within the pond. Samples ABPSS01 and ABPSS02 were collected near the field test-kit sampling locations ABPFT01 and ABPFT02, respectively. ABPSS03 was collected in the eastern portion of the pond floor. One surface soil sample was also collected at each soil boring location

at a depth of 0 to 1 foot. Surface soil samples ABPSS04, ABPSS05, ABPSS06, and ABPSS07 were collected from the top of the berm in the northern, eastern, southern, and western portions of the site, respectively.

Soil borings ABPSB01 through ABPSB04 were advanced at locations in the top of the berm and spaced equidistant around the pond. ABPSB01 through ABPSB04 were completed using hollow-stem auger and split-spoon sampling techniques. Seven subsurface soil samples were collected from the four soil borings. The samples were obtained over 2-foot intervals ranging from beginning depths of 4 to 10 feet. The samples were collected for Appendix IX metals, Appendix IX VOA, Appendix IX SVOA, and explosives. Figure 8-7 provides the specific sampling depths and positive detections for each sample collected.

8.2.3 Groundwater Investigation

As indicated in the EnSafe Work Plan (EnSafe, Allen, and Hoshall, 1995), no monitoring wells were installed for this VI. There are no existing monitoring wells at the site.

8.2.4 Surface water and Sediment Investigation

There were no surface waters collected because the proposed sampling locations were dry during the field effort. Four sediment samples (ABPSD01 through ABPSD04) were collected at locations shown on Figure 8-3. The samples were analyzed for Appendix IX metals, Appendix IX VOA, Appendix IX SVOA, and explosives. Table 8-1 provides the analytical program for each sample collected.

8.2.5 Summary of Environmental Investigation

The field activities consisted of field screening of soils using field test-kits (seven sampling locations and nine samples). Seven surface soil samples, seven subsurface soil samples, and four sediment samples were collected for fixed-base laboratory analyses to characterize the site.

8.3 SITE CHARACTERISTICS

This section discusses the geology and hydrogeology of the site.

8.3.1 Geology

Subsurface conditions at the site were investigated through the drilling and logging of four soil borings. No waste material was encountered at the site during the subsurface investigation. The cross-section

locations are shown on Figure 8-3. Cross-section profiles A-A' and B-B' are shown on Figures 8-4 and 8-5, respectively, and were generated to illustrate the subsurface materials encountered beneath the site.

Cross Section A-A'

Cross section A-A' traverses west to east across the site from soil boring ABPSB04 to ABPSB02. The materials encountered at boring ABPSB04 consist of a surfical 10-foot thick layer of silty sand (probably reworked natural material) underlain by sand and gravel to the bottom of the boring at a depth of 14 feet bgs. The same materials extend to boring ABPSB02, approximately 115 feet to the east.

Cross Section B-B'

Cross section B-B' traverses south to north across the site from boring ABPSB03 to ABPSB01. The materials encountered at boring ABPSB03 consist of a surficial 12-foot thick layer of silty sand (probably reworked natural material) underlain by sand and gravel to the bottom of the boring at a depth of 14 feet bgs. At boring ABPSB01, approximately 115 feet to the north, the same material is encountered at the ground surface and is approximately 9 feet thick. However, it is underlain by silty clay to the bottom of the boring at a depth of 16 feet bgs.

Summary

The subsurface materials were relatively consistent across the study area vertically and horizontally. The material encountered in and beneath the berm generally consisted of a 9- to 12-foot thickness of natural, reworked material classified as silty sand and was generally underlain by sand and gravel. In the northern portion of the site, however, it was underlain by silty clay.

8.3.2 Hydrogeology

Physical features, such as the ground surface topography (as shown on Figure 8-1) and the proximity to Chicamuxen Creek, were considered in making generalized interpretations regarding groundwater flow directions.

There are no monitoring wells located at the site; thus the groundwater flow direction could not be determined by groundwater-level measurements. The groundwater is presumed to flow toward and discharge into Chicamuxen Creek to the south.

8.4 NATURE AND EXTENT OF CONTAMINATION

This section presents the results of the sampling and analysis of environmental samples collected at Air Blast Pond as described in Sections 2.0 and 8.2. The location of Air Blast Pond is shown on Figure 8-1. Table 8-1 provided a summary of the sampling and analytical program for environmental samples collected by B&RE and analyzed by General Physics Environmental Services (GP), according to the methods specified in Section 2.0. Analytical results provided by GP are summarized in Tables 8-3 through 8-5 and are presented in detail in Appendix M.

All data generated by GP were validated according to EPA National and Region III guidelines. The data validation was performed by B&RE validation chemists, who routinely validate data from numerous laboratories producing data under the EPA Contract Laboratory Program (CLP). A copy of the validation packages is available to the Navy, the State of Maryland Department of Environment, and EPA Region III upon request. Additionally, data validation memorandum summarizing the results of the data validation are presented in Appendix.

8.4.1 Surface and Subsurface Soil

Surface and subsurface soil samples were collected at the Air Blast Pond during the field investigation conducted under CTO 287 for the presence of site-related contamination. Summarizing from Section 8.2, the field investigation included field screening for TNT and RDX in shallow soil at seven locations and the collection of three surface soil samples from within the Air Blast Pond and four surface and subsurface soil samples from soil borings advanced on the bermed area of the Air Blast Pond. Analytical results for any parameter detected at least once in surface and subsurface soil samples sent to GP for analysis are presented in Tables 8-3 and 8-4, respectively. Table 8-6 compares the data for surface and subsurface soil samples. Additionally, descriptive statistics (i.e., frequency of detection, range of detection, arithmetic mean of positive detections, location of maximum positive detection) are summarized in Tables 8-7 through 8-9, the COPC selection tables for Air Blast Pond soil. The location of the positive detections are depicted in Figures 8-6 and 8-7.

8.4.1.1 Surface Soil Characterization

The primary, site-related target analytes (explosives, components of explosives, or degradation by-products of explosives) were not detected in surface soil samples collected for field screening or fixed-base laboratory analysis. Acetone (C_{max} = 2,000 µg/kg) in two samples collected from the bermed area and styrene in one sample (92 µg/kg) collected from within the pond area were the only volatile organics detected in surface soil. Semivolatile compounds were detected in only three of seven surface soil

samples. Bis(2-ethylhexyl)phthalate (C_{max} =2,600 µg/kg) was detected in two samples (ABPSS001 and ABPSS003) located within the pond area and one sample located on the bermed area (ABPSS006). Acetone and bis(2-ethylhexyl)phthalate were also detected in soil samples collected for the facility background dataset. Chrysene (67 µg/kg) and phenanthrene (63 µg/kg) were detected in boring ABPSS006 located in the bermed area. These PAHs are by-products of the combustion process and may not be directly related to detonation activities at the Air Blast Pond. The concentration of all organics in surface soil were less than the EPA Region III RBCs and the EPA SSLs for migration of compounds from soil to groundwater (Table 8-7).

Several inorganic compounds were detected in Air Blast Pond surface soil samples:

Metal	Maximum Concentration (mg/kg)	$UTL_{95\%\ BACKGROUND}$ (mg/kg)	Eastern United States [1] (mg/kg)	State of Maryland Soils[2] (mg/kg)
Antimony	0.58	Not detected	<1 - 8.8	NA
Arsenic	9.6	4.25	<0.1 - 73	1.1 - 7.1
Barium	49.6	144	10 - 1500	150 - 700
Beryllium	0.51	0.905	<1 - 7	ND - 3
Cadmium	0.69	0.26	NA	<0.01 - 5.6
Chromium	26.3	24.2	<1 - 1000	15 - 100
Cobalt	4.0	39.7	<0.3 - 70	ND - 20
Copper	33.8	18.7	<1 - 700	5 - 70
Lead	47	149	<10 - 300	10 - 50
Mercury	0.06	0.087	0.01 - 3.4	0.04 - 0.14
Nickel	7.6	18.2	<5 - 700	ND - 30
Selenium	1.1	1.09	<0.1 - 3.9	<0.1 - 0.5
Silver	0.08	Not detected	NA	NA
Vanadium	32.4	53.5	<7 - 300	20 - 150
Zinc	80.8	38.1	<5 - 2900	8 - 113

1 Shacklette and Boerngen, 1984.
2 Dragun, 1991

Overall concentrations of cadmium, copper, and zinc were highest in the pond area and concentrations of barium, beryllium, chromium, and vanadium were highest in the bermed area. Maximum concentrations of antimony, arsenic, cadmium, chromium, copper, silver, and zinc exceeded their respective $UTLs_{95\%}$ calculated for the background data set. However, with the exception of arsenic all positive detections are within the concentration range reported in the literature for soils of the Eastern United States and the State of Maryland where available. Concentrations of cadmium, copper, and zinc exceed the site-specific background $UTL_{95\%}$ only for samples from locations within the pond area. The concentration of arsenic in sample ABPSS001 collected from within the pond area exceeded the EPA Region III RBC for industrial

exposures. All detected concentrations of arsenic and beryllium exceeded the EPA Region III RBCs for residential exposures (Table 8-7). The detected concentrations of inorganics were less than the EPA SSLs for migration of compounds from soil to groundwater (Table 8-9).

8.4.1.2 Subsurface Soil Characterization

As noted in the preceding surface soil characterization, the primary, site-related target analytes (explosives, components of explosives, or degradation by-products of explosives) were not detected in subsurface soil samples collected for fixed-base laboratory analysis. Acetone (C_{max} = 1,100 µg/kg) and methylene chloride (C_{max} = 7µg/kg) were the only volatile organics detected in subsurface soil. Acetone was detected at the same locations in surface and subsurface soil. Concentrations of acetone were higher in the surface soil sample ABPSB002 (i.e., at boring ABPSS005) than in the associated subsurface soil boring sample. Concentrations of acetone were lower in the surface soil sample ABPSB004 (i.e., at boring ABPSS007) than in the associated subsurface soil boring sample. Methylene chloride was not detected in surface soil. Semivolatile compounds were detected in only three of seven surface soil samples. Bis(2-ethylhexyl)phthalate in two samples (C_{max} = 1,200 µg/kg) was the only semivolatile compound detected in subsurface soil. Bis(2-ethylhexyl)phthalate was detected at different locations in subsurface soil than surface soil. As noted previously, acetone and bis(2-ethylhexyl)phthalate were also detected in soil samples collected for the basewide background dataset. The positive detections of all organics noted in subsurface soil samples were less than the EPA Region III RBCs (Table 8-8) and the EPA SSLs for migration of compounds from soil to groundwater (Table 8-9).

Maximum concentrations of metals detected in Air Blast Pond subsurface soil were as follows:

Metal	Maximum Concentration (mg/kg)	$UTL_{95\% \text{ BACKGROUND}}$ (mg/kg)
Antimony	0.48	3.6
Arsenic	3.5	24.4
Barium	70.8	191
Beryllium	0.5	2.46
Chromium	24	101
Cobalt	3.9	133
Copper	11.9	56.5
Lead	14.7	37.5
Mercury	0.05	0.13
Nickel	5.9	22.1
Selenium	1.8	8.93
Vanadium	30.3	133
Zinc	22.8	79.5

Metals concentrations in the subsurface soil samples were similar to or lower than those reported for surface soil samples. Maximum concentrations of all metals were less than the $UTL_{95\%}$ developed for the basewide background dataset. The maximum arsenic concentration exceeded the EPA Region III RBCs for industrial exposures (Table 8-8). The maximum concentrations of arsenic and beryllium exceeded the EPA Region III RBCs for residential exposures. The detected concentrations of inorganics were less than the EPA SSLs for migration of compounds from soil to groundwater (Table 8-9).

8.4.2 Sediment

Four sediment samples were collected in the vicinity of the Air Blast Pond as shown on Figure 8-3. The results of the analysis of these sediments are consistent with the preceding characterization of soils. The primary, site-related target analytes (explosives and degradation by-products of explosives) were not detected.

The following volatile and semivolatile organic compounds were detected in Air Blast Pond sediment samples :

Volatile Organics	Maximum Concentration (µg/kg)
1,1,1-Trichloroethane	2
Carbon Disulfide	3

Semivolatile Organics	Maximum Concentration (µg/kg)
Acenaphthylene	170
Anthracene	160
Benzo(a)anthracene	580
Benzo(a)pyrene	510
Benzo(b)fluoranthene	950
Benzo(g,h,i)perylene	320
Benzo(k)fluoranthene	720
Bis(2-ethylhexyl)phthalate	150
Chrysene	810
Di-n-buthyl phthalate	40
Dibenzo(a,h)anthracene	130
Fluoranthene	860
Indeno(1,2,3-cd)pyrene	340
Phenanthrene	99
Pyrene	970

The two volatile organic chemicals noted were not detected in site soil samples. PAHs were only detected in one sediment sample (ABPSD003) and the reported concentrations exceed those noted in the soil samples.

Maximum concentrations of benzo(a)pyrene, benzo(b)fluoranthene, and dibenzo(a,h)anthracene in sediment samples exceeded the EPA Region III RBCs for residential exposures to soil (Table 8-10). Concentrations of all volatiles and semivolatiles in sediment samples were less than the EPA Region III RBCs for industrial exposures to soil.

The following inorganic compounds were detected in Air Blast Pond sediment samples:

Metal	**Maximum Concentration (mg/kg)**	**$UTL_{95\%\ BACKGROUND}$ (mg/kg)**
Arsenic	5.8	63
Barium	80.6	577
Beryllium	0.52	10.9
Cadmium	0.39	1.85
Chromium	20	79.2
Cobalt	4.4	18
Copper	90	296
Lead	141	476
Mercury	0.12	0.778
Nickel	11.5	382
Selenium	1.1	8.45
Tin	10	Not detected
Vanadium	40.5	196
Zinc	337	1660

With the exception of tin all positive detections were less than the respective $UTLs_{95\%}$ calculated for the background freshwater sediment dataset. With the exception of copper, lead, and zinc, the maximum concentrations reported are similar to or less than those noted in the soil samples or the maximum concentrations reported for the basewide background freshwater sediment dataset. The maximum detected concentrations of these three metals were in sample SD03, which was collected from the effluent ditch west of the Air Blast Pond.

Maximum concentrations of arsenic and beryllium in Air Blast Pond sediments exceeded EPA Region III RBCs for residential exposures (Table 8-10). Maximum concentrations of all inorganics were less than the EPA Region III RBCs for industrial exposures.

8.5 CONTAMINANT FATE AND TRANSPORT

The Air Blast Pond was used as an explosives testing area. The pond was filled with water from Chicamuxen Creek by means of a 14-inch pipe. Water was periodically discharged through the same pipe into Chicamuxen Pond.

The main COPCs at the Air Blast Pond based on historical use would be energetics (e.g., TNT, RDX, HMX) and by-products of energetics (2-amino-4,6-dinitrotoluene). Overall, energetics are not considered to be persistent in the environment, particularly in comparison to chemicals such as PCBs and pesticides.

The data indicates that no significant migration of chemicals from the Air Blast Pond into the surrounding area is occurring. No areas of significant contamination have been identified in the Air Blast Pond area. Volatile organics (acetone and styrene) and semivolatiles (bis(2-ethylhexyl)phthalate, chrysene, and phenanthrene) were detected sporadically and at low concentrations in surface and subsurface soil. Volatile organics typically are not persistent compounds in the environment. PAHs and phthalates are relatively insoluble and tend to strongly adhere to soil, consequently they tend to be fairly immobile in the environment. In addition, acetone and phthalates are common laboratory contaminants and their presence in site samples may not be site related.

Concentrations of metals in surface soil were similar to those in subsurface soils. With a few exceptions concentrations of metals in soil and sediments were within the range of background concentrations.

Phthalates were detected in the sediment sample collected at the pipe discharge point and may have migrated from the Air Blast Pond via soil erosion.

8.6 BASELINE HUMAN HEALTH RISK ASSESSMENT

This section contains the site-specific risk assessment for the identified exposure scenarios for the Air Blast Pond. The risk assessment methodology was described in Section 2.5, and detailed calculations are contained in Appendix P.

8.6.1 Data Evaluation/Selection of Chemicals of Potential Concern

8.6.1.1 Data Evaluation SWMU 6 - Air Blast Pond

All field samples collected for fixed-base laboratory analysis for the RFI/VI at NSWC Indian Head underwent the data validation process as described in Section 2.3. This section summarizes the SWMU-specific data validation results for SWMU 6 - Air Blast Pond. Analytical data for samples collected from the Air Blast Pond are contained in SDGs 9707119, 9707161, and 9707063.

Some positive analytical results for acetone, methylene chloride, di-n-butyl phthalate, bis(2-ethylhexyl)phthalate, arsenic, nickel, copper, tin, and beryllium associated with Air Blast Pond soils were flagged B during data validation indicating that they are false positives attributable to field/laboratory blank contamination. Blank contamination was not noted in the sediments samples collected at the Air Blast Pond.

Nondetected results for the organic compounds: 2-butanone, acrolein, acrylonitrile, acetonitrile, propionitrile, isobutyl alcohol, vinyl acetate, 4-nitroquinoline-1-oxide, famphur, and kepone, in most soil and sediment samples were qualified as rejected, "UR," during data validation. No positive results were reported for any of the noted compounds. The rejection of results for the noted compounds were a result of extremely low (0.050 unitless) initial and continuing calibration relative response factors. These low response factors indicate that the laboratory's instruments could not achieve satisfactory sensitivity for the aforementioned compounds which severely compromises the associated positive and nondetected results.

The method of analysis for the determination of these volatile and semivolatile organic compounds utilizes Gas Chromatography/Mass Spectrometry (GC/MS). Isobutyl alcohol and 2-butanone are soluble in water and are difficult to purge effectively. There are technical adjustments the laboratory could have made that would have improved the responses for isobutyl alcohol and 2-butanone. Vinyl acetate may react under certain chromatographic conditions thus yielding a poor instrument response. Kepone is best analyzed by GC using an Electron Capture Detector (ECD). Acrolein and Acrylonitrile, chemically, are more suited for analysis by High Performance Liquid Chromatography (HPLC). Acetonitrile may be analyzed using GC with a Nitrogen-Phosphorus Detector (NPD). The chemical properties of propionitrile, 4-nitroquinoline-1-oxide, and famphur may restrict these compounds from yielding satisfactory chromatographic response regardless of the analytical method of detection. However, the substitution of alternative analytical methods would be cost prohibitive in comparison to the value they would add to the final data. Therefore, the poor response of the aforementioned compounds is attributable to both the specific chemical properties and the use of GC/MS as all encompassing method of analysis in an attempt to eliminate a

variety of complex alternatives. Furthermore, the rejection of result for these compounds in environmental matrices does not create any significant data gaps that would warrant resampling.

No inorganic analyte results were rejected during the data validation process.

8.6.1.2 Selection of Chemicals of Potential Concern

Chemicals of potential concern at this site were selected using the risk-based COPC screening levels (i.e., the Section 2.0 benchmarks) described in Section 2.5.1. COPC summary screening tables for all media are presented in Tables 8-7 through 8-10. The list of COPCs for the Air Blast Pond is presented in Table 8-11.

Maximum chemical concentrations in soil were compared to EPA Region III RBCs for industrial land use and basewide background levels. Additionally, maximum concentrations in soil were compared to EPA SSLs for transfers from soil to air and for migration to groundwater to justify the exclusion of the inhalation pathway and to provide a cursory evaluation of potential transport of soil chemicals to groundwater.

A discussion of the chemicals identified as COPCs and the rationale for their selection is provided in the following subsections.

Surface Soil

Two VOCs, 3 SVOCs (phthalates), and 15 inorganics were detected in surface soil (0 to 2 feet bgs) at the Air Blast Pond. A comparison of the maximum detected soil concentrations to EPA Region III RBCs and EPA SSLs for soil to air is presented in Table 8-7. No VOCs and SVOCs were present in surface soil at concentrations in excess of the RBCs or SSLs. Arsenic was the only inorganic in surface soil which exceeded the RBCs for industrial exposures. Maximum concentrations of arsenic and beryllium exceeded the RBCs for residential exposures. Future site use is anticipated to be nonresidential so only those compounds exceeding nonresidential RBCs will be retained as COPCs. Therefore, only arsenic was selected as a COPC for surface soil.

Maximum surface soil concentrations were also compared to EPA SSLs for migration to groundwater (Table 8-9). There were no exceedances of the SSLs in surface soil.

Surface/Subsurface Soil

Three VOCs, 3 SVOCs (phthalates), and 15 inorganics were detected in surface/subsurface soil (0 to >10 feet bgs) at the Air Blast Pond. A comparison of the maximum detected soil concentrations to EPA Region III RBCs and EPA SSLs for soil to air is presented in Table 8-8. No VOCs and SVOCs were present in surface/subsurface soil at concentrations in excess of the RBCs or SSLs. Arsenic was the only inorganic which exceeded the RBCs for industrial exposures. Maximum concentrations of arsenic and beryllium in surface/subsurface soil exceeded the RBCs for residential exposures. Future site use is anticipated to be nonresidential so only those compounds exceeding nonresidential RBCs will be retained as COPCs. Therefore, only arsenic was selected as a COPC for surface/subsurface soil.

Maximum surface/subsurface soil concentrations were also compared to EPA SSLs for migration to groundwater (Table 8-9). There were no exceedances of the SSLs in surface/subsurface soil.

Sediment

Two VOCs, 15 SVOCs (PAHs and phthalates) and 14 inorganics were detected in sediment samples at Rum Point Landfill. A comparison of the maximum detected sediment concentrations to EPA Region III RBCs for soil is presented in Table 8-10. Arsenic was the only compound in sediment which exceeded the RBCs for industrial exposures. Maximum concentrations of benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, arsenic and beryllium in sediment exceeded the RBCs for residential exposures. Future site use is anticipated to be nonresidential so only those compounds exceeding nonresidential RBCs will be retained as COPCs. The maximum detected arsenic concentration of 5.8 mg/kg exceeded the residential and nonresidential RBCs of 3.8 mg/kg and 0.43 mg/kg, respectively, but was below the basewide background sediment concentration of 63 mg/kg. Consequently, arsenic was not retained as a COPC. No chemicals were selected as COPCs for sediment, since no maximum concentrations exceeded applicable RBCs.

8.6.2 Exposure Assessment

The location of the Air Blast Pond is shown on Figure 8-1. Because of the potential for UXO at the site it is anticipated that future use of the site will remain nonresidential. Potential receptors for the Air Blast Pond include future maintenance workers, future full-time employees, and future construction workers. Since access to the Air Blast Pond is restricted by fences and military patrols civilian trespassers were not considered as potential human receptors.

Maintenance workers and full-time employees are assumed to enter the site to conduct maintenance (such as mowing) and related activities. The only medium of concern for these workers would be surface soil (0 to 2 feet bgs). Exposure to subsurface soil is expected to be limited to ground-intrusive activities. Although no major construction projects are planned for the site or the surrounding areas, construction workers are evaluated as potential receptors to assess future exposure to subsurface soil (assumed to be exposed to surface and subsurface soil to an estimated maximum depth of 10 feet bgs or greater).

The primary routes of exposure for potential human receptors at the Air Blast Pond are incidental ingestion of soil and dermal contact with soil. Exposure routes associated with soil contact are evaluated for maintenance workers, full-time employees, and construction workers.

Ingestion of groundwater, inhalation of volatile emissions, direct contact with surface waters and sediments, and ingestion of wildlife were not considered for the following reasons:

- The shallow aquifer at NSWC is not used as a potable water supply either on base or in surrounding off-base areas. Shallow groundwater at the site is tidally influenced and the source of potable water is the deeper aquifers. The deeper aquifers are not believed to be impacted by the surficial aquifer. Thus, groundwater exposures by base personnel are eliminated. In addition, no groundwater samples were collected in the Air Blast Pond area.

- Potential exposure to fugitive dust and volatile emissions from the Air Blast Pond is considered to be minimal, thereby eliminating the need for quantitative evaluation of this exposure pathway. As shown in Tables 8-7 and 8-8 all reported surface and subsurface soil concentrations are less than the EPA SSLs for transfers from soil to air (USEPA, 1996a).

- Direct contact with sediment by potential human receptors was not evaluated because there were no COPCs identified for this medium.

- Ingestion of wildlife by hunters and their families was eliminated as a significant exposure pathway. The large size of the home ranges for game species at NSWC Stump Neck relative to the size of the Air Blast Pond is not expected to result in significant foraging at the site. Moreover, the restrictive nature of the site would limit access both to the game species and to human receptors.

Exposure assumptions for these receptors are presented in Table 2-14. Table 8-12 presents a summary of the COPCs and exposure point concentrations for the Air Blast Pond. A summary of the potentially significant exposures identified for quantitative evaluation for the Air Blast Pond is provided in Table 8-13.

The dose-response factors (RfDs and CSFs) for COPCs at the Air Blast Pond were presented in Tables 2-10 and 2-11. Appendix P contains the toxicological profiles for the COPCs.

8.6.3 Risk Characterization

Potential cancer risks and hazard indices were calculated for maintenance workers, full-time employees, and construction workers (future land use) using the methodology presented in Section 2.0. Both RME and CTE exposure scenarios were evaluated. Table 8-13 contains a summary of the estimated risks for the Air Blast Pond. All spreadsheets containing the detailed, chemical-specific risks for the site are included in Appendix P. The following text presents a summary of the results of the risk characterization.

8.6.3.1 Carcinogenic Effects

All estimated cancer risks for exposures to surface and subsurface soil were within or below EPA's target risk range of 10^{-4} to 10^{-6}. The estimated cancer risk for maintenance workers based on RME and CTE exposures to surface soil were 1.4×10^{-6} and 7.4×10^{-8}, respectively. The estimated cancer risk for full-time employees based on RME and CTE exposures to surface soil were 7.1×10^{-6} and 7.4×10^{-7}, respectively. The estimated cancer risk for construction workers based on RME and CTE exposures to surface and subsurface soil were 4.5×10^{-7} and 2.8×10^{-7}, respectively.

8.6.3.2 Noncarcinogenic Effects

All estimated hazard indices were below 1.0 indicating that no toxic effects are anticipated for these receptors under the defined exposure scenarios. The hazard indices for maintenance workers exposed to surface soil were 0.0088 for RME exposures and 0.00053 for CTE exposures. The hazard indices for full-time employees exposed to surface soil were 0.044 or RME exposures and 0.0053 or CTE exposures. The hazard indices for construction workers exposed to surface and subsurface soil were 0.07 for RME exposures and 0.024 for CTE exposures.

8.6.3 Uncertainty Analysis

A detailed discussion of uncertainties associated with the various aspects of risk assessment in general was provided in Section 2.8. There are no site-specific uncertainties for the Air Blast Pond.

8.6.4 Summary of Risk Assessment

The following items summarize the human health risk assessment for the Air Blast Pond.

- The human health risk assessment for the Air Blast Pond considered exposures to maintenance workers, full-time employees, and construction workers. Potential exposure pathways for direct contact with soil for all receptors included incidental ingestion and dermal contact with soil. Inhalation of fugitive dust and volatiles from soil were not considered since concentrations of all COPCs in soil were less than the EPA soil to air SSLs.

- Incremental lifetime cancer risks for all receptors were within or below EPA's target risk range of 10^{-4} to 10^{-6}.

- Noncarcinogenic risk estimates (HIs) for all receptors were less than 1.0 indicating that no toxic effects are anticipated for these receptors under the defined exposure scenarios.

8.7 ECOLOGICAL ISSUES

This section presents the ERA, ecological risk management, ERA/risk management summary for the Air Blast Pond, and site-specific uncertainties.

8.7.1 Ecological Risk Assessment

This section presents the results of the ecological risk assessment performed at Air Blast Pond, and consists of a discussion of the preliminary problem formulation, effects characterization, exposure assessment, and risk characterization.

8.7.1.1 Preliminary Problem Formulation

This section includes a discussion of available habitats, ecological receptors, contaminant sources, release mechanisms, migration pathways, exposure routes, selection of preliminary contaminants of potential concern (PCOCs), assessment and measurement endpoints, and the conceptual site model.

Habitat Types and Ecological Receptors

The Air Blast Pond is located adjacent to Chicamuxen Creek at the end of a dirt access road off of Archer Avenue (Figure 8-3). The pond is encircled by an earthen berm approximately 8 feet high and the bottom of the pond is a few feet lower in elevation than the surrounding area. An influent pipe (IW32) runs from Chicamuxen Creek underground to the southern portion of the pond. An effluent ditch approximately 8 feet wide runs from the western edge of the pond to Chicamuxen Creek. Scattered metal and wood

debris are located throughout the area, including the remains of the pumphouse next to the berm and metal structures that were used for blasting activity in the pond. The bank of the Creek near the pond is steeply graded and the top of the bank is approximately 8 to 10 feet higher in elevation than the shoreline. The portion of the effluent ditch near the Creek also contains steep banks approximately 6 feet in elevation. The area including the pond, the area to the north of the pond, and the area between the pond and the Creek are heavily wooded.

The pond was permanently drained several years ago. As a result, several immature trees have grown in the pond. Maples (*Acer* spp.), tulip poplar (*Liriodendron tulipera*), and a few scattered eastern red cedar trees (*Juniperus virginiana*) are located in the pond and on the earthen berm. The wooded areas outside the pond are dominated by maples and tulip. Occasional willow oaks (*Quercus phellos*) and black locust (*Robinia pseudoacacia*) are also present. The understory is dominated by thick American holly (*Ilex opaca*) and sassafras (*Sassafras albidum*). A 200 foot wide swath of turfgrass and brush is located east of the site. Wooded areas are located to the east and south of the grassy area. Large freshwater tidal marshes are located across Chicamuxen Creek from the Air Blast Pond. These marshes are part of the Chicamuxen Creek Marsh Protection Area, as designated by MDNHP (1992). A detailed description of this marsh system is presented in the SWMU 4, Chicamuxen Creek's Edge Dump Site B, ERA discussion (Section 7.0).

Precipitation temporarily pools in the pond and infiltrates. Some runoff from the site, particularly along the bank area, will flow into Chicamuxen Creek. The top of the Creek bank is higher in elevation along most of the shoreline than the area behind it. Hence, runoff will tend to pond and infiltrate rather than flow to the Creek. However, some precipitation from the area southwest and west of the site may enter the effluent and ditch and ultimately reach Chicamuxen Creek during periods of heavy rainfall. Communication between shallow groundwater and Chicamuxen Creek probably occurs at the site.

Again, the pond has been drained and no standing water is present, precluding the existence of an aquatic community. The wooded area in and around the pond provides excellent terrestrial habitat. No threatened or endangered species are known to occur in or closely adjacent to the pond. Chicamuxen Creek and the Chicamuxen Creek marshes, located across the Creek from the site, provide excellent aquatic and semi-aquatic habitat.

Contaminant Sources, Release Mechanisms, and Migration Pathways

The major potential contaminant source at Air Blast Pond is residual soil contamination from historical blasting activities in the pond. The contaminant release pathways from this area include overland runoff and infiltration of contaminants. Air transport is unlikely since the site is heavily vegetated.

Precipitation runoff can carry contaminants via overland runoff to Chicamuxen Creek, mainly via the effluent ditch. The heavily vegetated areas that are higher in elevation than the pond (between the pond and Chicamuxen Creek) may trap surface runoff. The occasional discharge of pond water to Chicamuxen Creek during historical site activities may have also introduced contaminants into Chicamuxen Creek. Also, infiltrating precipitation can cause potential contamination of subsurface soil and groundwater, which probably is a major contaminant transport mechanism because water in the pond and low lying areas from precipitation will tend to pond and infiltrate. Contaminants can be deposited subsequently in sediment or surface water, and can potentially accumulate in the tissues of aquatic organisms in Chicamuxen Creek.

Exposure Routes

Terrestrial animals at Air Blast Pond can be exposed to soil contaminants through the ingestion of contaminated food items. In addition, animals can incidentally ingest soil while grooming fur, preening feathers, digging, grazing close to the soil, or feeding on items that are covered with soil (such as roots and tubers). Terrestrial vegetation can be exposed to contaminants through direct aerial deposition and root translocation, although aerial deposition is probably minuscule since the site is heavily vegetated. Terrestrial receptors can also come into contact with contaminants in surface water in Chicamuxen Creek by using it for drinking, although this exposure route generally represents a negligible portion of total exposure for most receptors. Aquatic and semi-aquatic organisms can be exposed to contaminants through direct contact with surface water and sediments in Chicamuxen Creek, incidental ingestion of surface water and sediments in the Chicamuxen Creek, and consumption of contaminated food items. Exposure to contaminants in the soil via dermal contact can occur but is unlikely to represent a major exposure pathway because fur, feathers, and chitinous exoskeletons minimize the transfer of contaminants across dermal tissue.

Volatilization and soil-bound contaminant airborne suspension are not relevant at Air Blast Pond since the site is heavily vegetated. In addition, inhalation does not represent a significant exposure pathway because this investigation assumes that air contaminant concentrations are quite low, even for burrowing wildlife. Furthermore, inhalation ecotoxicity data for chronic exposure are lacking. Hence, the air pathway was not considered for ecological receptors.

Selection of Preliminary Contaminants of Concern (PCOCs)

The PCOC selection process for this ERA is described in Section 2.6.

Assessment and Measurement Endpoints

A description of assessment and measurement endpoints for this ERA is presented in Section 2.6.

Conceptual Site Model

Figure 8-9 shows the conceptual model for Air Blast Pond.

8.7.1.2 Ecological Effects Characterization

Ecologically-based screening levels (concentrations of contaminants in various media protective of ecological receptors) were compared to exposure point concentrations of detected analytes in sediment and surface soil to determine if they should be retained as ecological PCOCs at Air Blast Pond. The thresholds were USEPA Region III BTAG screening levels (EPA, 1995). The derivation of toxicity reference values (TRVs) for Air Blast Pond foodchain modeling is described in Section 2.6, as well as the selection of representative receptors. Briefly, the red-tailed hawk, red fox, meadow vole, short-tailed shrew, woodcock, and great blue heron were selected as representative ecological receptors for the foodchain modeling at Air Blast Pond.

8.7.1.3 Exposure Assessment

This section presents the ecological exposure assessment for Air Blast Pond and includes a discussion of exposure point contaminant concentrations.

Exposure Point Contaminant Concentrations

The maximum detected contaminant concentrations in sediment and soil were used as exposure point concentrations for screening against USEPA Region III BTAG screening levels. The maximum and mean concentrations of contaminants detected in Air Blast Pond media were used in the foodchain modeling.

8.7.1.4 Risk Characterization

This section presents the results and a discussion of the ecological risk assessment for Air Blast Pond.

Results - Ecological Screening Assessment

The maximum concentrations of arsenic, copper, lead, and zinc in sediments exceeded BTAG screening levels and, thus, these inorganics were retained as PCOCs (Table 8-14). Several PAHs had maximum concentrations in sediments that exceeded BTAG screening levels (Table 8-14). Barium, beryllium, cobalt, selenium, tin, vanadium, and two VOCs (carbon disulfide and 1,1,1-trichloroethane) were retained as PCOCs in sediments since no BTAG screening levels were available.

The maximum concentrations of antimony, beryllium, chromium, copper, lead, mercury, nickel, silver, and zinc in surface soils exceeded BTAG screening levels. Consequently, these inorganics were retained as PCOCs (Table 8-15). Bis(2-ethylhexyl)phthalate and acetone were retained as PCOCs in surface soils since no BTAG screening levels were available.

Results - Foodchain Modeling

Arsenic, cobalt, copper, lead, vanadium, and zinc were retained as PCOCs after the aquatic foodchain modeling because at least one EEI value developed for these metals exceeded 1.0 when maximum concentrations were evaluated (Table 8-16). At least one EEI value developed for arsenic, copper, lead, and zinc also exceeded 1.0 when mean concentrations were evaluated in the aquatic foodchain modeling (Table 8-16). Beryllium, carbon disulfide, and 1,1,1-trichloroethane were retained as foodchain modeling PCOCs since no toxicity data were available.

Antimony, chromium, copper, lead, mercury, vanadium, and zinc were retained as PCOCs after the terrestrial foodchain modeling because at least one EEI value developed for these metals exceeded 1.0 when maximum or mean concentrations were evaluated (Tables 8-17 and 8-18).

8.7.2 Risk Management

Risk management considerations for contaminants in SWMU 6 sediments and surface soils are discussed below.

8.7.2.1 Sediments

Arsenic, copper, lead, and zinc were retained as sediment PCOCs after the aquatic foodchain modeling. The maximum concentration of arsenic was less than the alternate guideline for this metal (Table 8-19), which is the MOE LEL. As discussed in Section 2.6, this is a conservative guideline indicative of low potential risks. The maximum concentration of copper, lead, and zinc were higher than the BTAG screening levels (all ER-Ls) and were between the MOE LELs and SELs, which are presented as alternative guidelines (Table 8-19). The average concentrations of copper, lead, and zinc in sediments are less than the BTAG screening level, as are all other detections of copper in sediments. The maximum detected concentrations of these three metals are in sample SD03, which was collected in the effluent ditch west of the pond. Concentrations of copper, lead, and zinc in sediment sample SD01, which was collected in the effluent ditch downgradient of SD03, 5.7 mg/kg, 9.3 mg/kg, and 15.9 mg/kg, respectively, were much lower than those reported for location SD03. Metals concentrations noted at location SD01 were less than average basewide background and BTAG screening levels, suggesting that contaminants have not migrated further down the effluent ditch and into Chicamuxen Creek.

Beryllium, cobalt, and vanadium were also retained as sediment PCOCs after aquatic foodchain modeling. No BTAG sediment screening levels were available for these three metals. The maximum detected concentrations of beryllium and cobalt were less than the average basewide background concentrations (Table 8-19). All EEI values developed for cobalt in the foodchain modeling were less than 1.0 when mean concentrations were evaluated. Both the maximum and average concentrations of vanadium in sediments were greater than the average basewide background concentrations. However, the maximum detected concentration of vanadium (40.5 mg/kg) is less than the maximum concentration reported for the basewide background dataset (46.3 mg/kg). Vanadium is generally not considered to be toxic in the environment (Mailman, 1980). All EEI developed values for vanadium in the foodchain modeling were less than 1.0 when mean concentrations were evaluated.

The organics 1,1,1-trichloroethane and carbon disulfide, detected in 2 and 1 of 4 sediment samples, respectively, were retained as PCOCs after the aquatic foodchain modeling because no toxicity data were available. No BTAG sediment screening levels were available for these compounds. The lack of aquatic toxicity data for these compounds precludes a thorough determination of their potential risks, although qualitatively their concentrations appear to be low (all less than 3 ug/kg). In addition, these two compounds were not detected in SWMU 6 surface soil or subsurface soil samples collected at the Air Blast Pond.

In summary and for the reasons described in the preceding paragraphs, copper, lead, vanadium, and zinc are retained as final PCOCs in Air Blast Pond sediments. Copper, lead, and zinc may be slightly elevated in pond soils, as discussed below. However, these three metals appear to be elevated in one sample only (SD03), and were not elevated in downgradient sample SD01. It should also be noted that the effluent ditch where these two sediment samples were collected has essentially moist soils. As described earlier, in general, water is present in these ditches after periods of heavy rainfall only. This precludes the presence of a diverse and abundant aquatic community, and therefore, potential risks from contaminants in these sediments are more likely to terrestrial and semi-aquatic receptors. This ditch, and in particular the area near sample SD03, represents a limited surface area (i.e., limited aerial extent). Thus, the exposure area for terrestrial and semi-aquatic receptors would be relatively small.

8.7.2.2 Surface Soils

Antimony, chromium, copper, lead, mercury, vanadium, and zinc were retained as surface soil PCOCs after the terrestrial foodchain modeling. The following paragraphs discuss the risk management considerations for these metals.

Antimony was detected at a maximum concentration of 0.58 mg/kg (Table 8-19), which was only slightly above the BTAG screening level of 0.48 mg/kg. Antimony was not detected in basewide background. However, Boerngen and Shacklette (1981) presented a background concentration range for antimony in Maryland coastal plain counties of <1-1 mg/kg. The maximum concentration of antimony is within this range. No alternate guidelines were available for antimony.

The maximum concentration of chromium in surface soils (26.3 mg/kg) was approximately two times greater than the average basewide background concentration (Table 8-19), and was slightly higher than the range of Maryland coastal plain county background concentrations (15-20 mg/kg). However, chromium concentrations were within the range of concentrations reported for the State of Maryland in an additional reference (15-100 mg/kg) (Dragun, 1981). The average concentration of chromium in Air Blast Pond surface soils (12.8 mg/kg) is essentially equal to the average concentration in basewide background samples (12.0 mg/kg). Both the maximum and average concentrations exceeded alternate guidelines indicative of toxicity to soil organisms, but both of those guidelines are less than the average background concentration of chromium.

The maximum detected concentration of copper in Air Blast Pond surface soils (33.8 mg/kg) is greater than the average concentration in site-specific background (5.15 mg/kg; Table 8-19), and regional background (7-10 mg/kg). The maximum detection of copper, however, is less than the alternate

guidelines of 50 and 100 mg/kg, which are indicative of toxicity to soil organisms (Table 8-19). The maximum concentration is also within the background soil concentrations reported in an additional reference for the soils of State of Maryland (5-70 mg/kg) (Dragun, 1981).

The maximum detected concentration of lead surface soils (47 mg/kg) is greater than the average basewide background concentration (20 mg/kg; Table 8-19), but is less than both of the alternate guidelines for this metal of (500 and 900 mg/kg), which are indicative of toxicity to soil organisms. In addition, the average concentration of lead in surface soils (15.2 mg/kg) is less than the average concentration in basewide background (20 mg/kg), and comparable to the range of regional background concentrations (10-15 mg/kg).

The maximum detected concentration of mercury (0.06 mg/kg) falls within the range of regional background concentrations (0.04-0.07 mg/kg), and is less than the alternate guidelines presented of 0.1 and 30 mg/kg (Table 8-19), which are indicative of toxicity to soil organisms. Also the maximum concentration of mercury is slightly greater than the average concentration of mercury in basewide background concentrations (0.06 mg/kg).

The maximum and average detected concentrations of zinc surface soils (80.8 mg/kg / 34.3 mg/kg) are greater than the average basewide background concentration of 18.1 mg/kg (Table 8-19) and the regional range of 15-26 mg/kg (Boerngen and Shacklette, 1981). However, the maximum concentration of zinc in surface soils is less than the alternate guidelines of 200 and 100 mg/kg which are indicative of toxicity to soil organisms (Table 8-19). The average concentration of zinc (34.4 mg/kg) is slightly higher than the regional background range of 15-26 mg/kg, but is within the background soil concentration range reported in at least one additional reference (8-113 mg/kg) (Dragun, 1991). The maximum detection (sample SS01) and one other detection (sample SS02) are significantly higher than the average basewide (Figure 8-3); all of the other detections are comparable to or lower (all 25.1 mg/kg or less) than the average basewide background concentration (18.1 mg/kg). Samples SS01 and SS02 were collected inside the pond.

In summary, the maximum and average concentrations of chromium in surface soil exceeded alternate guidelines. However, the maximum concentration of chromium in surface soil is only slightly higher than the maximum concentration in basewide background and the average concentration of chromium is almost identical to the average concentration in basewide background. The maximum concentrations of copper, lead, and zinc were moderately higher than the average concentrations in basewide background samples. Yet, the maximum concentrations of copper, lead, and zinc are all less than the alternate guidelines presented in Table 8-19. Also, the maximum concentrations of copper, lead, and zinc were all

in one sample, sample SS01. This sample was collected in the middle of the Air Blast Pond. The other elevated concentrations of copper (33.1 mg/kg) and zinc (58.8 mg/kg) were also from sample SS02, collected in the pond. The maximum concentrations of copper, lead, and zinc in subsurface soils 11.9, 14.7, and 22.8 mg/kg, respectively, are much lower than in surface soils.

The Air Blast Pond was drained several years ago, and hence, discharges of surface water into the effluent ditch are defunct. Rainwater pools and infiltrates in the pond since it is bermed and effluent waters do not escape, indicating that migration of copper, lead, and zinc via overland runoff will not occur. The aerial extent of the pond itself is relatively small compared to the surrounding wooded areas, limiting the aerial extent of the exposure area.

The entire site, including the inside of the Air Blast Pond, supports a diverse and abundant flora that is dominated by canopy and understory species commonly found in similar shoreline habitats in Maryland (e.g., tulip poplar, willow oak, American holly). No evidence of stressed vegetation is evident at the site. Moreover, metals at hazardous waste sites are usually in poorly available forms (Will and Suter, 1995), although the site-specific bioavailability of metals in soils at the Air Blast Pond is not known. For these reasons, although their maximum concentrations are higher than the average basewide background, any potential risks to terrestrial receptors from copper, lead, and zinc in surface soils would be confined to the inner pond area. This area is approximately 50 feet in diameter. Copper, lead, and zinc will be conservatively retained as surface soil PCOCs due to the presence of maximums in excess of average basewide background, but the extent of their potential risks to terrestrial receptors appears to be limited.

8.7.3 ERA and Risk Management Summary and Conclusions

The maximum detected concentrations of contaminants detected in the Air Blast Pond sediment and surface soil samples were compared to BTAG screening levels. All of the contaminants with maximum concentrations that exceeded BTAG screening levels were retained as PCOCs and the PCOCs in sediments and surface soils were included in foodchain modeling at the site for several representative ecological receptors. Contaminants demonstrative an EEI greater than 1.0 in the foodchain modeling (for any representative receptors) when maximum concentrations were evaluated retained as PCOCs. Finally, those PCOCs were assessed using risk management considerations to develop a list of final PCOCs. As a result of these analyses, the following conclusions are drawn:

- Copper, lead, and zinc were retained as PCOCs in sediments because their maximum concentrations exceeded basewide background concentrations. The maximum concentrations of these three metals

were detected in sediment sample SD03, and metals concentrations were not elevated in sediment samples collected downgradient of that sample.

- The effluent ditch where the sediment samples were collected is essentially comprised of moist soils, precluding the existence of an aquatic community. Therefore, potential risks from copper, lead, and zinc would most likely be confined to terrestrial and semi-aquatic receptors. Since the ditch, and in particular the area near sample SD03 represent a limited surface area (i.e., limited areal extent), the exposure area for these receptors would be small.

- The maximum concentrations of copper, lead, and zinc in surface soil were higher than the average basewide background concentrations and the range of regional background concentrations, but were below the alternate guidelines presented. The elevated hits of copper, lead, and zinc in surface soil were in two samples located in the Air Blast Pond itself (SS01 and SS02).

8.7.4 Site-specific Uncertainties

The following items summarize site-specific uncertainties for the ERA at the Air Blast Pond:

- Sample sizes in sediment were low, reducing confidence in the use of the average concentration as a representative exposure concentration.

- No BTAG screening levels or alternate guidelines were available for the beryllium, cobalt, or vanadium, which were all sediment PCOCs after the foodchain modeling. Although the maximum concentrations of all of these inorganics generally were comparable to or less than basewide background concentrations, the general lack of toxicity data for these metals precludes a thorough toxicological evaluation of their presence in site sediments.

- 1,1,1-Trichloroethane and carbon disulfide were detected in sediments and no BTAG screening levels or alternate guidelines were available. The concentrations appear to be relatively low and they were not PCOCs in surface soil. However, without adequate toxicity data, the potential risks associated with their concentrations in sediments cannot be fully determined.

- The maximum concentrations of copper, lead, and zinc were slightly elevated in surface soils relative to background. As mentioned earlier, metals at hazardous waste sites are usually in poorly available forms (Will and Suter, 1995). However, the lack of site-specific bioavailability data introduces uncertainty into the ERA.

8.8 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Section 8.8 summarizes the environmental investigations conducted to date, the nature and extent of the chemicals detected in the environmental media, and the results of the human health risk assessment. Conclusions and recommendations are provided.

The following items summarize the investigative work conducted to date:

1. The field investigation activities included field screening of soils for TNT and RDX using field test kits (seven sampling locations and nine samples). Locations within and outside the actual air blast pond were tested.

2. Four soil borings were advanced at locations on the top of the berm at the Air Blast Pond; a surface and subsurface soil sample were collected from each boring. Surface soil samples were also collected at three additional locations within the pond.

3. Four sediment samples were collected from intermittent streams/ditches located in the immediate vicinity of the Air Blast Pond.

4. No surface water or groundwater samples were collected.

5. Environmental samples collected for analysis by the fixed-base laboratory were analyzed for a comprehensive suite of analytes including volatile organic and semivolatile organic compounds, metals, and explosives.

The following items summarize the environmental conditions at the Air Blast Pond:

1. The subsurface soil materials were relatively consistent across the study area both vertically and horizontally. The material encountered in and beneath the berm of the Air Blast Pond generally consists of a 9- to 12 foot thickness of natural, reworked material classified as silty sand and was generally underlain by sand and gravel. In the northern portion of the site; however, it was underlain by silty clay.

2. There are no groundwater monitoring wells located at the Air Blast Pond. The groundwater is presumed to flow toward and discharge into Chicamuxen Creek to the south.

3. The results of the analysis of surface and subsurface soil samples from the Air Blast Pond suggest that historic activities have not resulted in significant contamination of the soils. No explosive compounds were detected. Acetone (C_{max} = 2,000 µg/kg), styrene (C_{max} = 92 µg/kg), and methylene chloride (C_{max} = 7 µg/kg) were the only volatile organic chemicals noted. Acetone was reported at a maximum concentration less than that reported for the background soil dataset. Bis(2-ethylhexyl)phthalate (C_{max} = 2,600 ug/kg), chrysene (C_{max} = 67 ug/kg), and phenanthene(C_{max} = 63 ug/kg) were the only semi-volatile organics detected in soils. Site-related as well as non-site-related activities may have contributed to the presence of these compounds in the environmental media. With few exceptions, metals concentrations reported in the surface and subsurface soils samples appear to reflect background conditions.

4. Two volatile organics (carbon disulfide [C_{max} = 3 ug/kg] and 1,1,1-trichloroethane [C_{max} = 2 ug/kg]), one phthalate compounds (bis[2-ethylhexyl]phthalate [C_{max} = 150 ug/kg]), and several PAH compounds (e.g., benzo(a)pyrene [C_{max} = 510 ug/kg]) were detected in the sediment samples collected at the Air Blast Pond. As noted with the soil characterization, site-related as well as non-site-related activities may have contributed to the presence of the phthalate and PAH compounds in the sediments.

5. With the exception of copper, lead, tin, and zinc, metals concentrations in the sediment samples were similar to or less than those noted in the soil samples or the maximum concentrations reported for the background freshwater sediment dataset. Maximum metals concentrations were reported for the sample collected from the effluent ditch west of the Air Blast Pond.

The following items summarize the baseline human health risk assessment conducted for the Air Blast Pond:

1. The human health risk assessment for the Air Blast Pond considered exposures to maintenance workers, full-time employees, and construction workers. Potential exposure pathways for direct contact with soil for all receptors included incidental ingestion and dermal contact with soil. Inhalation of fugitive dust and volatiles from soil were not considered since concentrations of all COPCs in soil were less than the SSLs developed by the EPA for the migration of contaminants from soil to air.

2. Arsenic was the only chemical selected as a COPC for soil. No chemicals were selected as COPCs for sediments.

3. Incremental lifetime cancer risk estimates for all receptors hypothetically exposed to arsenic in soil were within the EPA's target risk range of 10^{-4} to 10^{-6}.

4. Noncarcinogenic risk estimates (HIs) calculated for all human receptors hypothetically exposed to arsenic in soils were less than unity indicating that adverse noncarcinogenic health effects are not anticipated under the conditions established in the exposure assessment.

The following items summarize the baseline ecological risk assessment conducted for the Air Blast Pond:

- Copper, lead, and zinc were retained as PCOCs in sediments because their maximum concentrations exceeded basewide background concentrations. The maximum concentrations of these three metals were detected in sediment sample SD03, and metals concentrations were not elevated in sediment samples collected downgradient of that sample.

- The effluent ditch where the sediment samples were collected is essentially comprised of moist soils, precluding the existence of an aquatic community. Therefore, potential risks from copper, lead, and zinc would most likely be confined to terrestrial and semi-aquatic receptors. Since the ditch, and in particular the area near sample SD03 represent a limited surface area (i.e., limited areal extent), the exposure area for these receptors would be small.

- The maximum concentrations of copper, lead, and zinc in surface soil were higher than the average basewide background concentrations and the range of regional background concentrations, but were below the alternate guidelines presented. The elevated detections of copper, lead, and zinc in surface soil were in two samples located in the Air Blast Pond itself (SS01 and SS02).

It is recommended that the risk managers for NSWC Indian Head consider a "No further action" decision for the Air Blast Pond - SWMU 6. The human health risk assessment indicates that the cancer risk estimates for human receptors evaluated are within the EPA's target risk range of 10^{-4} to 10^{-6}. Arsenic in surface soils was the only COPC contributing to the estimated cancer risk. However, the maximum concentration detected in the surface soils (9.6 mg/kg) is similar to the 95 percent upper tolerance limit value established for the basewide background surface soils (4.25 mg/kg) and background soils concentrations reported for the State of Maryland (C_{max} = 7.1 mg/kg). It is also less than the maximum concentration reported for the basewide background subsurface soils (10.4 mg/kg). Adverse noncarcinogenic health effects are not anticipated for the human receptors evaluated. The ecological risk assessment indicates that risks to ecological receptors appear to be relatively low. COPCs were not

detected in soils at concentrations exceeding benchmarks established to evaluate the migration of chemicals from soils to groundwater.

TABLE 8-1

SUMMARY OF SAMPLING AND ANALYTICAL PROGRAM FOR SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE	MEDIA	Explosives SW846 8330	APP IX Metals SW846 6010A/7000	APP IX SVOA SW846 8270B	APP IX VOA SW846 8240B	TOC SW846 9060	TOX SW846 9020B	Miscellaneous
ABPSB0010101	Subsurface soil	X	X	X	X			
ABPSB0020101	Subsurface soil	X	X	X	X			
ABPSB0020201	Subsurface soil	X	X	X	X			
ABPSB0030101	Subsurface soil	X	X	X	X			
ABPSB0030201	Subsurface soil	X	X	X	X			
ABPSB0040101	Subsurface soil	X	X	X	X			
ABPSB0040201	Subsurface soil	X	X	X	X			
ABPSD0010101	Sediment	X	X	X				
ABPSD0020101	Sediment	X	X	X				
ABPSD0030101	Sediment	X	X	X				
ABPSD0040101	Sediment	X	X	X				
ABPSS0010101	Surface Soil	X	X	X	X			
ABPSS0020101	Surface Soil	X	X	X	X			
ABPSS0030101	Surface Soil	X	X	X	X			
ABPSS0040101	Surface Soil	X	X	X	X			
ABPSS0040101-D	Surface Soil	X	X	X	X			
ABPSS0050101	Surface Soil	X	X	X	X			
ABPSS0060101	Surface Soil	X	X	X	X			
ABPSS0060101-D	Surface Soil	X	X	X	X			
ABPSS0070101	Surface Soil	X	X	X	X			

APP IX - Appendix IX
VOA - Volatile organic analyte
SVOA - Semi-volatile organic analyte
TOC - Total organic carbon
TOH - Total organic halides
Miscellaneous - Parmeters include ammonia and nitrate/nitrite.

TABLE 8-2

FIELD TEST KIT RESULTS FOR SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Grid Location Identification	Laboratory Sample Identification	TNT Result (mg/kg)	RDX Result (mg/kg)
ABPFT01 (0-6")	ABPFT0010101	ND	ND
ABPFT02 (6"-12")	ABPFT0020101	ND	ND
ABPFT03 (1'-2')	ABPFT0030101	ND	ND
ABPFT04	ABPFT0040101	ND	ND
ABPFT05	ABPFT0050101	ND	ND
ABPFT06	ABPFT0060101	ND	ND
ABPFT07	ABPFT0070101	ND	ND

ND = Not Detected
TNT = 2,4,6-Trinitrotoluene
RDX = Cyclo-1,3,5-Trimethylene-2,4,6-Trinitramine
Published detection limit is 0.7 mg/kg for TNT and 0.8 mg/kg for RDX

TABLE 8-3
SUMMARY OF POSITIVE DETECTIONS IN SURFACE SOIL FOR SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	ABPSS0010101	ABPSS0020101	ABPSS0030101	ABPSS0040101	ABPSS0040101-D	ABPSS0050101	ABPSS0060101
SAMPLE DATE:	07/13/97	07/13/97	07/13/97	07/21/97	07/21/97	07/21/97	07/22/97
LOCATION:	ABPSS0010101	ABPSS0020101	ABPSS0030101	ABPSS0040101	ABPDUP010	ABPSS0050101	ABPSS0060101
FIELD DUPLICATE OF:					ABPSS0040101		
VOLATILES (µg/kg)							
ACETONE						2000	
STYRENE	92						
SEMIVOLATILES (µg/kg)							
BIS(2-ETHYLHEXYL)PHTHALATE	51 J		110 J				
CHRYSENE							67 J
PHENANTHRENE							63 J
METALS (mg/kg)							
ANTIMONY	0.46 L		0.24 L	0.36 L	0.28 L	0.58 L	0.30 L
ARSENIC	9.6		1.7	3.0	2.9	2.5	2.8
BARIUM	8.2	6.2	15.5	49.6 J	40.0 J	32.9 J	27.8 J
BERYLLIUM			0.22	0.47	0.51	0.41	0.27
CADMIUM	0.69	0.59 K	0.22 K				0.16
CHROMIUM	5.9 J	4.3 J	9.8 J	22.1 J	26.3 J	22.4 J	15.9 J
COBALT	2.3	0.59	1.1	3.1	2.5	2.2	2.4
COPPER	33.8	33.1	20.8	9.1	8.5	7.6	10.9
LEAD	47.0 J	8.2 J	15.0 J	10.0 J	8.9 J	8.9 J	8.4 J
MERCURY	0.02	0.02	0.05	0.06	0.04	0.04	0.03
NICKEL	7.6	1.2	2.8	6.2	5.6	4.5	5.5
SELENIUM	1.1	0.29	0.58	0.98	0.95	1.1	0.77
VANADIUM	6.5	5.0	15.0	30.6	32.4	28.3	19.4
ZINC	80.8 J	58.8 J	19.7 J	22.0 J	21.1 J	19.2 J	25.1 J

TABLE 8-3
SUMMARY OF POSITIVE DETECTIONS IN SURFACE SOIL FOR SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	ABPSS0060101-D	ABPSS0070101	/ /	/ /	/ /	/ /	/ /
SAMPLE DATE:	07/22/97	07/22/97					
LOCATION:	ABPDUP011	ABPSS0070101					
FIELD DUPLICATE OF:	ABPSS0060101						
VOLATILES (µg/kg)							
ACETONE		660 J					
SEMIVOLATILES (µg/kg)							
BIS(2-ETHYLHEXYL)PHTHALATE	2600 J						
METALS (mg/kg)							
ANTIMONY		0.24 L					
ARSENIC	2.7	1.7					
BARIUM	12.5 J	47.0 J					
BERYLLIUM	0.21	0.44					
CHROMIUM	9.9 J	10.2 J					
COBALT	3.9	4.0					
COPPER	12.6	17.3					
LEAD	9.3 J	9.1 J					
MERCURY	0.04	0.03					
NICKEL	3.6	4.1					
SELENIUM	0.61	0.58					
SILVER	0.08						
VANADIUM	16.3	16.2					
ZINC	13.8 J	20.3 J					

TABLE 8-4
SUMMARY OF POSITIVE DETECTIONS IN SUBSURFACE SOIL FOR SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	ABPSB0010101	ABPSB0020101	ABPSB0020201	ABPSB0030101	ABPSB0030201	ABPSB0040101	ABPSB0040201
SAMPLE DATE:	07/21/97	07/21/97	07/21/97	07/22/97	07/22/97	07/22/97	07/22/97
LOCATION:	ABPSB0010101	ABPSB0020101	ABPSB0020201	ABPSB0030101	ABPSB0030201	ABPSB0040101	ABPSB0040201
FIELD DUPLICATE OF:							
VOLATILES (µg/kg)							
ACETONE		830 J	530 J		600 J	1100 J	970 J
METHYLENE CHLORIDE						7 J	
SEMIVOLATILES (µg/kg)							
BIS(2-ETHYLHEXYL)PHTHALATE	2100 J						1200 J
METALS (mg/kg)							
ANTIMONY		0.48 L	0.24 L			0.37 L	0.34 L
ARSENIC	3.0	2.5	1.8		1.4	2.7	3.5
BARIUM	70.8 J	38.5 J	27.7 J	37.1 J	22.9 J	40.4 J	21.1 J
BERYLLIUM	0.40	0.47	0.40		0.40	0.50	0.45
CHROMIUM	18.5 J	24.2 J	28.2 J	13.8 J	22.7 J	14.3 J	19.4 J
COBALT	3.2	2.8	1.1	2.9	1.5	3.9	2.6
COPPER	11.9	7.6		9.4		6.6	6.5
LEAD	14.7 J	9.4 J	6.6 J	7.9 J	6.3 J	12.8 J	5.6 J
MERCURY	0.05	0.04				0.03	0.02
NICKEL	5.9	5.5	3.1		3.0	5.5	3.2
SELENIUM	0.85	0.67	0.70	1.8	0.65	0.76	1.2
VANADIUM	26.5	30.3	28.8	19.0	23.1	22.5	20.9
ZINC	21.6 J	19.7 J	13.7 J	20.0 J	12.8 J	22.8 J	13.2 J

TABLE 8-5
SUMMARY OF POSITIVE DETECTIONS IN SEDIMENT FOR SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	ABPSD0010101	ABPSD0020101	ABPSD0030101	ABPSD0040101	/ /	/ /	/ /
SAMPLE DATE:	07/24/97	07/24/97	07/24/97	07/24/97			
LOCATION:	ABPSD0010101	ABPSD0020101	ABPSD0030101	ABPSD0040101			
FIELD DUPLICATE OF:							
VOLATILES (µg/kg)							
1,1,1-TRICHLOROETHANE		2 J	2 K				
CARBON DISULFIDE				3 J			
SEMIVOLATILES (µg/kg)							
ACENAPHTHYLENE			170 J				
ANTHRACENE			160 J				
BENZO(A)ANTHRACENE			580 J				
BENZO(A)PYRENE			510 J				
BENZO(B)FLUORANTHENE			950 J				
BENZO(G,H,I)PERYLENE			320 J				
BENZO(K)FLUORANTHENE			720 J				
BIS(2-ETHYLHEXYL)PHTHALATE			150 J	58 J			
CHRYSENE			810 J				
DI-N-BUTYL PHTHALATE				40 J			
DIBENZO(A,H)ANTHRACENE			130 J				
FLUORANTHENE			860 J				
INDENO(1,2,3-CD)PYRENE			340 J				
PHENANTHRENE			99 J				
PYRENE			970 J				
METALS (mg/kg)							
ARSENIC	1.5	2.9	5.8	1.2			
BARIUM	19.0 J	23.5 J	80.6 J	18.3 J			
BERYLLIUM		0.37 K	0.52 K				
CADMIUM			0.39 K	0.18 K			

TABLE 8-5
SUMMARY OF POSITIVE DETECTIONS IN SEDIMENT FOR SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

SAMPLE NUMBER:	ABPSD0010101	ABPSD0020101	ABPSD0030101	ABPSD0040101			
SAMPLE DATE:	07/24/97	07/24/97	07/24/97	07/24/97	/ /	/ /	/ /
LOCATION:	ABPSD0010101	ABPSD0020101	ABPSD0030101	ABPSD0040101			
FIELD DUPLICATE OF:							
METALS (mg/kg)							
CHROMIUM	10.7 J	18.7 J	20.0 J	6.4 J			
COBALT	1.1	1.9	4.4	2.1			
COPPER	5.7	15.5	90.0	8.6			
LEAD	9.3	14.2	141	7.9			
MERCURY	0.03	0.02	0.12	0.03			
NICKEL	2.3	4.1	11.5	4.3			
SELENIUM	0.51	0.89	1.1	0.35			
TIN			10.0				
VANADIUM	18.2 J	30.9 J	40.5 J	9.1 J			
ZINC	15.9 J	18.3 J	337 J	32.9 J			

TABLE 8-6

COMPARISON OF SURFACE AND SUBSURFACE SOIL DATA FOR SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	SURFACE SOIL				SUBSURFACE SOIL			
	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum
VOLATILE ORGANIC COMPOUNDS (µg/kg)								
Acetone	2/7	660-2000	1330.00	ABPSS0050101	5/7	530-1100	806.00	ABPSB0040101
Styrene	1/7	92	92.00	ABPSS0010101	ND	ND	ND	ND
Methylene Chloride					1/7	7	7.00	ABPSB0040101
SEMIVOLAITLE ORGANIC COMPOUNDS (µg/kg)								
Bis(2-ethylhexyl)phthalate	3/7	51-2600	497.83	ABPSS0060101-D	2/7	1200-2100	1650.00	ABPSB0010101
Chrysene	1/7	67	67.00	ABPSS0060101	ND	ND	ND	ND
Phenanthrene	1/7	63	63.00	ABPSS0060101	ND	ND	ND	ND
INORGANICS (mg/kg)								
Antimony	6/7	0.24-0.58	0.34	ABPSS0050101	4/7	0.24-0.48	0.36	ABPSB0020101
Arsenic	6/7	1.7-9.6	3.53	ABPSS0010101	6/7	1.4-3.5	2.48	ABPSB0040201
Barium	7/7	6.2-49.6	24.96	ABPSS0040101	7/7	21.1-70.8	36.93	ABPSB0010101
Beryllium	5/7	0.21-0.51	0.36	ABPSS0040101-D	6/7	0.40-0.50	0.44	ABPSB0040101
Cadmium	4/7	0.16-0.69	0.40	ABPSS0010101	ND	ND	ND	ND
Chromium (10)	7/7	4.3-26.3	12.81	ABPSS0040101-D	7/7	13.8-28.2	20.16	ABPSB0020201
Cobalt	7/7	0.59-4	2.31	ABPSS0070101	7/7	1.1-3.9	2.57	ABPSB0040101
Copper	7/7	7.6-33.8	19.02	ABPSS0010101	5/7	6.5-11.9	8.40	ABPSB0010101
Lead	7/7	8.2-47	15.21	ABPSS0010101	7/7	5.6-14.7	9.04	ABPSB0010101
Mercury	7/7	0.02-0.06	0.04	ABPSS0040101	4/7	0.02-0.05	0.04	ABPSB0010101
Nickel	7/7	1.2-7.6	4.38	ABPSS0010101	6/7	3.0-5.9	4.37	ABPSB0010101
Selenium	7/7	0.29-1.1	0.76	PSS0010101, ABPSS00501	7/7	0.65-1.8	0.95	ABPSB0030101
Silver	1/7	0.08	0.06	SS0010101, ABPSS006010	ND	ND	ND	ND
Vanadium	7/7	5-32.4	17.19	ABPSS0040101-D	7/7	19.0-30.3	24.44	ABPSB0020101
Zinc	7/7	13.8-80.8	34.26	ABPSS0010101	7/7	12.8-22.8	17.69	ABPSB0040101

* Screening level exceeded by maximum site concentration.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.

TABLE 8-7

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT FOR SURFACE SOIL (0 TO 2 FEET)
SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections (1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tol. Limit for Background	Greater Than Background?	SSL Transfer from Soil to Air (5)	Selected as COPC?
					Industrial	Residential					
Volatile Organic Compounds (µg/kg)											
Acetone	2/7	660-2000	1330.00	ABPSS0050101	20000000	780000	N	13000	No	100000000	No
Styrene	1/7	92	92.00	ABPSS0010101	41000000	1600000	N	ND (6)	Yes (7)	1500000	No
Semivolatile Organic Compounds (µg/Kg)											
Bis(2-ethylhexyl)phthalate	3/7	51-2600	497.83	ABPSS0060101-D	410000	46000	C	640	Yes	31000000	No
Chrysene	1/7	67	67.00	ABPSS0060101	780000	88000	C	ND	Yes (7)	(8)	No
Phenanthrene	1/7	63	63.00	ABPSS0060101	-	-	-	ND	Yes (7)	-	No (9)
Inorganics (mg/kg)											
Antimony	6/7	0.24-0.58	0.34	ABPSS0050101	82	3.1	N	ND	Yes (7)	-	No
Arsenic	6/7	1.7-9.6	3.53	ABPSS0010101	**3.8***	**0.43**	C	4.25	Yes	750	Yes
Barium	7/7	6.2-49.6	24.96	ABPSS0040101	14000	550	N	144	No	690000	No
Beryllium	5/7	0.21-0.51	0.36	ABPSS0040101-D	1.3	**0.15**	C	0.905	No	1300	No
Cadmium	4/7	0.16-0.69	0.40	ABPSS0010101	100	3.9	N	0.26	Yes	1800	No
Chromium (10)	7/7	4.3-26.3	12.81	ABPSS0040101-D	1000	39	N	24.2	No	270	No
Cobalt	7/7	0.59-4	2.31	ABPSS0070101	12000	470	N	39.7	No	-	No
Copper	7/7	7.6-33.8	19.02	ABPSS0010101	8200	310	N	18.7	Yes	-	No
Lead	7/7	8.2-47	15.21	ABPSS0010101	2000 (11)	400 (11)	N	149	No	-	No
Mercury	7/7	0.02-0.06	0.04	ABPSS0040101	61	2.3	N	0.087	No	10	No
Nickel	7/7	1.2-7.6	4.38	ABPSS0010101	4100	160	N	18.2	No	13000	No
Selenium	7/7	0.29-1.1	0.76	ABPSS0010101, ABPSS0050101	1000	39	N	1.09	Yes	-	No
Silver	1/7	0.08	0.06	ABPSS0010101, ABPSS0060101-D	1000	39	N	ND	Yes (7)	-	No
Vanadium	7/7	5-32.4	17.19	ABPSS0040101-D	1400	55	N	53.5	No	-	No
Zinc	7/7	13.8-80.8	34.26	ABPSS0010101	61000	2300	N	38.1	Yes	-	No

* Screening level exceeded by maximum site concentration.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 Soil Screening Levels (SSLs) for transfers from soil to air (USEPA, 1996) included for qualitative evaluation only.
6 ND = not detected; NA = not applicable.
7 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
Organic background data presented for information purposes, but not for COPC selection.
8 Data not available.
9 Sufficient toxicity criteria not available; maximum concentration below screening levels of related chemicals (naphthalene, fluoranthene,fluorene).
10 Considered as hexavalent chromium.
11 OSWER screening level for lead in soil (USEPA, 1993).

TABLE 8-8

SELECTION OF CHEMICALS OF POTENTIAL CONCERN FOR HUMAN HEALTH RISK ASSESSMENT FOR ALL SOIL
SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tolerance Limit for Background		Greater Than Background?	SSL Transfer from Soil to Air (5)	Selected as COPC?
					Industrial	Residential		Surface	Subsurface			
VOLATILE ORGANIC COMPOUNDS (µg/kg)												
Acetone	7/14	530-2000	955.71	ABPSS0050101	20000000	780000	N	13000	1800	No	100000000	No
Methylene chloride	1/14	7	7.00	BPSB0040101, ABPSS0060101-	760000	85000	C	ND (6)	ND	Yes (7)	13000	No
Styrene	1/14	92	92.00	ABPSS0010101	41000000	1600000	N	ND	ND	Yes (7)	1500000	No
SEMIVOLATILE ORGNAIC COMPOUNDS (µg/kg)												
Bis(2-ethylhexyl)phthalate	5/14	51-2600	958.70	ABPSS0060101-D	410000	46000	C	640	ND	Yes	31000000	No
Chrysene	1/14	67	67.00	ABPSS0060101	780000	88000	C	ND	ND	Yes (7)	(8)	No
Phenanthrene	1/14	63	63.00	ABPSS0060101	-	-	-	ND	ND	Yes (7)	-	No (9)
INORGANICS (mg/kg)												
Antimony	10/14	0.24-0.58	0.35	ABPSS0050101	82	3.1	N	ND	3.6	No	-	No
Arsenic	12/14	1.4-9.6	3.01	ABPSS0010101	**3.8***	**0.43**	C	4.25	24.4	Yes	750	Yes
Barium	14/14	6.2-70.8	30.95	ABPSB0010101	14000	550	N	144	191	No	690000	No
Beryllium	11/14	0.21-0.51	0.40	ABPSS0040101-D	1.3	**0.15**	C	0.905	2.46	No	1300	No
Cadmium	4/14	0.16-0.69	0.40	ABPSS0010101	100	3.9	N	0.26	0.388	Yes	1800	No
Chromium (10)	14/14	4.3-28.2	16.49	ABPSB0020201	1000	39	N	24.2	101	No	270	No
Cobalt	14/14	0.59-4	2.44	ABPSS0070101	12000	470	N	39.7	133	No	-	No
Copper	12/14	6.5-33.8	14.60	ABPSS0010101	8200	310	N	18.7	56.5	Yes	-	No
Lead	14/14	5.6-47	12.13	ABPSS0010101	2000 (11)	400 (11)	N	149	37.5	No	-	No
Mercury	11/14	0.02-0.06	0.04	ABPSS0040101	61	2.3	N	0.087	0.13	No	10	No
Nickel	13/14	1.2-7.6	4.37	ABPSS0010101	4100	160	N	18.2	22.1	No	13000	No
Selenium	14/14	0.29-1.8	0.85	ABPSB0030101	1000	39	N	1.09	8.93	Yes	-	No
Silver	1/14	0.08	0.06	BPSS0010101, ABPSS0060101-	1000	39	N	ND	0.63	No	-	No
Vanadium	14/14	5-32.4	20.82	ABPSS0040101-D	1400	55	N	53.5	133	No	-	No
Zinc	14/14	12.8-80.8	25.97	ABPSS0010101	61000	2300	N	38.1	79.5	Yes	-	No

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 Soil Screening Levels (SSLs) for transfers from soil to air (USEPA, 1996) included for qualitative evaluation only.
6 ND = not detected; NA = not applicable.
7 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
Organic background data presented for information purposes, but not for COPC selection.
8 Data not available.
9 Sufficient toxicity criteria not available; maximum concentration below screening levels of related chemicals (naphthalene, fluoranthene,fluorene).
10 Considered as hexavalent chromium.
11 OSWER screening level for lead in soil (USEPA, 1993).

TABLE 8-9

SOIL CONCENTRATION VERSUS SOIL SCREENING LEVELS (SSLs) FOR PROTECTION OF GROUNDWATER
SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Upper Tolerance Limit for Background		Greater Than Background?	SSL Transfer from Soil to GW-20DAF(3)
					Surface	Subsurface		
VOLATILE ORGANIC COMPOUNDS (µg/kg)								
Acetone	7/14	530-2000	955.71	ABPSS0050101	13000	1800	No	16000
Methylene Chloride	1/14	7	7.00	ABPSB0040101, ABPSS0060101-D	ND (4)	ND	Yes (5)	20
Styrene	1/14	92	92.00	ABPSS0010101	ND	ND	Yes (5)	4000
SEMIVOLATILE ORGANIC COMOUNDS (µg/kg)								
Bis(2-ethylhexyl)phthalate	5/14	51-2600	958.70	ABPSS0060101-D	640	ND	Yes	3600000
Chrysene	1/14	67	67.00	ABPSS0060101	ND	ND	Yes (5)	160000
Phenanthrene	1/14	63	63.00	ABPSS0060101	ND	ND	Yes (5)	(6)
INORGANICS (mg/kg)								
Antimony	10/14	0.24-0.58	0.35	ABPSS0050101	ND	3.6	No	5
Arsenic	12/14	1.4-9.6	3.01	ABPSS0010101	4.25	24.4	Yes	29
Barium	14/14	6.2-70.8	30.95	ABPSB0010101	144	191	No	1600
Beryllium	11/14	0.21-0.51	0.40	ABPSS0040101-D	0.905	2.46	No	63
Cadmium	4/14	0.16-0.69	0.40	ABPSS0010101	0.26	0.388	Yes	8
Chromium (7)	14/14	4.3-28.2	16.49	ABPSB0020201	24.2	101	No	38
Cobalt	14/14	0.59-4	2.44	ABPSS0070101	39.7	133	No	-
Copper	12/14	6.5-33.8	14.60	ABPSS0010101	18.7	56.5	Yes	-
Lead	14/14	5.6-47	12.13	ABPSS0010101	149	37.5	No	-
Mercury	11/14	0.02-0.06	0.04	ABPSS0040101	0.087	0.13	No	2
Nickel	13/14	1.2-7.6	4.37	ABPSS0010101	18.2	22.1	No	130
Selenium	14/14	0.29-1.8	0.85	ABPSB0030101	1.09	8.93	Yes	5
Silver	1/14	0.08	0.06	ABPSS0010101, ABPSS0060101-D	ND	0.63	No	34
Vanadium	14/14	5-32.4	20.82	ABPSS0040101-D	53.5	133	No	6000
Zinc	14/14	12.8-80.8	25.97	ABPSS0010101	38.1	79.5	Yes	12000

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Soil Screening Levels (SSLs) for migration from soil to groundwater (USEPA, 1996) corresponding to a dilution and attenuation factor (DAF) of 20.
4 ND = not detected; NA = not applicable.
5 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
Organic background data presented for information purposes, but not for COPC selection.
6 Data not available.
7 Considered as hexavalent chromium.

TABLE 8-10

SELECTION OF CHEMICALS OF CONCERN FOR HUMAN HEALTH RISK ASSESSMENT FOR FRESHWATER SEDIMENTS
SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection (1)	Range of Detection (2)	Average of Positive Detections(1)	Location Of Maximum	Risk-Based COPC Screening Level (3)		Soil Basis (4)	Upper Tol. Limit for Background	Greater Than Background?	Selected as COPC?
					Industrial	Residential				
VOLATILE ORGANIC COMPOUNDS (µg/kg)										
1,1,1-Trichloroethane	2/4	2	2	ABPSD0020101, ABPSD0030101	4100000	160000	N	ND (5)	Yes (6)	No
Carbon Disulfide	1/4	3	3	ABPSD0040101	20000000	780000	N	ND	Yes (6)	No
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)										
Acenaphthylene	1/4	170	170	ABPSD0030101	(7)	-	-	ND	Yes (6)	No (8)
Anthracene	1/4	160	160	ABPSD0030101	61000000	2300000	N	ND	Yes (6)	No
Benzo(a)anthracene	1/4	580	580.00	ABPSD0030101	7800	880	C	ND	Yes (6)	No
Benzo(a)pyrene	1/4	510	510.00	ABPSD0030101	780	**88***	C	ND	Yes (6)	No
Benzo(b)fluoranthene	1/4	950	950.00	ABPSD0030101	7800	**880**	C	ND	Yes (6)	No
Benzo(g,h,i)perylene	1/4	320	320.00	ABPSD0030101	-	-	-	ND	Yes (6)	No (8)
Benzo(k)fluoranthene	1/4	720	720.00	ABPSD0030101	78000	8800	C	ND	Yes (6)	No
Bis(2-ethylhexyl)phthalate	2/4	58-150	104.00	ABPSD0030101	410000	46000	C	ND	Yes (6)	No
Chrysene	1/4	810	810.00	ABPSD0030101	780000	88000	C	ND	Yes (6)	No
Di-n-butyl phthalate	1/4	40	40.00	ABPSD0040101	20000000	780000	N	ND	Yes (6)	No
Dibenzo(a,h)anthracene	1/4	130	130.00	ABPSD0030101	780	**88**	C	ND	Yes (6)	No
Fluoranthene	1/4	860	860.00	ABPSD0030101	8200000	310000	N	ND	Yes (6)	No
Indeno(1,2,3-cd)pyrene	1/4	340	340.00	ABPSD0030101	7800	880	C	ND	Yes (6)	No
Phenanthrene	1/4	99	99.00	ABPSD0030101	-	-	-	ND	Yes (6)	No (8)
Pyrene	1/4	970	970.00	ABPSD0030101	6100000	230000	N	ND	Yes (6)	No
INORGANICS (mg/kg)										
Arsenic	4/4	1.2-5.8	2.85	ABPSD0030101	**3.8**	**0.43**	C	63	No	No
Barium	4/4	18.3-80.6	35.35	ABPSD0030101	14000	550	N	577	No	No
Beryllium	2/4	0.37-0.52	0.45	ABPSD0030101	1.3	**0.15**	C	10.9	No	No
Cadmium	2/4	0.18-0.39	0.29	ABPSD0030101	100	3.9	N	1.85	No	No
Chromium (9)	4/4	6.4-20	13.95	ABPSD0030101	1000	39	N	79.2	No	No
Cobalt	4/4	1.1-4.4	2.38	ABPSD0030101	12000	470	N	118	No	No
Copper	4/4	5.7-90	29.95	ABPSD0030101	8200	310	N	297	No	No
Lead	4/4	7.9-141	43.10	ABPSD0030101	2000 (10)	400 (10)	N	476	No	No
Mercury	4/4	0.02-0.12	0.05	ABPSD0030101	61	2.3	N	0.778	No	No
Nickel	4/4	2.3-11.5	5.55	ABPSD0030101	4100	160	N	382	No	No
Selenium	4/4	0.35-1.1	0.71	ABPSD0030101	1000	39	N	6.45	No	No
Tin	1/4	10	10.00	ABPSD0030101	100000	4700	N	ND	Yes (6)	No
Vanadium	4/4	9.1-40.5	24.68	ABPSD0030101	1400	55	N	196	No	No
Zinc	4/4	15.9-337	101.03	ABPSD0030101	61000	2300	N	1660	No	No

* Screening levels exceeded by maximum site concentration have been bolded.

1 Statistics calculated considering a duplicate pair as one data point.
2 Duplicate samples are considered as individual data points.
3 Region III risk-based COPC screening levels (Oct. 22, 1997 on-line version) corresponding to either a target hazard quotient of 0.1 or a target cancer risk of 1E-6.
4 N = noncarcinogenic basis; C = carcinogenic basis.
5 ND = not detected; NA = not applicable.
6 For non-detected chemicals in backgound samples, any positive detections from the site samples are considered to be greater than background.
Organic background data presented for information purposes, but not for COPC selection.
7 Data not available.
8 Sufficient toxicity criteria not available; maximum concentration below screening levels of related chemicals.
9 Considered as hexavalent chromium.
10 OSWER screening level for lead in soil (USEPA, 1993).

TABLE 8-11

CHEMICALS OF POTENTIAL CONCERN AND EXPOSURE CONCENTRATIONS
SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Medium	Organics		Inorganics	
	Chemical	Exposure Point Concentration[1]	Chemical	Exposure Point Concentration[1]
Surface Soil	None[2]	-	Arsenic	9.60 mg/kg (max.) 3.53 mg/kg (ave.)
All Soil (Surface/ Subsurface Soil)	None[2]	-	Arsenic	9.60 mg/kg (max.)
Sediments	None[2]	-	None[2]	-
Groundwater (Unfiltered)	None[3]	-	None[3]	-
Surface Water/Fish Tissue	None[3]	-	None[3]	-

1 95 Percent UCLs of the arithmetic mean were used as exposure point concentrations for RME and CTE, unless they exceeded the maximum concentration or fewer than 10 sample were analyzed. In these instances, the maximum concentrations were used for the RME. The mean of positive detects for data sets with fewer than 10 samples (if less than the maximum) were used for the CTE. Statistics for distribution of data sets and 95 percent UCLs are presented in Appendix I.

2 No maximum analyte concentrations exceeded screening levels and\or background concentrations.

3 No groundwater or surface water samples were collected.

TABLE 8-12

SUMMARY OF EXPOSURE SCENARIOS FOR SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Medium	Receptor	Exposure Route
Current Scenario		
None[1]	None[1]	None[1]
Future Scenario		
Surface Soil[2]	Maintenance Worker/ Full-Time Employee	Incidental Ingestion Dermal Contact
Surface/Subsurface Soil[3]	Construction Worker	Incidental Ingestion Dermal Contact

1 Currently there are no worker receptors on the site and no media COPCs were identified for other potential pathways.

2 Surface soil is defined as soil collected from depths of 0 to 2 feet bgs.

3 Surface soil/subsurface soil is defined as soil collected from depths of 0 to >10 feet bgs.

TABLE 8-13

SUMMARY OF CANCER RISKS AND HAZARD INDICES [1]
SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION REPORT/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

EXPOSURE ROUTE	MAINTENANCE WORKER [2]		FULL-TIME EMPLOYEE [2]		CONSTRUCTION WORKER [3]	
	RME [4]	CTE [5]	RME	CTE	RME	CTE
INCREMENTAL CANCER RISK						
Soil						
Incidental Ingestion of Soil	6.0E-07	2.0E-08	3.0E-06	2.0E-07	2.9E-07	1.2E-07
Dermal Contact with Soil	8.1E-07	5.4E-08	4.1E-06	5.4E-07	1.6E-07	1.6E-07
Cumulative Risk	**1.4E-06**	**7.4E-08**	**7.1E-06**	**7.4E-07**	**4.5E-07**	**2.8E-07**
HAZARD INDEX						
Soil						
Incidental Ingestion of Soil	0.0038	0.00035	0.019	0.0035	0.045	0.019
Dermal Contact with Soil	0.0051	0.00019	0.025	0.0019	0.025	0.0051
Total Hazard Index	**0.0088**	**0.00053**	**0.044**	**0.0053**	**0.07**	**0.024**

Notes:
1 - Chemical specific risks present in Appendix ?
2 - Maintenance worker and full-time employee are exposed to surface soil.
3 - Construction worker is exposed to surface/subsurface soil.
4 - Reasonable Maximum Exposures
5 - Central Tendency Exposures
NA - Not applicable, exposure route not evaluated for this receptor.

TABLE 8-14

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN FOR SEDIMENT - SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	BTAG Screening Level	EEQ (unitless)	Retained as PCOC?
		Min.	Max.				
INORGANICS (mg/kg)							
Arsenic	4/4	1.2	5.8	ABPSD0030101	0.057	101.75	Y
Barium	4/4	18.3	80.6	ABPSD0030101	NA	NA	Y
Beryllium	2/4	0.37	0.52	ABPSD0030101	NA	NA	Y
Cadmium	2/4	0.18	0.39	ABPSD0030101	1.2	0.33	N
Chromium	4/4	6.4	20	ABPSD0030101	260	0.08	N
Cobalt	4/4	1.1	4.4	ABPSD0030101	NA	NA	Y
Copper	4/4	5.7	90	ABPSD0030101	34	2.65	Y
Lead	4/4	7.9	141	ABPSD0030101	46.7	3.02	Y
Mercury	4/4	0.02	0.12	ABPSD0030101	0.15	0.80	N
Nickel	4/4	2.3	11.5	ABPSD0030101	20.9	0.55	N
Selenium	4/4	0.35	1.1	ABPSD0030101	NA	NA	Y
Tin	1/4	10	10	ABPSD0030101	NA	NA	Y
Vanadium	4/4	9.1	40.5	ABPSD0030101	NA	NA	Y
Zinc	4/4	15.9	337	ABPSD0030101	150	2.25	Y
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)							
Acenaphthylene	1/4	170	170	ABPSD0030101	44	3.86	Y
Anthracene	1/4	160	160	ABPSD0030101	85.3	1.88	Y
Benzo(a)anthracene	1/4	580	580	ABPSD0030101	63.4	9.15	Y
Benzo(a)pyrene	1/4	510	510	ABPSD0030101	430	1.19	Y
Benzo(b)fluoranthene	1/4	950	950	ABPSD0030101	3200	0.30	N
Benzo(g,h,i)perylene	1/4	320	320	ABPSD0030101	670	0.48	N
Benzo(k)fluoranthene	1/4	720	720	ABPSD0030101	3200	0.23	N
Bis(2-ethylhexyl)phthalate	2/4	58	150	ABPSD0030101	1300	0.12	N
Chrysene	1/4	810	810	ABPSD0030101	384	2.11	Y

TABLE 8-14

SELECTION OF ECOLOGICAL CONTAMINANTS OF POTENTIAL CONCERN FOR SEDIMENT - SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	BTAG Screening Level	EEQ (unitless)	Retained as PCOC?
		Min.	Max.				
Di-n-butyl phthalate	1/4	40	40	ABPSD0040101	1400	0.03	N
Dibenzo(a,h)anthracene	1/4	130	130	ABPSD0030101	63.4	2.05	Y
Fluoranthene	1/4	860	860	ABPSD0030101	600	1.43	Y
Indeno(1,2,3-cd)pyrene	1/4	340	340	ABPSD0030101	600	0.57	N
Phenanthrene	1/4	99	99	ABPSD0030101	240	0.41	N
Pyrene	1/4	970	970	ABPSD0030101	665	1.46	Y
VOLATILE ORGANIC COMPOUNDS (µg/kg)							
1,1,1-Trichloroethane	2/4	2	2	ABPSD0030101	NA	NA	Y
Carbon Disulfide	1/4	3	3	ABPSD0040101	NA	NA	Y

EEQ = Ecological Effects Quotient
NA = Not Available

TABLE 8-15

SELECTION OF ECOLOGICAL POTENTIAL CONTAMINANTS OF CONCERN FOR SURFACE SOIL
SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Contaminant	Frequency of Detection	Range of Detections		Location of Maximum	BTAG Screening Level	EEQ (unitless)	Retained as PCOC?
		Min.	Max.				
INORGANICS (mg/kg)							
Antimony	6/7	0.24	0.58	ABPSS0050101	0.48	1.21	Y
Arsenic	6/7	1.7	9.6	ABPSS0010101	328	0.03	N
Barium	7/7	6.2	49.6	ABPSS0040101	440	0.11	N
Beryllium	5/7	0.21	0.51	ABPSS0040101-D	0.02	25.50	Y
Cadmium	4/7	0.16	0.69	ABPSS0010101	2500	0.00	N
Chromium	7/7	4.3	26.3	ABPSS0040101-D	0.0075	3506.67	Y
Cobalt	7/7	0.59	4	ABPSS0070101	200	0.02	N
Copper	7/7	7.6	33.8	ABPSS0010101	15	2.25	Y
Lead	7/7	8.2	47	ABPSS0010101	0.01	4700.00	Y
Mercury	7/7	0.02	0.06	ABPSS0040101	0.058	1.03	Y
Nickel	7/7	1.2	7.6	ABPSS0010101	2	3.80	Y
Selenium	7/7	0.29	1.1	ABPSS0050101	1.8	0.61	N
Silver	1/7	0.08	0.08	ABPSS0010101	9.80E-06	8163.27	Y
Vanadium	7/7	5	32.4	ABPSS0040101-D	58	0.56	N
Zinc	7/7	13.8	80.8	ABPSS0010101	10	8.08	Y
SEMIVOLATILE ORGANIC COMPOUNDS (µg/kg)							
Bis(2-ethylhexyl)phthalate	3/7	51	2600	ABPSS0060101-D	NA	NA	Y
Chrysene	1/7	67	67	ABPSS0060101	100	0.67	N
Phenanthrene	1/7	63	63	ABPSS0060101	100	0.63	N
VOLATILE ORGANIC COMPOUNDS (µg/kg)							
Acetone	2/7	660	2000	ABPSS0050101	NA	NA	Y
Styrene	1/7	92	92	ABPSS0010101	100	0.92	N

EEQ = Ecological Effects Quotient
NA = Not Available

TABLE 8-16

RESULTS OF AQUATIC FOODCHAIN MODELING FOR MAXIMUM AND MEAN CONCENTRATIONS
SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Heron - Maximum		Heron - Mean	
	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI
INORGANICS				
Arsenic	5.16	0.52	2.53	0.25
Barium	0.11	0.06	0.05	0.02
Beryllium	NA	NA	NA	NA
Cobalt	1.29	0.13	0.70	0.07
Copper	11.24	1.12	3.74	0.37
Lead	137.90	13.79	42.15	4.22
Selenium	0.65	0.32	0.42	0.21
Tin	0.43	0.17	0.17	0.07
Vanadium	1.04	0.10	0.64	0.06
Zinc	7.11	0.71	2.13	0.21
SEMIVOLATILE ORGANIC COMPOUNDS				
Acenaphthylene	0.00	0.00	0.00	0.00
Anthracene	0.00	0.00	0.00	0.00
Benzo(a)anthracene	0.02	0.00	0.00	0.00
Benzo(a)pyrene	0.01	0.00	0.00	0.00
Chrysene	0.02	0.00	0.01	0.00
Dibenzo(a,h)anthracene	0.00	0.00	0.00	0.00
Fluoranthene	0.03	0.00	0.01	0.00
Pyrene	0.03	0.00	0.01	0.00
VOLATILE ORGANIC COMPOUNDS				
Trichloroethane	NA	NA	NA	NA
Carbon disulfide	NA	NA	NA	NA

NA = Not Available
EEI = Ecological Effects Index

TABLE 8-17

RESULTS OF TERRESTRIAL FOODCHAIN MODELING FOR MAXIMUM CONCENTRATIONS
SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Shrew		Hawk		Fox		Vole		Woodcock	
	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI
INORGANICS										
Antimony	3.18	0.32	NA	NA	0.62	0.06	1.66	0.17	NA	NA
Beryllium	0.65	0.06	NA	NA	0.13	0.01	0.34	0.03	NA	NA
Chromium	105.89	10.59	110.70	11.07	20.70	2.07	55.45	5.54	144.25	1.44
Copper	23.14	2.31	6.05	0.61	4.52	0.45	12.11	1.21	7.89	0.79
Lead	214.47	21.45	65.94	6.59	41.92	4.19	112.30	11.23	85.93	8.59
Mercury	0.82	0.08	2.53	0.25	0.80	0.08	0.43	0.04	2.74	0.27
Nickel	0.08	0.00	0.04	0.03	0.02	0.00	0.04	0.00	0.05	0.04
Silver	0.00	0.00	NA	NA	0.00	0.00	0.00	0.00	NA	NA
Vanadium	110.89	11.09	1.20	0.12	21.67	2.17	58.06	5.81	1.56	0.16
Zinc	2.21	0.22	2.45	0.24	0.43	0.04	1.16	0.12	3.19	0.32
SEMIVOLATILE ORGANIC COMPOUNDS										
Bis(2-ethylhexyl)phthalate	0.10	0.00	NA	NA	0.02	0.00	0.05	0.00	NA	NA
VOLATILE ORGANIC COMPOUNDS										
Acetone	0.14	0.03	NA	NA	0.03	0.00	0.07	0.01	NA	NA

NA = Not Available
EEI = Ecological Effects Index

TABLE 8-18

RESULTS OF TERRESTRIAL FOODCHAIN MODELING FOR MEAN CONCENTRATIONS
SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Shrew		Hawk		Fox		Vole		Woodcock	
	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI	NOAEL EEI	LOAEL EEI
INORGANICS										
Antimony	1.70	0.17	NA	NA	0.33	0.03	0.89	0.09	NA	NA
Beryllium	0.33	0.03	NA	NA	0.06	0.00	0.17	0.02	NA	NA
Chromium	51.58	5.16	53.92	5.39	10.08	1.01	27.01	2.70	70.26	0.70
Copper	13.01	1.30	3.40	0.34	2.54	0.25	6.81	0.68	4.43	0.44
Lead	69.36	6.94	21.33	2.13	13.56	1.36	36.32	3.63	27.79	2.78
Mercury	0.48	0.05	1.47	0.15	0.47	0.05	0.25	0.03	1.60	0.16
Nickel	0.05	0.00	0.02	0.02	0.00	0.00	0.03	0.00	0.03	0.02
Silver	0.00	0.00			0.00	0.00	0.00	0.00	NA	NA
Vanadium	58.52	5.85	0.63	0.06	11.44	1.14	30.64	3.06	0.82	0.08
Zinc	0.94	0.09	1.04	0.10	0.18	0.02	0.49	0.05	1.35	0.14
SEMIVOLATILE ORGANIC COMPOUNDS										
Bis(2-ethylhexyl)phthalate	0.01	0.00	NA	NA	0.00	0.00	0.00	0.00	NA	NA
VOLATILE ORGANIC COMPOUNDS										
Acetone	0.03	0.00	NA	NA	0.00	0.00	0.01	0.00	NA	NA

NA = Not Available
EEI = Ecological Effects Index

TABLE 8-19

RISK MANAGEMENT CONSIDERATIONS FOR SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

Preliminary Contaminant of Concern	Frequency of Detection	Range of Detections		Location of Maximum	Mean Concentration	BTAG Screening Level	Alternate Guideline(s)1	Max/Mean Background	Retained as Final PCOC?
		Minimum	Maximum						
SEDIMENT[2]									
Arsenic	4/4	1.2	5.8	ABPSD0030101	2.85	0.057	6/33	10.6/3.3	N
Beryllium	2/4	0.37	0.52	ABPSD0030101	0.26	NA	NA	1/0.52	N
Cobalt	4/4	1.1	4.4	ABPSD0030101	2.38	NA	NA	17.6/5.97	N
Copper	4/4	5.7	90	ABPSD0030101	29.95	34	16/110	28.3/9.5	Y
Lead	4/4	7.9	141	ABPSD0030101	43.1	46.7	31/250	79.3/23.1	Y
Vanadium	4/4	9.1	40.5	ABPSD0030101	24.68	NA	NA	46.3/18.6	N
Zinc	4/4	15.9	337	ABPSD0030101	101	150	120/820	158/41.2	Y
Trichloroethane	2/4	2	2	ABPSD0030101	2.5	NA	NA	ND	N
Carbon disulfide	1/4	3	3	ABPSD0040101	3.1	NA	NA	ND	N
SURFACE SOIL [2]									
Antimony	6/7	0.24	0.58	ABPSS0050101	0.31	0.48	NA	ND	N
Chromium	7/7	4.3	26.3	ABPSS0040101-D	12.8	0.0075	0.4/10	20.8/12	N
Copper	7/7	7.6	33.8	ABPSS0010101	19.0	15	50/100	17.3/5.15	Y
Lead	7/7	8.2	47	ABPSS0010101	15.2	0.01	500/900	149/20	Y
Mercury	7/7	0.02	0.06	ABPSS0040101	0.04	0.058	0.1/30	0.08/0.04	N
Zinc	7/7	13.8	80.8	ABPSS0010101	34.3	10	200/100	30.8/18.1	Y

1 Alternate guidelines are as follows: sediment = MOE LELS and SELs (MOE, 1992); soil = ORNL screening levels for earthworms/soil microbes (when 2 values are present) (Will and Suter, 1995) or Dutch guidelines (when one value is present) (NMHSP&E, 1994)

2 Inorganics = mg/kg, organics = ug/kg

NA = Not Available

ND = Not Detected

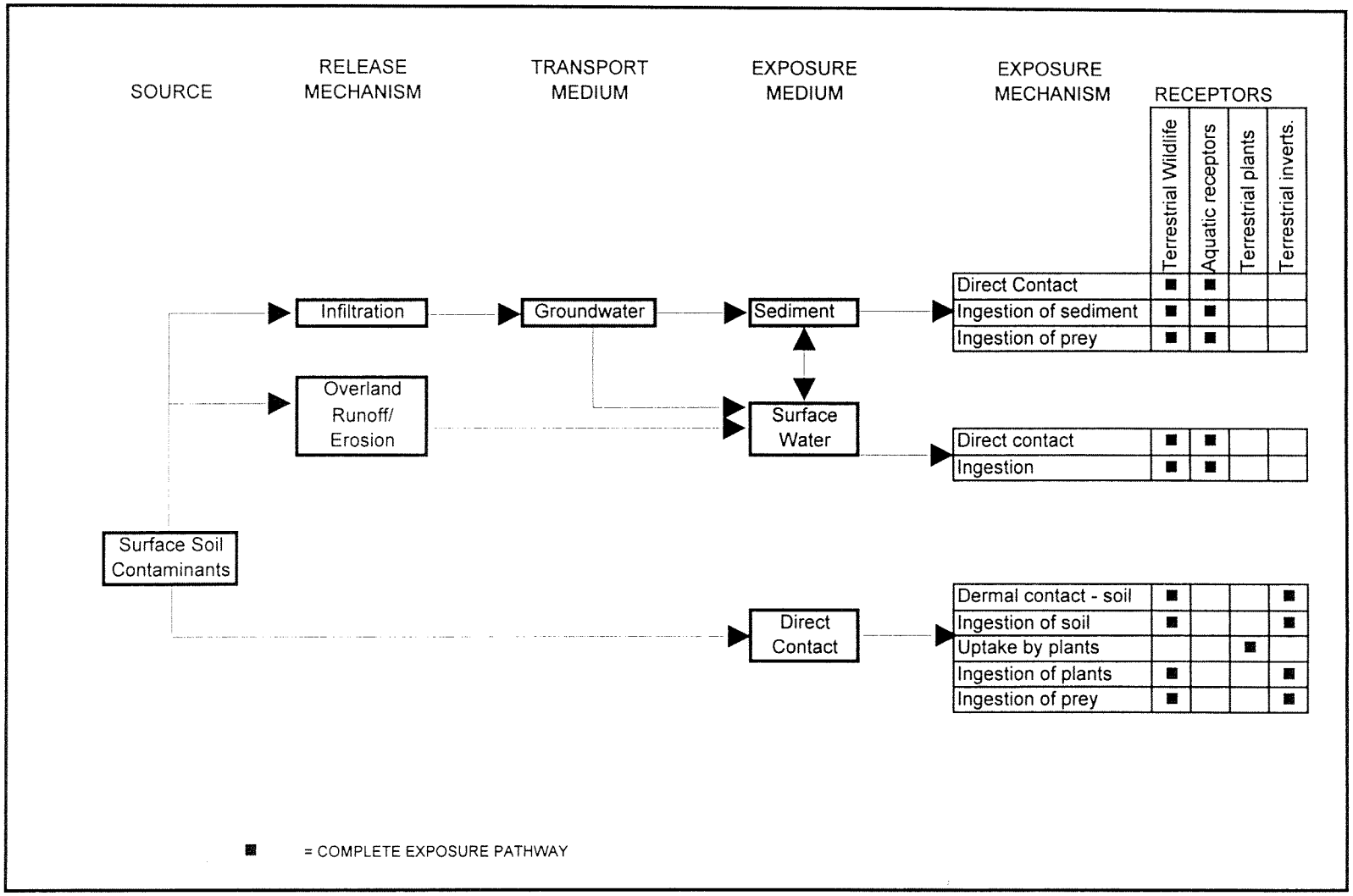
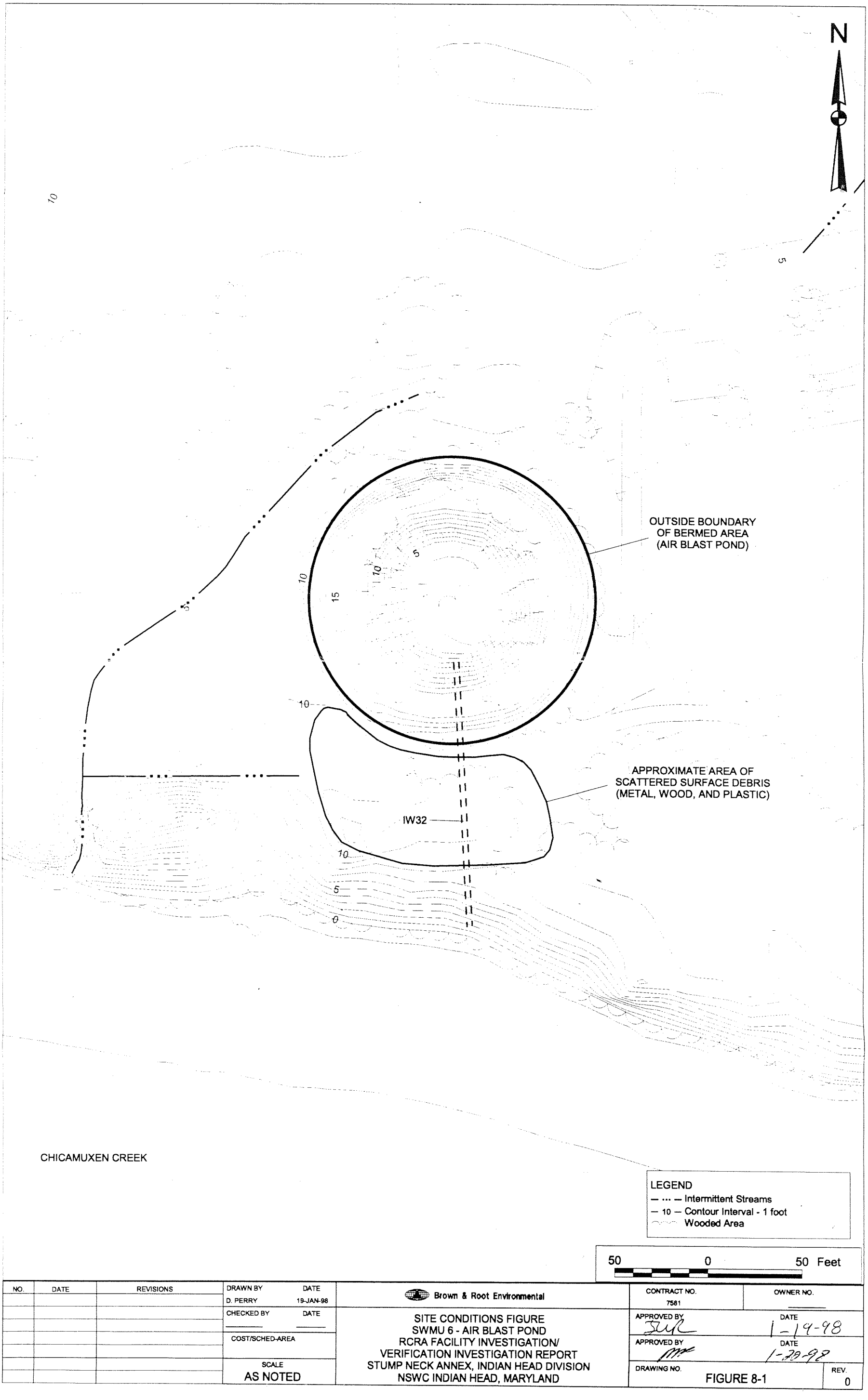


FIGURE 8-9

CONCEPTUAL SITE MODEL - SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

P:\GIS\APR\75810303.APR 19-JAN-98 DNP AIR BLAST POND SITE COND LAYOUT



NO.	DATE	REVISIONS

DRAWN BY: D. PERRY	DATE: 19-JAN-98
CHECKED BY:	DATE:
COST/SCHED-AREA	
SCALE: AS NOTED	

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SITE CONDITIONS FIGURE
SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581	OWNER NO.
APPROVED BY:	DATE: 1-14-98
APPROVED BY:	DATE: 1-29-98
DRAWING NO. FIGURE 8-1	REV. 0

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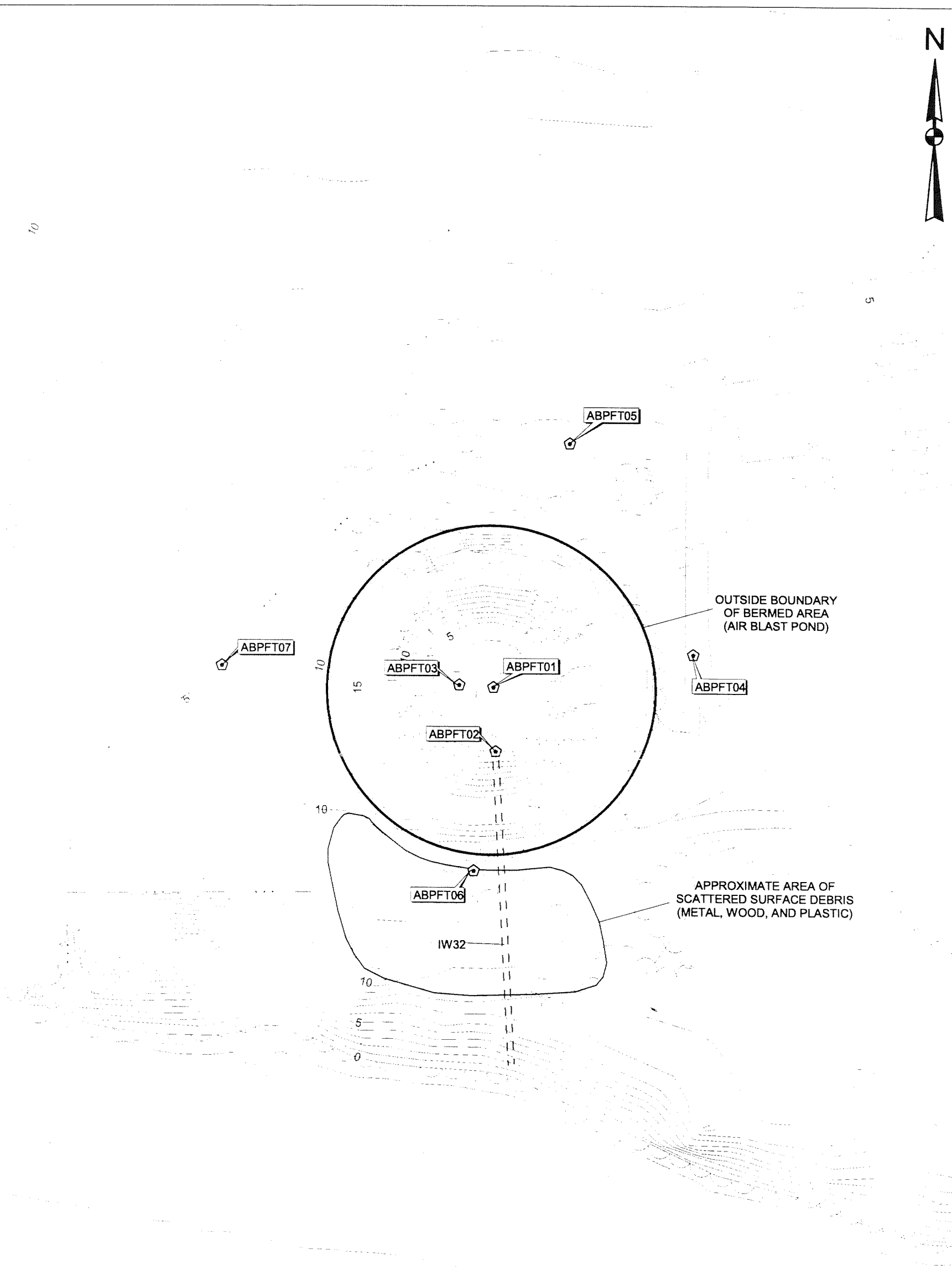

NO.	DATE	REVISIONS

DRAWN BY: D. PERRY	DATE: 19-JAN-98
CHECKED BY:	DATE:
COST/SCHED-AREA	
SCALE: AS NOTED	

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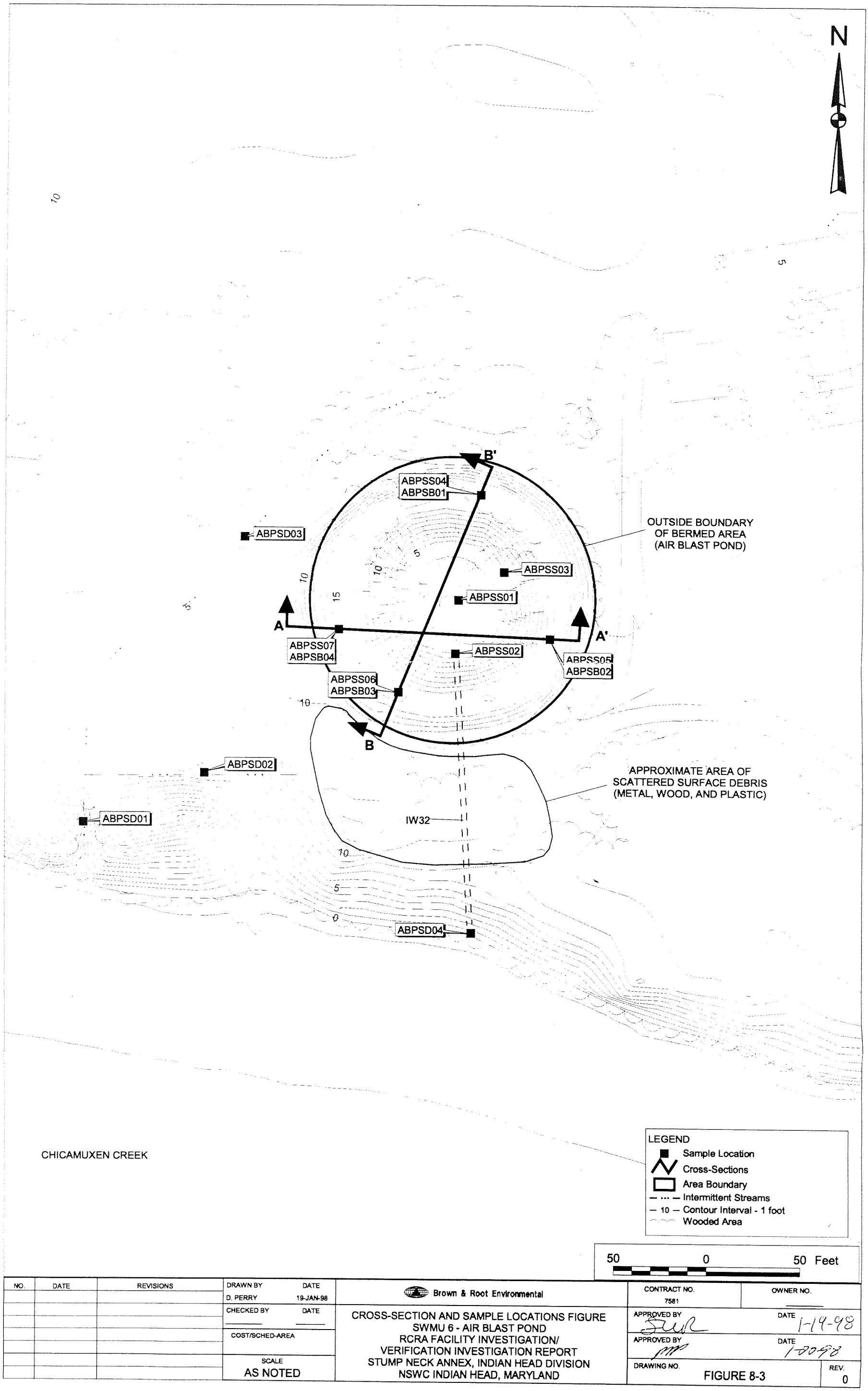
FIELD TEST-KIT SAMPLE LOCATIONS
SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581	OWNER NO.
APPROVED BY: SLR	DATE: 1-19-98
APPROVED BY:	DATE: 1-20-98
DRAWING NO. FIGURE 8-2	REV. 0

P:\GIS\APR\75810303.APR 19-JAN-98 DNP AIR BLAST POND XS + SAMPLE LAYOUT



NO.	DATE	REVISIONS

DRAWN BY: D. PERRY	DATE: 19-JAN-98
CHECKED BY:	DATE:
COST/SCHED-AREA:	
SCALE: AS NOTED	

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CROSS-SECTION AND SAMPLE LOCATIONS FIGURE
SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO.: 7581	OWNER NO.:
APPROVED BY:	DATE: 1-14-98
APPROVED BY:	DATE: 1-20-98
DRAWING NO.: FIGURE 8-3	REV.: 0

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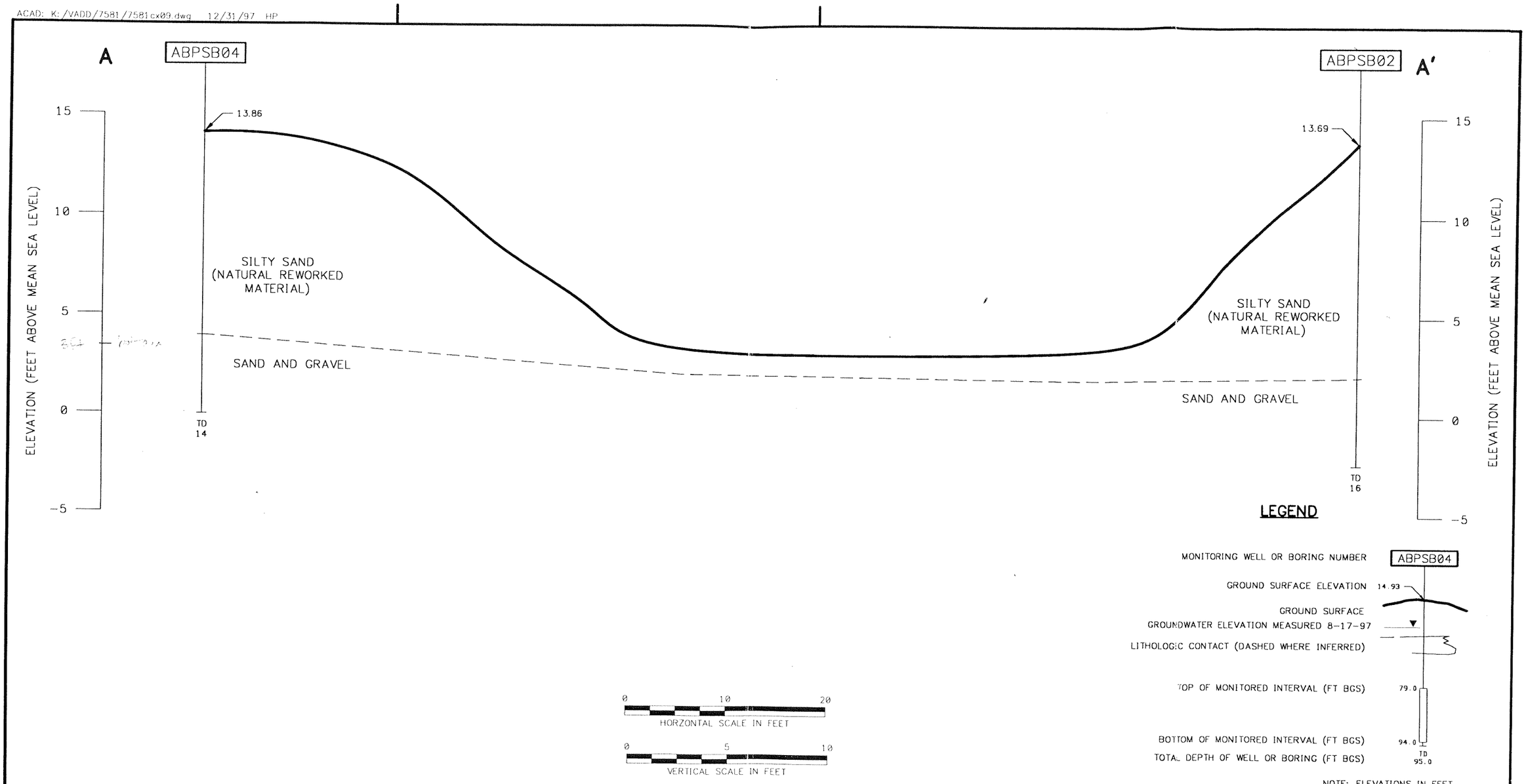

NOTE: ELEVATIONS IN FEET
ABOVE MEAN SEA LEVEL (FT AMSL)

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DLT 11/22/97 DATE
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

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GENERALIZED GEOLOGIC CROSS SECTION A-A'
SWMU 6 - AIR BLAST POND
RFI/VI REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581
OWNER NO. 0287
APPROVED BY DATE 1-16-98
APPROVED BY DATE 1-16-98
DRAWING NO. FIGURE 8-4
REV. 0

FORM CADD NO. SOUTH_BH.DGN - REV 0 - 02/11/97

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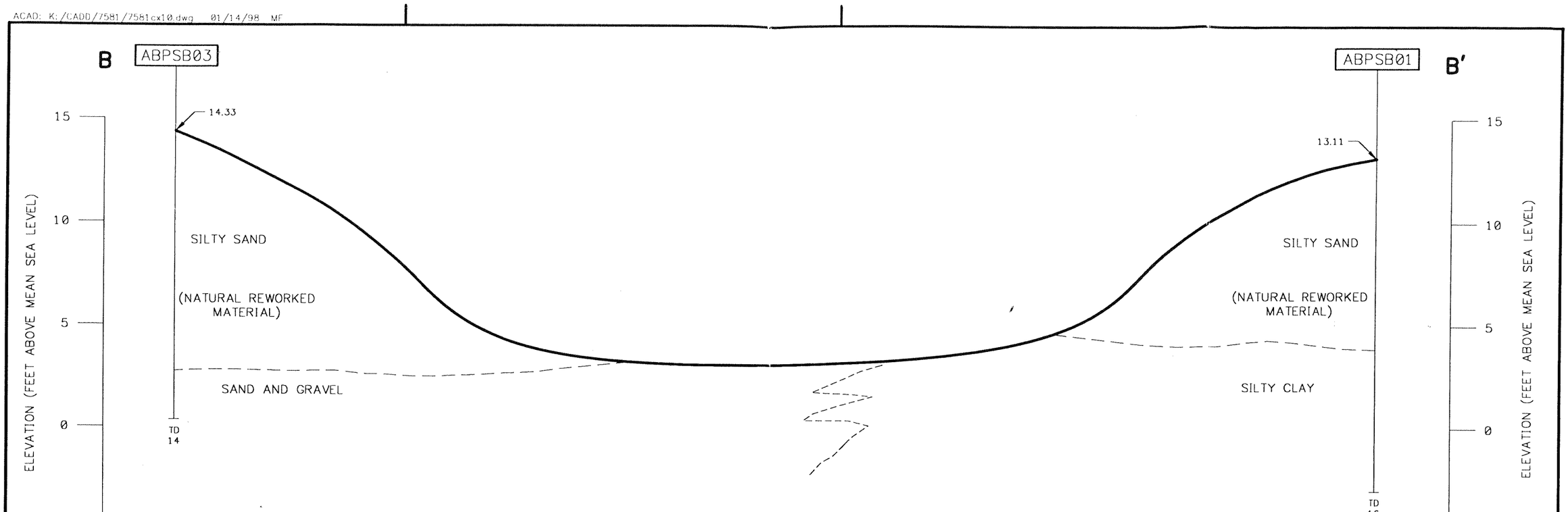
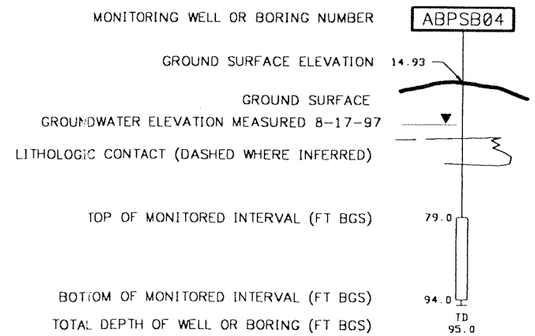
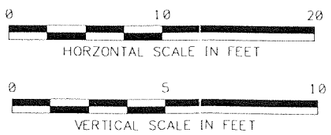


LEGEND





NOTE: ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL (FT AMSL)

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DLT DATE 11/22/97
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

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GENERALIZED GEOLOGIC CROSS SECTION B-B'
SWMU 6 - AIR BLAST POND
RFI/VI REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581
OWNER NO. 0287
APPROVED BY SUR DATE 1-16-98
APPROVED BY DATE 1-16-98
DRAWING NO. FIGURE 8-5
REV. 0

FORM CADD NO. SOUTH_BH.DGN - REV 0 - 02/11/97

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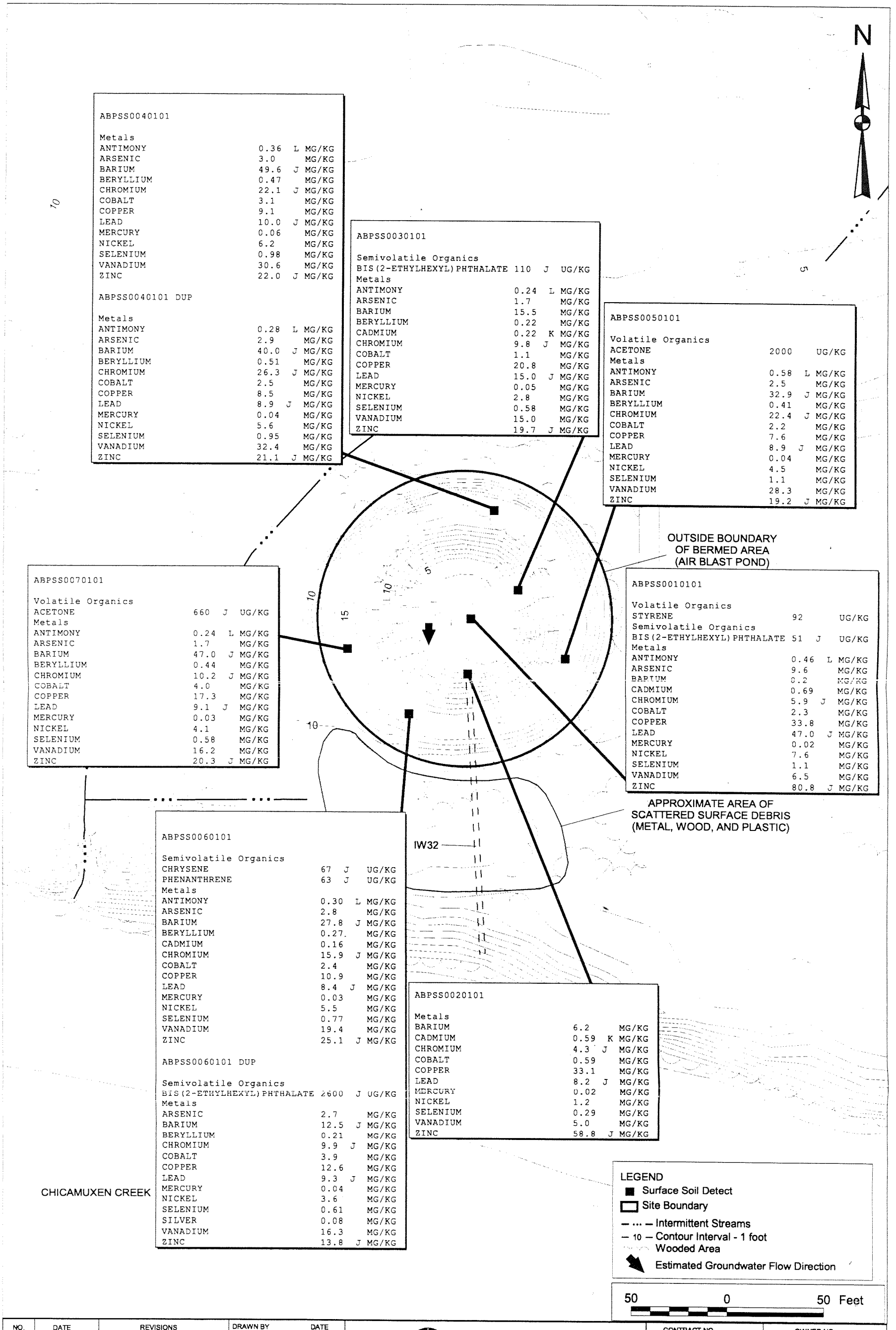


ABPSS0040101

Metals			
ANTIMONY	0.36	L	MG/KG
ARSENIC	3.0		MG/KG
BARIUM	49.6	J	MG/KG
BERYLLIUM	0.47		MG/KG
CHROMIUM	22.1	J	MG/KG
COBALT	3.1		MG/KG
COPPER	9.1		MG/KG
LEAD	10.0	J	MG/KG
MERCURY	0.06		MG/KG
NICKEL	6.2		MG/KG
SELENIUM	0.98		MG/KG
VANADIUM	30.6		MG/KG
ZINC	22.0	J	MG/KG

ABPSS0040101 DUP

Metals			
ANTIMONY	0.28	L	MG/KG
ARSENIC	2.9		MG/KG
BARIUM	40.0	J	MG/KG
BERYLLIUM	0.51		MG/KG
CHROMIUM	26.3	J	MG/KG
COBALT	2.5		MG/KG
COPPER	8.5		MG/KG
LEAD	8.9	J	MG/KG
MERCURY	0.04		MG/KG
NICKEL	5.6		MG/KG
SELENIUM	0.95		MG/KG
VANADIUM	32.4		MG/KG
ZINC	21.1	J	MG/KG

ABPSS0030101

Semivolatile Organics			
BIS(2-ETHYLHEXYL)PHTHALATE	110	J	UG/KG
Metals			
ANTIMONY	0.24	L	MG/KG
ARSENIC	1.7		MG/KG
BARIUM	15.5		MG/KG
BERYLLIUM	0.22		MG/KG
CADMIUM	0.22	K	MG/KG
CHROMIUM	9.8	J	MG/KG
COBALT	1.1		MG/KG
COPPER	20.8		MG/KG
LEAD	15.0	J	MG/KG
MERCURY	0.05		MG/KG
NICKEL	2.8		MG/KG
SELENIUM	0.58		MG/KG
VANADIUM	15.0		MG/KG
ZINC	19.7	J	MG/KG

ABPSS0050101

Volatile Organics			
ACETONE	2000		UG/KG
Metals			
ANTIMONY	0.58	L	MG/KG
ARSENIC	2.5		MG/KG
BARIUM	32.9	J	MG/KG
BERYLLIUM	0.41		MG/KG
CHROMIUM	22.4	J	MG/KG
COBALT	2.2		MG/KG
COPPER	7.6		MG/KG
LEAD	8.9	J	MG/KG
MERCURY	0.04		MG/KG
NICKEL	4.5		MG/KG
SELENIUM	1.1		MG/KG
VANADIUM	28.3		MG/KG
ZINC	19.2	J	MG/KG

ABPSS0070101

Volatile Organics			
ACETONE	660	J	UG/KG
Metals			
ANTIMONY	0.24	L	MG/KG
ARSENIC	1.7		MG/KG
BARIUM	47.0	J	MG/KG
BERYLLIUM	0.44		MG/KG
CHROMIUM	10.2	J	MG/KG
COBALT	4.0		MG/KG
COPPER	17.3		MG/KG
LEAD	9.1	J	MG/KG
MERCURY	0.03		MG/KG
NICKEL	4.1		MG/KG
SELENIUM	0.58		MG/KG
VANADIUM	16.2		MG/KG
ZINC	20.3	J	MG/KG

ABPSS0010101

Volatile Organics			
STYRENE	92		UG/KG
Semivolatile Organics			
BIS(2-ETHYLHEXYL)PHTHALATE	51	J	UG/KG
Metals			
ANTIMONY	0.46	L	MG/KG
ARSENIC	9.6		MG/KG
BARIUM	0.2		MG/KG
CADMIUM	0.69		MG/KG
CHROMIUM	5.9	J	MG/KG
COBALT	2.3		MG/KG
COPPER	33.8		MG/KG
LEAD	47.0	J	MG/KG
MERCURY	0.02		MG/KG
NICKEL	7.6		MG/KG
SELENIUM	1.1		MG/KG
VANADIUM	6.5		MG/KG
ZINC	80.8	J	MG/KG

ABPSS0060101

Semivolatile Organics			
CHRYSENE	67	J	UG/KG
PHENANTHRENE	63	J	UG/KG
Metals			
ANTIMONY	0.30	L	MG/KG
ARSENIC	2.8		MG/KG
BARIUM	27.8	J	MG/KG
BERYLLIUM	0.27		MG/KG
CADMIUM	0.16		MG/KG
CHROMIUM	15.9	J	MG/KG
COBALT	2.4		MG/KG
COPPER	10.9		MG/KG
LEAD	8.4	J	MG/KG
MERCURY	0.03		MG/KG
NICKEL	5.5		MG/KG
SELENIUM	0.77		MG/KG
VANADIUM	19.4		MG/KG
ZINC	25.1	J	MG/KG

ABPSS0060101 DUP

Semivolatile Organics			
BIS(2-ETHYLHEXYL)PHTHALATE	2600	J	UG/KG
Metals			
ARSENIC	2.7		MG/KG
BARIUM	12.5	J	MG/KG
BERYLLIUM	0.21		MG/KG
CHROMIUM	9.9	J	MG/KG
COBALT	3.9		MG/KG
COPPER	12.6		MG/KG
LEAD	9.3	J	MG/KG
MERCURY	0.04		MG/KG
NICKEL	3.6		MG/KG
SELENIUM	0.61		MG/KG
SILVER	0.08		MG/KG
VANADIUM	16.3		MG/KG
ZINC	13.8	J	MG/KG

ABPSS0020101

Metals			
BARIUM	6.2		MG/KG
CADMIUM	0.59	K	MG/KG
CHROMIUM	4.3	J	MG/KG
COBALT	0.59		MG/KG
COPPER	33.1		MG/KG
LEAD	8.2	J	MG/KG
MERCURY	0.02		MG/KG
NICKEL	1.2		MG/KG
SELENIUM	0.29		MG/KG
VANADIUM	5.0		MG/KG
ZINC	58.8	J	MG/KG

LEGEND
- Surface Soil Detect
- Site Boundary
- — ··· — Intermittent Streams
- — 10 — Contour Interval - 1 foot
- Wooded Area
- Estimated Groundwater Flow Direction

50 0 50 Feet

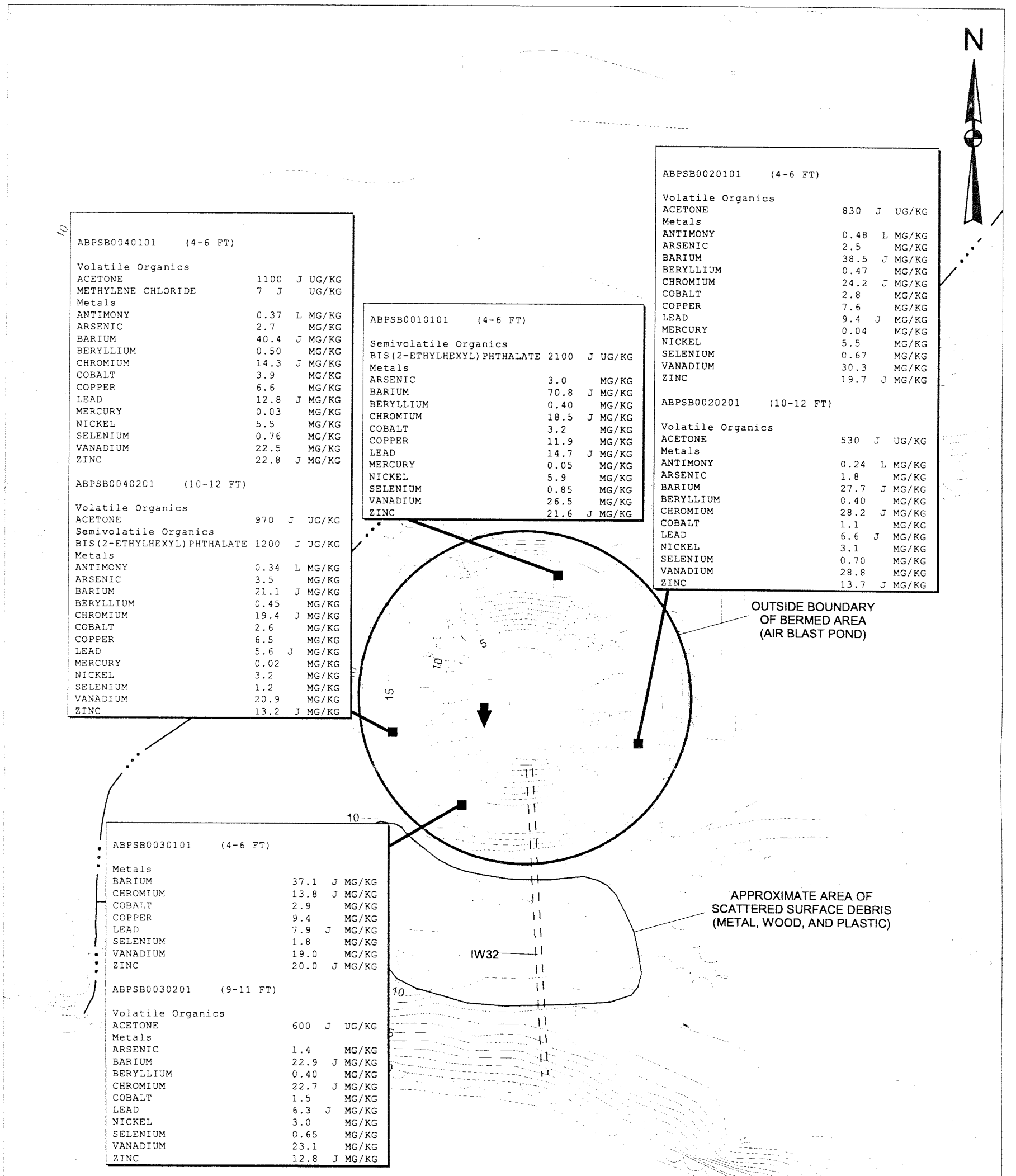
NO.	DATE	REVISIONS	DRAWN BY	DATE
			D. PERRY	16-JAN-98
			CHECKED BY	DATE
			DET	1/16/98
			COST/SCHED-AREA	
			SCALE	
			AS NOTED	

Brown & Root Environmental

SURFACE SOIL DETECTS
SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581	OWNER NO.
APPROVED BY	DATE
APPROVED BY	DATE 1-16-98
DRAWING NO. FIGURE 8-6	REV. 0

P:\GIS\INDIANHD\75810303TAG.APR 16-JAN-98 DNP AIR BLAST POND SB LAYOUT



NO.	DATE	REVISIONS

DRAWN BY: D. PERRY	DATE: 16-JAN-98
CHECKED BY: DCT	DATE: 1/16/98
COST/SCHED-AREA	
SCALE: AS NOTED	

Brown & Root Environmental

SUBSURFACE SOIL DETECTS
SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581	OWNER NO.
APPROVED BY	DATE
APPROVED BY	DATE 1-16-98
DRAWING NO. FIGURE 8-7	REV. 0

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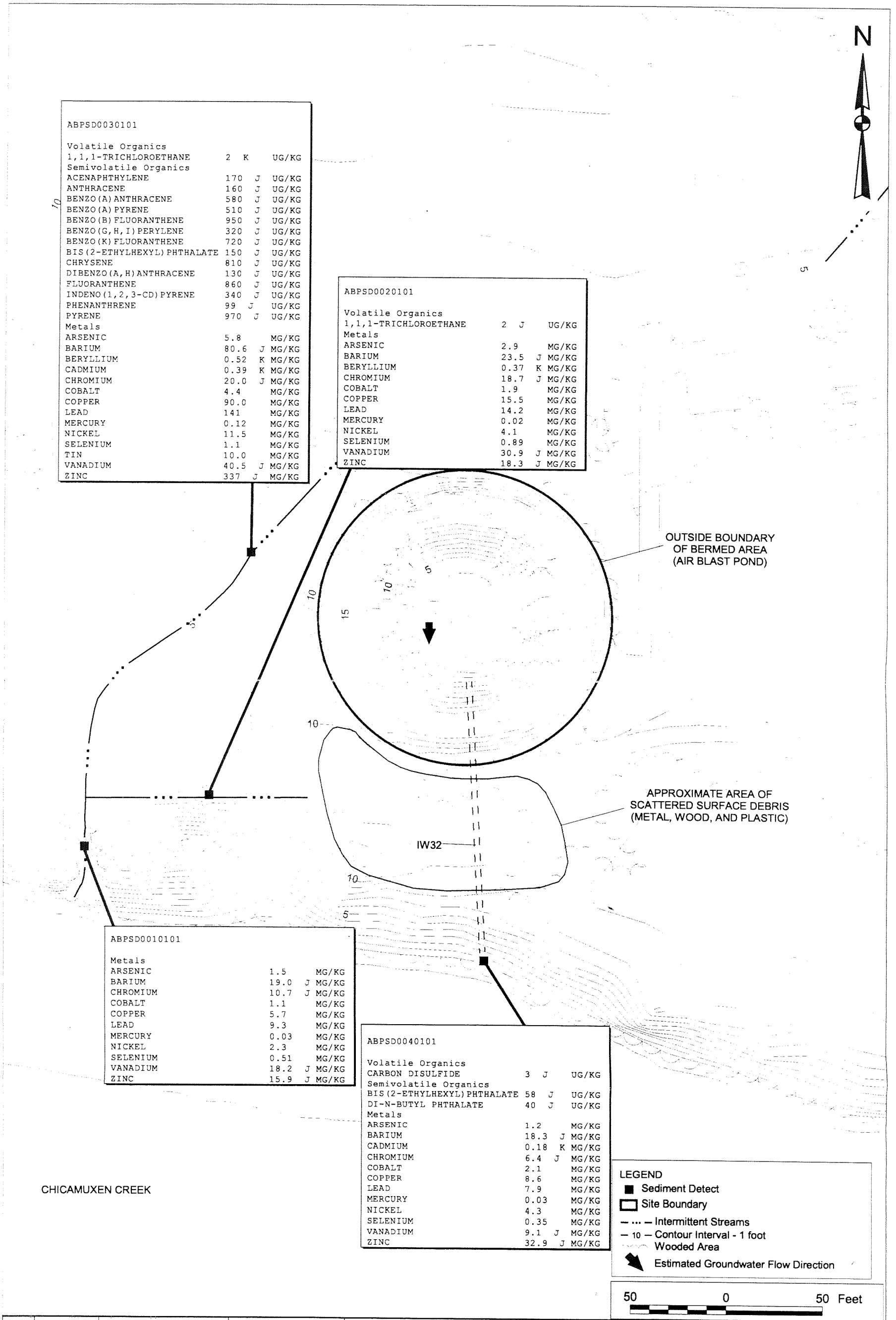


NO.	DATE	REVISIONS

DRAWN BY: D. PERRY — DATE: 16-JAN-98
CHECKED BY: DRF — DATE: 1/16/98
COST/SCHED-AREA:
SCALE: AS NOTED

Brown & Root Environmental

SEDIMENT DETECTS
SWMU 6 - AIR BLAST POND
RCRA FACILITY INVESTIGATION/
VERIFICATION INVESTIGATION REPORT
STUMP NECK ANNEX, INDIAN HEAD DIVISION
NSWC INDIAN HEAD, MARYLAND

CONTRACT NO. 7581 — OWNER NO.
APPROVED BY — DATE
APPROVED BY — DATE 1-16-98
DRAWING NO. FIGURE 8-8 — REV. 0

B-17

Department of Natural Resources
Resource Assessment Service
MARYLAND GEOLOGICAL SURVEY
Emery T. Cleaves, Director

REPORT OF INVESTIGATIONS NO. 69

THE GEOHYDROLOGY AND WATER-SUPPLY POTENTIAL OF THE LOWER PATAPSCO AQUIFER AND PATUXENT AQUIFERS IN THE INDIAN HEAD-BRYANS ROAD AREA, CHARLES COUNTY, MARYLAND

by

David C. Andreasen

Prepared in cooperation with
the Maryland Department of the Environment
and the
Charles County Department of Planning
and Growth Management

1999

CONTENTS

Page

Key results. . . . 1
Introduction. . . . 3
Objectives. . . . 3
Location of study area. . . . 3
Previous studies. . . . 3
Methods of investigation. . . . 5
Test drilling. . . . 5
Definition of terms. . . . 6
Acknowledgments. . . . 8
Geohydrology of the lower Patapsco aquifer and Patuxent aquifers 9
Framework 9
Hydraulic properties. . . . 20
Water levels and direction of ground-water flow. . . . 20
Effects of pumpage on water levels. . . . 27
Ground-water-flow barrier in the upper Patuxent aquifer. . . . 32
Water quality of the upper and lower Patuxent aquifers. . . . 37
Ground-water use. . . . 37
Water-supply potential of the lower Patapsco and upper Patuxent aquifers 40
Simulation of ground-water flow. . . . 40
Conceptual model. . . . 40
Grid design and model layers. . . . 42
Boundary conditions. . . . 42
Recharge. . . . 45
Hydraulic parameters. . . . 46
Transmissivity and storage coefficient. . . . 46
Vertical leakance. . . . 46
Pumpage. . . . 49
Steady-state flow simulation. . . . 49
Transient-flow simulation. . . . 49
Initial conditions and time discretization. . . . 49
Model calibration. . . . 50
Mass balance. . . . 53
Sensitivity analysis. . . . 53
Predictive model simulations. . . . 60
Model Simulation I: Effect of pumpage from the lower Patapsco aquifer outside of the Indian Head-Bryans Road area on water levels in the lower Patapsco aquifer within the study area. . . . 60
Pumping alternative IA. . . . 60
Pumping alternative IB. . . . 62
Model Simulation II: Maximum yield from the lower Patapsco aquifer within the study area. . . . 62
Model Simulation III: Maximum yield from the upper Patuxent aquifer within the Indian Head-Bryans Road area. . . . 66
Model Simulation IV: Simulation of potential-development scenarios. . . . 73
Pumping alternative IVA. . . . 73
Pumping alternative IVB. . . . 74
Pumping alternative IVC. . . . 74

CONTENTS–CONTINUED

Page

Model Simulation V: Effect of pumpage from the upper Patuxent aquifer on water levels in the lower Patapsco aquifer. . . . 76
Transient model-simulated head changes in the lower Patapsco and upper Patuxent aquifers. . . . 76
Model accuracy. . . . 76
Conclusions. . . . 81
Selected references. . . . 82
Appendixes. . . . 85
A. Selected well records 86
B. Descriptive log of washed drill cuttings from test holes drilled during this study. . . . 99
C. Core descriptions and sieve analyses—Well CH Bc 80 (Chapman's Landing test site). . . . 108
D (Part I). Appropriated ground-water use (1997) over 10,000 gallons per day in the lower Patapsco aquifer in the model area. . . . 110
(Part II). Appropriated ground-water use (1997) over 10,000 gallons per day in the upper Patuxent aquifer in the model area. . . . 112
E. Appropriated ground-water use over 10,000 gallons per day in the lower Patapsco and upper Patuxent aquifers in Charles County and southern Prince George's County for 1900-74. . . . 113
F. Appropriated ground-water use over 10,000 gallons per day in the lower Patapsco and upper Patuxent aquifers in Charles County and southern Prince George's County for 1975-97. . . . 114
G. Simulated pumpage for 2020 in the upper Patuxent aquifer used in predictive Model Simulation III. . . . 116
H. Simulated pumpage for 2020 in the upper Patuxent aquifer used in predictive Model Simulations IVA, IVB, and IVC. . . . 117
I. Planned subdivisions in the Indian Head-Bryans Road area. . . . 119

ILLUSTRATIONS

Page

Figure 1. Map showing the study and model areas and location of geohydrologic cross-sections A-A′, B-B′, and C-C′. . . . 4
2. Geophysical logs, core depths, and well construction for test wells drilled during this study. . . . 7
3. Schematic showing remaining available drawdown and management water level. . . . 8
4.-6. Geohydrologic cross-section:
4. A-A′ from Hallowing Point, Virginia, to Waldorf, Maryland. . . . 11
5. B-B′ from Indian Head to La Plata, Maryland. . . . 12
6. C-C′ from Douglas Point to southern Prince George's County, Maryland. . . . 13
7-11. Map showing the approximate:
7. Altitude of the top of the basement rock. . . . 14
8. Altitude of the top of the upper Patuxent aquifer. . . . 15
9. Thickness of the upper Patuxent aquifer. . . . 16
10. Altitude of the top of the lower Patapsco aquifer. . . . 17
11. Thickness of the lower Patapsco aquifer. . . . 18

ILLUSTRATIONS–CONTINUED

Page

Figure 12. Graphs showing the calculation of transmissivity using the Jacob straight-line method for the upper Patuxent aquifer in test wells drilled during this study. 21

13.-17. Map showing the:

13. Transmissivity distribution of the upper Patuxent aquifer in Charles County and southern Prince George's County. 23

14. Transmissivity distribution of the lower Patapsco aquifer in Charles County and southern Prince George's County. 25

15. Potentiometric surface of the lower Patapsco aquifer in Charles County and southern Prince George's County during the fall, 1997. 26

16. Potentiometric surface of the upper Patuxent aquifer in Charles County and southern Prince George's County during the fall, 1997. 28

17. Remaining available drawdown in the lower Patapsco and upper Patuxent aquifers in 1997. 29

18. Hydrographs showing water levels in the upper Patuxent and lower Patapsco aquifers related to pumpage in the lower Patapsco aquifer in Charles County and southern Prince George's County. 30

19. Map showing the location of wells monitored during a 5-day aquifer test of well CH Bc 75 (Chapman's Landing well 2). 31

20. Water-level fluctuations in the upper and lower Patuxent aquifers during a 5-day aquifer test conducted November 19-24, 1996 on the upper Patuxent aquifer in well CH Bc 75 (Chapman's Landing well 2) 33

21. Hydrographs showing water-level fluctuations in the upper and lower Patuxent and lower Patapsco aquifers related to upper Patuxent pumpage at South Hampton and lower Patapsco pumpage at Bryans Road. 34

22. Semi-log plots of drawdown in wells CH Bc 75 and CH Bc 78 showing ground-water-flow barrier. 35

23.-24. Map showing:

23. Alignment of the Stafford and Brandywine fault systems proposed by Mixon and Newell (1977). 36

24. Locations of appropriated water use in 1997 greater than 10,000 gallons per day in the lower Patapsco and upper Patuxent aquifers. 39

25. Conceptual ground-water-flow model. 41

26. Grid and boundary conditions used in the finite-difference ground-water-flow model. 43

27. Generalized cross-section along model row 32. 44

28.-29. Map showing:

28. Transmissivity zones assigned to model layer 2. 47

29. Transmissivity zones assigned to model layer 3. 48

30. Maps showing model-simulated potentiometric surface of layers 2 and 3 for steady-state, prepumping conditions. 50

31. Location of wells used in model calibration. 52

32. Graph showing relation between observed and simulated water levels in the lower Patapsco aquifer for December 1997. 53

33.-34. Hydrographs of measured and simulated heads in the lower Patapsco aquifer in:

33. Charles County and Prince George's County, 1950 to 1997. 54

34. Charles County, 1970 to 1997 55

ILLUSTRATIONS–CONTINUED

Page

Figure 35. Map showing simulated potentiometric surface and measured water levels in model layer 2 for 1997. 56
36. Hydrographs of measured and simulated heads in the upper Patuxent aquifer, 1970 to 1997. 57
37. Map showing simulated potentiometric surface and measured water levels in model layer 3 for 1997. 58
38. Effects of simulated head match by varying model parameters. 59
39. Maps showing simulated drawdown in the lower Patapsco aquifer between 1997 and 2020 based on 1997 pumpage in the Indian Head-Bryans Road area and 2020 pumpage in the remainder of the model area (Model Simulations IA and IB). 63
40.-47. Map showing:
40. Percentage of available drawdown remaining in 2020 in the lower Patapsco aquifer based on 1997 pumpage in the Indian Head-Bryans Road area and 2020 pumpage in the remainder of the model area (Model Simulation IA). 64
41. Simulated remaining available drawdown in the lower Patapsco aquifer in 2020 (Model Simulation IA). 65
42. Simulated potentiometric surfaces of the lower Patapsco aquifer in 2020 based on 1997 pumpage in the Indian Head-Bryans Road area and 2020 pumpage in the remainder of the model area (Model Simulations IA and IB). 66
43. Simulated remaining available drawdown in the lower Patapsco aquifer in 2020 (Model Simulation II). 67
44. Well sites in the upper Patuxent aquifer used in predictive model simulations. 69
45. Percentage of available drawdown remaining in 2020 in the upper Patuxent aquifer based on a pumping rate of 3.4 million gallons per day (Model Simulation III). 70
46. Simulated remaining available drawdown in the upper Patuxent aquifer in 2020 (Model Simulation III). 71
47. Simulated potentiometric surface of the upper Patuxent aquifer in 2020 (Model Simulation III). 72
48. Water budget for model layer 3 (upper Patuxent aquifer) in 2020 based on a pumping rate of 3.4 million gallons per day (Model Simulation III). 73
49. Maps showing percentage of available drawdown remaining for the upper Patuxent aquifer in 2020 based on pumping rates of 2.1, 4.0, and 4.7 million gallons per day (Model Simulations IVA, IVB, and IVC). 75
50. Map showing simulated drawdown between 1997 and 2020 in the lower Patapsco aquifer caused by the withdrawal of 3.4 million gallons per day from the upper Patuxent aquifer. 77
51.-53. Model-simulated head changes in the:
51. Lower Patapsco aquifer in well CH Bd 22 at Bryans Road, 1976 to 2020. 78
52. Lower Patapsco aquifer in well CH Bc 5 at the U.S. Naval Surface Warfare Center (Indian Head), 1976 to 2020. 79
53. Upper Patuxent aquifer in well CH Bc 77 (Chapman's Landing well 1), 1993 to 2020. 80

TABLES

			Page
Table	1.	Geohydrologic units included in this study.	10
	2.	Transmissivity data for the upper Patuxent aquifer in Charles County and southern Prince George's County, Maryland and Prince William County, Virginia.	22
	3.	Transmissivity data for the lower Patapsco aquifer in Charles County and southern Prince George's County.	24
	4.	Chemical analyses of water from the upper and lower Patuxent aquifers sampled in test wells CH Bc 80, Bd 52, and Cc 34, and production well CH Bc 75.	38
	5.	Time discretization used in transient ground-water-flow model.	51
	6.	Summary of results of Model Simulations I, II, III, IV, and V.	61
	7.	Simulated water use in the lower Patapsco aquifer in 1997 and 2020 outside of the Indian Head-Bryans Road area based on population estimates for Election Districts 1, 5, 6, 8, and 10 (Pumping Alternative 1A).	62
	8.	Pumpage values in 2020 for the lower Patapsco and upper Patuxent aquifers in the Indian Head-Bryans Road area for Model Pumping Alternatives IVA, IVB, and IVC.	74

PLATES

			Page
Plate	1.	Map showing well locations.	Pocket
	2.	Geohydrologic cross-section D-D′ from Chapman's Landing to Lexington Park, Maryland.	Pocket

THE GEOHYDROLOGY AND WATER-SUPPLY POTENTIAL OF THE LOWER PATAPSCO AQUIFER AND PATUXENT AQUIFERS IN THE INDIAN HEAD-BRYANS ROAD AREA, CHARLES COUNTY, MARYLAND

by

David C. Andreasen

KEY RESULTS

The Indian Head-Bryans Road area, in northwestern Charles County, relies primarily on ground water pumped from the lower Patapsco aquifer. Approximately 1.8 million gallons per day were withdrawn in 1997. Increasing population in the area may require an additional 5 million gallons per day by 2020. The upper Patuxent aquifer, lying beneath the lower Patapsco, is a potential source for the projected increase in water demand.

The lower Patapsco and upper Patuxent aquifers are the primary sources of ground water in the Indian Head-Bryans Road area. (pgs. 9 to 32)

- The aquifers consist of fine to coarse sand separated by layers of dense clay.

- Transmissivity–a measure of the ability of the aquifer to transmit water–ranges from 190 to 1,100 feet squared per day in the lower Patapsco aquifer and 152 to 2,600 feet squared per day in the upper Patuxent aquifer. The lower Patuxent aquifer is less transmissive (80 feet squared per day) at the one site tested.

- The productivity of the lower Patapsco aquifer is constrained by less available drawdown in "updip" areas along the Potomac River. At the 1997 pumping rate (1.8 million gallons per day) and pumping-well distribution, water levels in the lower Patapsco aquifer have reached the 80-percent management level along the Potomac River shoreline in the central part of the Indian Head Peninsula.

- The Arundel Clay provides an effective hydraulic seal between the two aquifers in most places.

- The lower Patapsco and upper Patuxent aquifers exhibit lateral hydraulic continuity with the Waldorf-La Plata area. Lateral hydraulic continuity of the upper Patuxent aquifer is apparently disrupted by a flow barrier, the location of which is estimated to be northwest of Bryans Road.

Ground-water-flow model simulations which simulate conditions from 1998 to 2020 indicate that a total of 4 million gallons per day is available for future use from the combined lower Patapsco and upper Patuxent aquifers in northwestern Charles County. (pgs. 62 to 68)

- The lower Patapsco aquifer is capable of producing an additional 0.6 million gallons per day beyond the 1997 rate of approximately 2 million gallons per day (2.6 million gallons per day total) provided that 0.5 million gallons per day of existing production along the Potomac River is shifted to areas southeast of the Bryans Road-Indian Head area.

- The upper Patuxent aquifer is capable of supplying 3.4 million gallons per day before drawdowns reach the 80-percent management level along the Potomac River shoreline.

Projected 2020 water use in the lower Patapsco and upper Patuxent aquifers will cause significant water-level declines. (pgs. 60 to 62 and 73 to 76)

- Water levels in the lower Patapsco aquifer may decline by as much as 60 feet in the vicinity of Bryans Road and 20 feet at Indian Head between 1997 and 2020 because of increased pumpage from the lower Patapsco aquifer outside the Indian Head-Bryans Road area. Water-level declines exceed the 80-percent management level along the Potomac River in the central part of the Indian Head peninsula. The 80-percent management level is also exceeded in a small area northwest of Bryans Road along the Potomac River.

- The lowest water levels in the upper Patuxent aquifer simulated as model-cell averages are 330 feet below sea level based on withdrawals from the upper Patuxent aquifer of 2.1 million gallons per day, and 540 feet below sea level based on withdrawals of 4.0 million gallons per day.

- The upper Patuxent aquifer begins to de-water within a narrow band located along the Potomac River shoreline near Chapman's Landing and in some pumping wells when pumped at a rate of 4.7 million gallons per day; model-cell water levels are as low as 650 feet below sea level.

Pumping from the upper Patuxent aquifer will cause minimal head decline in the lower Patapsco aquifer. (pg. 76)

- Drawdown in 2020 in the lower Patapsco aquifer caused by 3.4 million gallons per day withdrawn from the upper Patuxent aquifer is less than 18 feet.

Water from the upper and lower Patuxent aquifers is a sodium bicarbonate type of good quality. (pg. 37)

- Dissolved concentrations of all major inorganic constituents were within the recommended limits set by the U.S. Environmental Protection Agency. Dissolved solids, pH (field), and specific conductance (laboratory) range from 214 to 378 milligrams per liter, 7.7 to 7.9, and 322 to 627 microsiemens per centimeter, respectively.

INTRODUCTION

A water-supply study of the Indian Head-Bryans Road area of Charles County by the U.S. Army Corps of Engineers (1993) indicates that water demand will increase from about 3 million gallons per day (Mgal/d) in 1990 to between 5.5 Mgal/d and 7.2 Mgal/d in 2012. The Corps' study concludes "that ground water appears to be the most economical solution for the area's water supply needs." It recommends that future supplies be withdrawn from the Patuxent aquifer[1] to minimize the effects of declining water levels on current lower Patapsco users, particularly domestic well owners. The purpose of this study is to determine whether the lower Patapsco and upper Patuxent aquifers in the Indian Head-Bryans Road area have sufficient production capacity to implement the recommended water-supply plan.

OBJECTIVES

The objectives of this report are to: (1) Define the geohydrologic framework of the lower Patapsco aquifer and Patuxent aquifers in northwestern Charles County with an emphasis on the Indian Head-Bryans Road area, including a determination of the hydraulic connectivity between the aquifers, and establish their relation to the aquifers pumped by public-supply wells at Waldorf and La Plata; (2) Establish an observation-well network in the lower Patapsco aquifer and Patuxent aquifers to monitor water-level changes in the model area; (3) Assess the geohydrologic characteristics of the lower Patapsco aquifer and Patuxent aquifers and evaluate quantitatively: (a) the amount of water-level decline caused by ground-water withdrawals from the lower Patapsco aquifer outside of the Indian Head-Bryans Road area, (b) the potential for increasing ground-water production from the lower Patapsco and upper Patuxent aquifers through the selection of optimum well locations, and (c) the potential for redirecting existing pumpage from the lower Patapsco aquifer into the upper Patuxent aquifer; and, (4) Determine the water quality of the Patuxent aquifers.

[1]In this report the Patuxent aquifer is divided into two units–the upper Patuxent aquifer, which is a major aquifer, and the lower Patuxent aquifer, which is a minor aquifer.

LOCATION OF STUDY AREA

The study area is in the northwestern part of Charles County, Maryland, and includes the Indian Head-Bryans Road area and most of Election District 7 (fig. 1). The study area also includes parts of Election Districts 2, 6, and 10. The Indian Head-Bryans Road area is shown on plate 1. To properly evaluate the ground-water-flow system, a larger area was included in the ground-water-flow model (fig. 1). The model area covers approximately 1,300 square miles (mi^2) and includes all of Charles County, parts of Calvert, Prince George's, and St. Mary's Counties, and adjacent parts of the Virginia Coastal Plain. Major population centers within Charles County include Waldorf and La Plata. The model area is located entirely within the Coastal Plain Physiographic Province. The northwest side of the model area is located approximately along the trend of the Fall Line.

The study area is composed primarily of forests, wetlands, and open space with a mixture of light commercial, residential, and agricultural development. The U.S. Naval Surface Warfare Center, on the Indian Head peninsula, is a major military/industrial facility. The majority of the study area is located within the Mattawoman Creek drainage basin, which discharges to the Potomac River (pl. 1). The area is heavily dissected by numerous small streams. Land-surface altitudes range from sea level to as much as 214 feet (ft) above sea level.

PREVIOUS STUDIES

Investigations pertaining to the geology and geohydrology of the geologic formations and aquifers covered in the study area were made by Clark and others (1918), Overbeck (1948), Otton (1955), and Slaughter and Otton (1968). An early investigation of the ground-water supply for the U.S. Naval Surface Warfare Center, including estimates of aquifer properties determined by aquifer tests, well inventory, and interpretations of water-level fluctuations, was made by Fiedler and Jacob (1939). Inventories of selected well data in Charles County, including well construction, chemical analyses, and water levels, were made by Slaughter and Laughlin

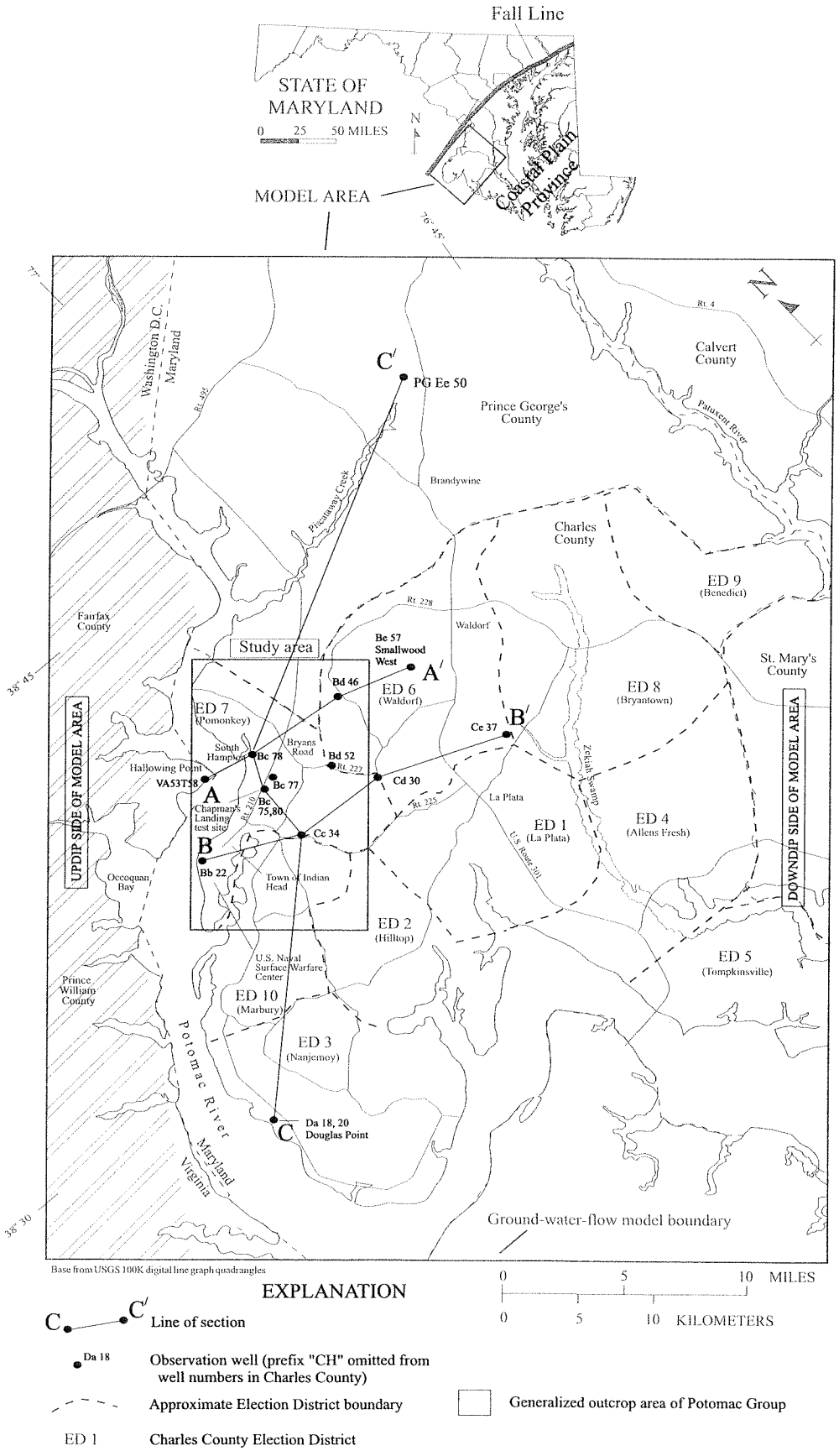


Figure 1. Study and model areas and location of geohydrologic cross-sections A-A′, B-B′, and C-C′.

(1966) and Weigle and Webb (1970). Ground-water levels measured between 1946-94 in an extensive network of observation wells in southern Maryland were compiled by Curtin and Dine (1995). The stratigraphy of the Cretaceous aquifers in the Waldorf /La Plata area was investigated by Wilson (1986) and Wilson and Fleck (1990). The water-supply potential of the aquifers developed in the Patapsco, Magothy, and Aquia Formations in the Waldorf-La Plata area was estimated using a three-dimensional ground-water-flow model by Fleck and Wilson (1990).

An investigation of the hydrogeology and pumpage history of the Potomac Group aquifer system in northwestern Charles County was made by Hiortdahl (1997). Part of that study focused on brackish-water intrusion as a function of ground-water withdrawal from the lower Patapsco aquifer at Indian Head. The first estimate of the water-supply potential of the Patuxent aquifer was made in the Bryans Road water-supply study conducted by the U.S. Army Corps of Engineers (1993). The initial findings of this study were presented in Maryland Geological Survey Open-File Report 98-02-9 (Andreasen and Mack, 1998).

METHODS OF INVESTIGATION

Methods of investigation used for this study included the review and compilation of existing Federal, state, and county ground-water data in the model area and vicinity, and a field inventory of high-capacity wells in the lower Patapsco and Patuxent aquifers. Data collected during the well inventory included location, altitude, water level, well construction, and, where possible, geophysical logs. Selected well records are given in Appendix A. Cross-sections and maps displaying the geohydrology of the lower Patapsco aquifer and Patuxent aquifers and their confining beds were prepared. Data sets of aquifer and confining-bed hydraulic parameters were developed for use in the U.S. Geological Survey's three-dimensional, finite-difference ground-water-flow model MODFLOW (McDonald and Harbaugh, 1988) code. The model, calibrated by matching simulated and historic water levels from 1952 through 1997, was used to predict water-level changes resulting from future ground-water use to 2020 in the lower Patapsco aquifer and Patuxent aquifers. Water samples were collected from selected wells screened in the upper and lower Patuxent aquifers and analyzed for major inorganic constituents. The analyses were made by the U.S. Geological Survey National Water-Quality Laboratory in Denver, Colorado.

An observation-well network, consisting in part of previously established observation wells, was developed in the model area to monitor water levels in the lower Patapsco aquifer and Patuxent aquifers. The observation- well network consisted of 32 wells screened in the lower Patapsco aquifer, 9 wells screened in the upper Patuxent aquifer, and 1 well screened in the lower Patuxent aquifer. Continuous water-level recorders were installed on 1 lower Patapsco well and 6 upper Patuxent wells.

Wells are identified in this report using the Maryland Geological Survey well-numbering system. In this numbering system, the first two letters are the county prefix (for example, CH for Charles County). The second part of the number consists of two letters that designate a 5-minute quadrangle within the county; the first letter (uppercase) denotes a 5-minute segment of latitude from north to south, and the second letter (lower case) denotes a 5-minute segment of longitude from west to east. The locations of 5-minute quadrangles in the study area are shown on plate 1. The wells are numbered sequentially in the order they were inventoried within each 5-minute quadrangle.

Altitudes of water-level measuring points on selected observation wells were determined by spirit level from National Geodetic Survey benchmarks.

TEST DRILLING

The major data collection component of this study was the drilling of three test holes that penetrated the basement-rock complex in the study area and the construction of observation wells screened in the upper and lower Patuxent aquifers. The purpose of the test drilling was to determine the total thickness of Coastal Plain sediments in the area of northwestern Charles County and to identify the depth, thickness, hydraulic properties, and lithology of the aquifers and confining beds beneath the lower Patapsco aquifer.

Test drilling started July 1996 at the Mattawoman Waste-Water Treatment Plant, located approximately 2 miles (mi) southeast of the Chapman's Landing test site (pl. 1). The drilling was

carried out by contract with A.C. Schultes of Maryland, Inc. Basement rock was reached at a depth of 1,170 ft below land surface in well CH Cc 34 (fig. 2). The borehole was converted to an observation well screened in the upper Patuxent aquifer at depths of 874 to 884 ft and 945 to 955 ft below land surface. The second hole (CH Bc 80) was drilled at the Chapman's Landing site (fig. 1) adjacent to an existing production well (CH Bc 75—Chapman's Landing well 2) that was screened in the upper Patuxent aquifer. The hole reached the basement-rock complex at a depth of 1,142 ft below land surface and was converted to an observation well screened in the lower Patuxent aquifer at depths of 1,085 to 1,095 ft and 1,105 to 1,115 ft below land surface. The purpose of testing the lower Patuxent aquifer was primarily to investigate the possible presence of brackish or salty water. Split-spoon cores (1.75-inch [in.] diameter) were collected at selected intervals in both aquifer and confining-bed material below the lower Patapsco aquifer. The final test hole (CH Bd 52) was drilled adjacent to Route 227 near Mattawoman Creek, approximately 3 mi from the Chapman's Landing test site (pl. 1). The hole reached the basement-rock complex at a depth of 1,328 ft below land surface. The hole was converted to an observation well screened in the upper Patuxent aquifer at depths of 1,043 to 1,053 ft and 1,085 to 1,095 ft below land surface.

The test holes were 9 7/8-in. in diameter and drilled to top of basement. Drill cuttings, collected at 20-ft intervals, were briefly described in the field and stored in containers. The drill cuttings were later washed, examined, and described using a 60X-power binocular microscope (Appendix B.). Geophysical logs (16- and 64-in. normal resistivity, 6-ft lateral resistivity, single-point resistivity, gamma radiation, and caliper) (fig. 2) were completed prior to well construction. The holes were back-filled with Morie No. 1 gravel to a depth near the base of the deepest well-screen setting. Well-screen positions were determined based primarily on the results of the geophysical log tests. Two 10-ft sections of 4-in. stainless steel, wire-wound screen with 0.02-in. slot size, separated by a 4-in. pipe, were installed in each hole. A 10-ft section of 4-in. pipe was attached to the bottom of the deepest well screen. The holes were cased from land surface to the top well screen with 4-in. steel pipe. Gravel pack (Morie No. 1) was placed around the well screens to a depth midway in the confining bed immediately overlying the screened sands. Approximately 10 to 20 ft of bentonite was placed on top of the gravel pack using a tremie pipe. The remainder of the annular space was filled with cement grout. The correct settings of the well screens were verified using caliper logs. After test-well construction was complete, a 12-hour, constant-rate aquifer test was conducted on each well and continuous-reading water-level recorders were installed on the wells.

DEFINITION OF TERMS

Figure 3 illustrates schematically the following terms that are used to discuss the effects of pumpage on water levels:

1) *Total available drawdown* is the difference between the prepumping water level and the top of the confined (artesian) aquifer.

2) The *80-percent management level* is a water-level drawdown to 80-percent of the total available drawdown. In Maryland, ground-water allocations may be permitted that lower water levels to the 80-percent management level.

3) *Remaining available drawdown* is the difference between the 80-percent management level and the measured or simulated water level.

4) *Percentage of available drawdown remaining* is the ratio between remaining available drawdown and the available drawdown (based on the prepumping water level and the 80-percent management level).

The maximum yield of an aquifer in the predictive model is limited by the 80-percent management level.

The simulated water level used to calculate the remaining available drawdown is the model-cell water level, which represents an average water level for the cell. Aquifer water levels at specific sites within a model cell can be shallower or deeper than the cell average. The pumping water level in the well shown in figure 3 is deeper than both the aquifer water level and the simulated model-cell water level.

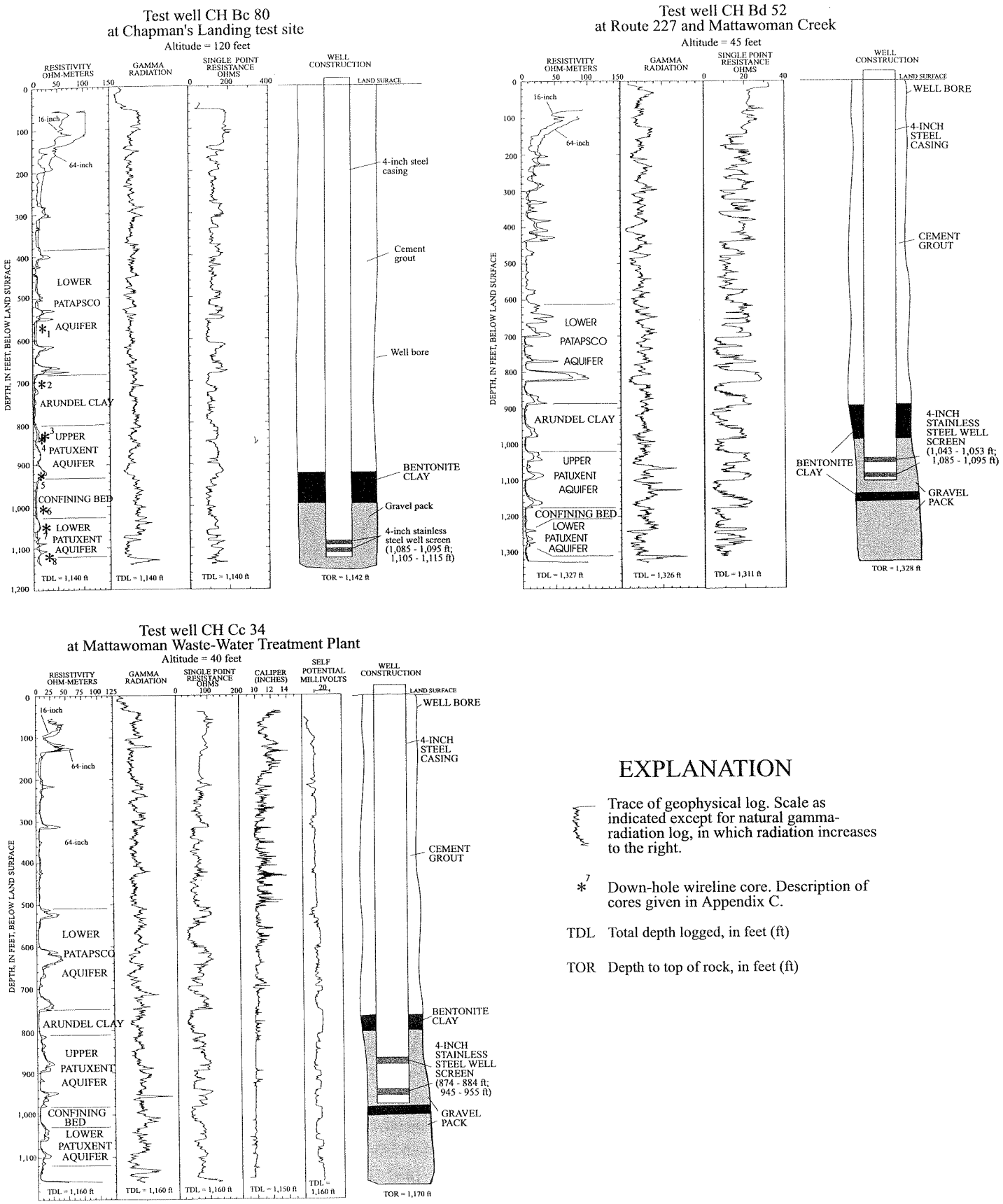


Figure 2. Geophysical logs, core depths, and well construction for test wells drilled during this study.

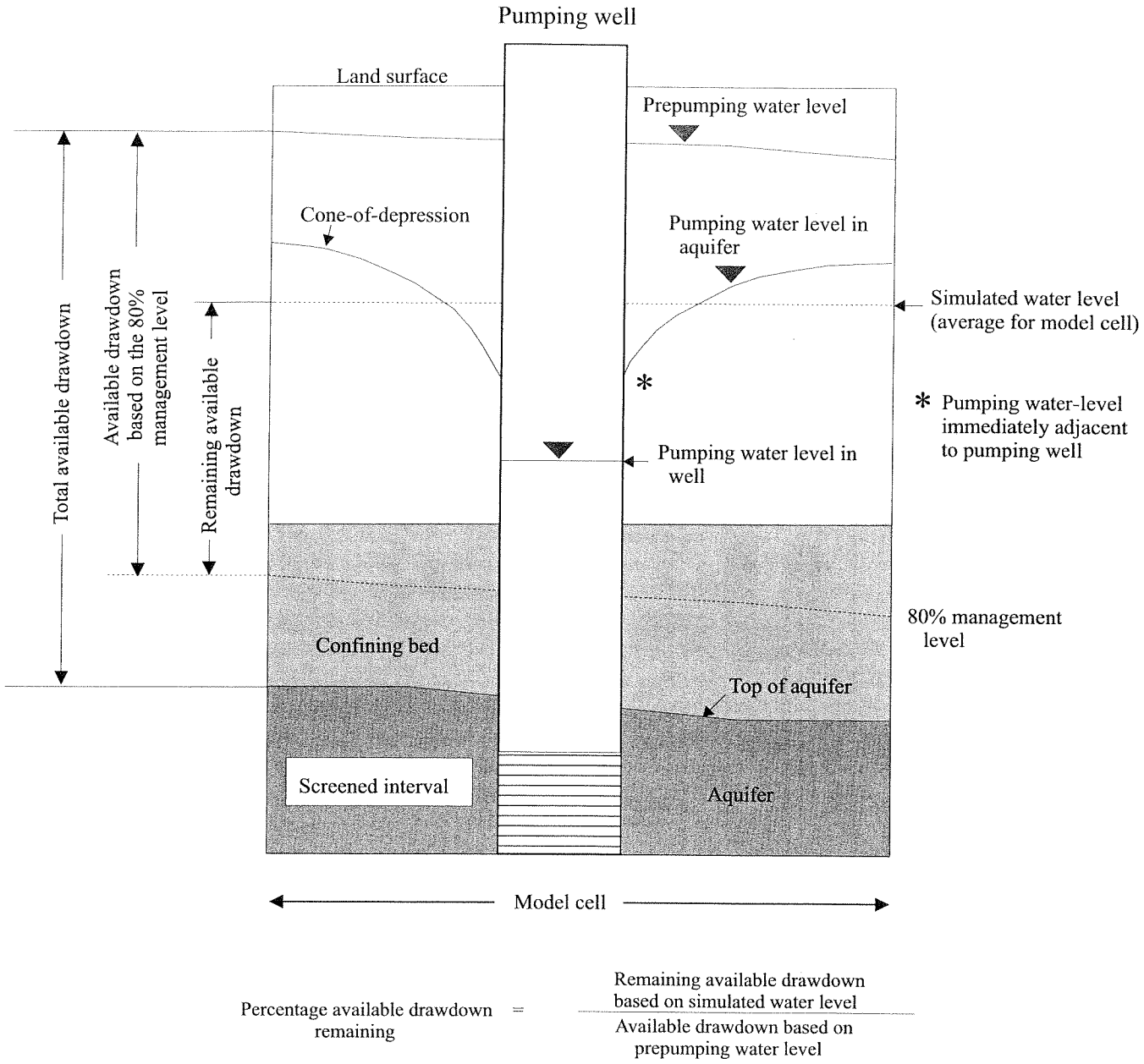


Figure 3. Schematic showing remaining available drawdown and management water level.

The difference is caused by head loss due to well inefficiency, which is not simulated by the model; it varies from well to well.

ACKNOWLEDGMENTS

Funding support for this study was provided by the Board of Commissioners of Charles County, the Maryland Department of the Environment, and the Maryland Geological Survey, a unit of the Maryland Department of Natural Resources (Resource Assessment Service). Test-drilling sites were provided by Charles County, Legend Properties, Inc., and the Maryland Department of Natural Resources (Parks and Recreation Division). Legend Properties, Inc. allowed one of their production wells to be used for a 5-day aquifer test. Frederick

Mack and Harry Hansen contributed their expertise in southern Maryland geohydrology. Jonathan Edwards, Jr. examined drill cuttings from the test-well sites and described the basement rocks. Throughout the investigation, a review committee composed of representatives from the Charles County and Prince George's County governments, Town of Indian Head, and U.S. Naval Surface Warfare Center provided critical comments. Also included on the committee were two citizen representatives, Arthur Krueger and Lawrence Berger. David Drummond, Maryland Geological Survey, and William Fleck, U.S. Geological Survey (Water Resources Division) provided technical reviews of the report. The manuscript was edited and typed by Donajean Appel with additional editorial review by Claire Richardson.

GEOHYDROLOGY OF THE LOWER PATAPSCO AQUIFER AND PATUXENT AQUIFERS

FRAMEWORK

The study area is located within the Coastal Plain province of Maryland (fig. 1). The Coastal Plain province consists of layers of gravel, sand, silt, and clay that are gently sloped downward toward the southeast. The layers form geologic formations that range in age from Cretaceous to Holocene. The geologic units of principal concern in this study are the Patuxent Formation, Arundel Clay, and Patapsco Formation (tab. 1). Collectively, these formations, consisting of alternating beds of sand, silt, and clay, form the Potomac Group. The outcrop area of the Potomac Group occurs within an irregular band northwest of the study area in Virginia and Washington, D.C. (Cooke and Cloos, 1951; Mixon and others, 1989). Sand layers, which generally allow the transmission and extraction of water, form aquifers. In contrast, silt and clay layers, which impede flow of ground water and do not yield water to wells, form confining beds. The aquifers considered in this report consist of multiple sand layers within the Patapsco and Patuxent Formations; they include, from shallowest to deepest, the upper Patapsco aquifer, lower Patapsco aquifer, upper Patuxent aquifer, and lower Patuxent aquifer. The lower Patapsco aquifer is separated from the upper Patuxent aquifer by the Arundel Clay. The Patuxent aquifer was informally divided into the upper and lower aquifer units based on the presence of two discrete sand bodies within the Patuxent Formation. The outcrop areas of the aquifers occur within the outcrop area of the Potomac Group. Outcrop areas of the individual aquifers are not differentiated from the Potomac Group outcrop.

Four geohydrologic cross-sections extending through the study area were prepared (figs. 4-6, and pl. 2) along with a series of structure maps showing the altitude of the top of the basement rock and the altitude of the top and thickness of the lower Patapsco and upper Patuxent aquifers (figs. 7-11).

The top of basement rock is at approximately 680 ft below sea level west of Chapman's Landing at Hallowing Point, Virginia and increases in depth to about 1,730 ft below sea level at La Plata and about 2,550 ft below sea level at Lexington Park (figs. 4, 5, and 7; pl. 2). The dip of the basement rock is steepest near the western edge of the Coastal Plain sediments (about 50 ft per mile [ft/mi]) and decreases to about 30 ft/mi in the eastern part of Charles County. Seismic reflection data reported by Jacobeen (1972), Dames & Moore (1973), and Hansen (1978) suggest that faulting may offset the Coastal Plain—basement-rock contact by as much as 250 ft along a line extending from southern Prince George's County, through Waldorf, to about La Plata. An interpretation of this structure (called the Brandywine fault system) is shown in Wilson and Fleck (1990, fig. 3, pl. 3). The Brandywine fault system may also affect the overlying Coastal Plain sediments, resulting in offsets or dip reversals in the Patuxent and Patapsco aquifers near the proposed fault trend (Wilson and Fleck, 1990, fig. 4, pl. 3). The structure maps and cross-sections presented in this report are generalized in the area of the Brandywine fault system and do not display possible effects of faulting.

Fragments of basement rock recovered from CH Bd 52 and Cc 34 consist of fine-grained biotite-plagioclase-quartz gneiss (Appendix B). This rock resembles the Oella Formation, a crystalline rock that outcrops in the Piedmont of Baltimore and Howard

(Text continued on p. 19.)

Table 1. Geohydrologic units included in this study

[ft = feet]

Erathem	System	Series	Group	Formation	Lithology	Aquifers and confining beds	Approximate formation thickness (ft) in well CH Bc 80
Cenozoic	Tertiary	Pliocene		Upland deposits	Sand, gravel, silt, and clay; yellow and brown	Surficial aquifer	50
		Paleocene	Pamunkey	Aquia	Sand, silt, and clay; glauconitic; dark gray		90
Mesozoic	Cretaceous	Lower Cretaceous	Potomac	Patapsco	Sand, interbedded with multi-colored clay	upper Patapsco aquifer	170
					Clay and silt	Confining bed	70
					Alternating beds of fine to coarse sand, interbedded with thicker layers of dense clay	lower Patapsco aquifer	Total: 300 Sand (84) Clay and silt (216)
				Arundel	Clay, dense; red, purple, and brown with relatively thin beds of fine-grained sand	Arundel confining bed	120
				Patuxent	Sand, medium to coarse; clean; light gray; quartzose; with some small gravel	upper Patuxent aquifer	Total: 135 Sand and silt (80) Clay and silt (35)
					Clay and silt	Confining bed	93
					Sand with intergranular silt and clay	lower Patuxent aquifer	Total: 115 Sand (50) Clay and silt (65)
Pre-Cretaceous				Basement complex	Granite gneiss	None	Unknown

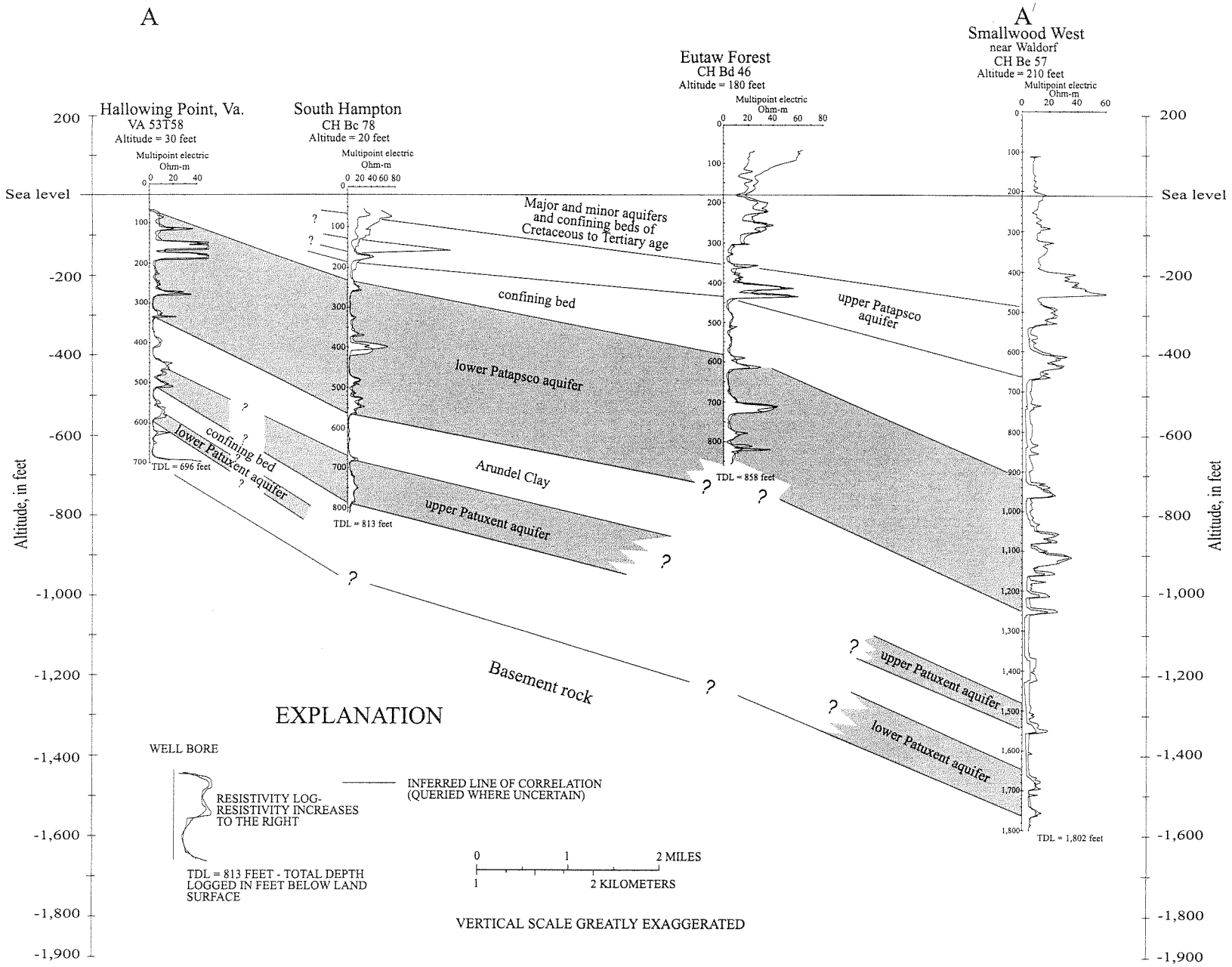


Figure 4. Geohydrologic cross-section A-A′ from Hallowing Point, Virginia, to Waldorf, Maryland.

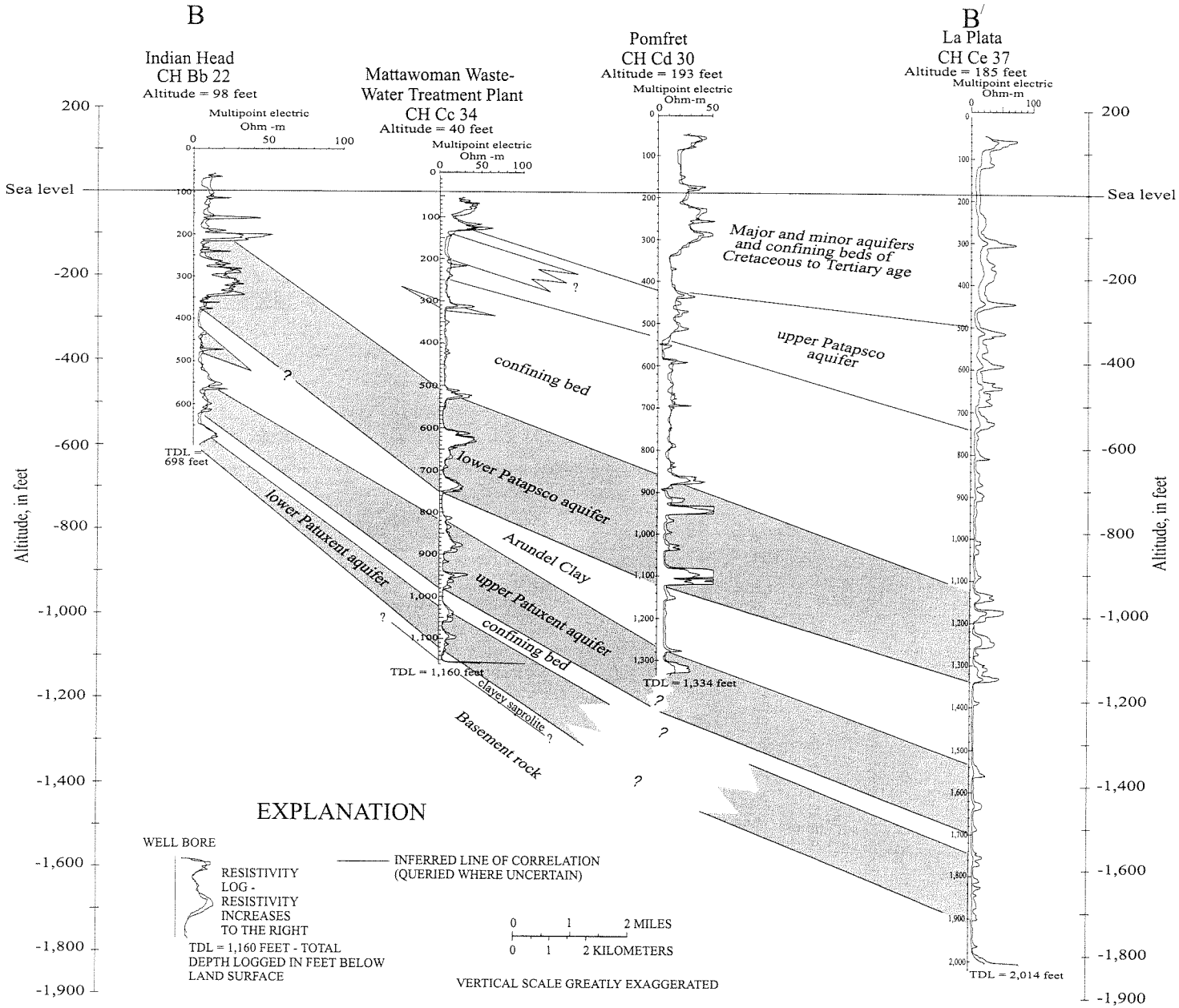


Figure 5. Geohydrologic cross-section B-B′ from Indian Head to La Plata, Maryland.

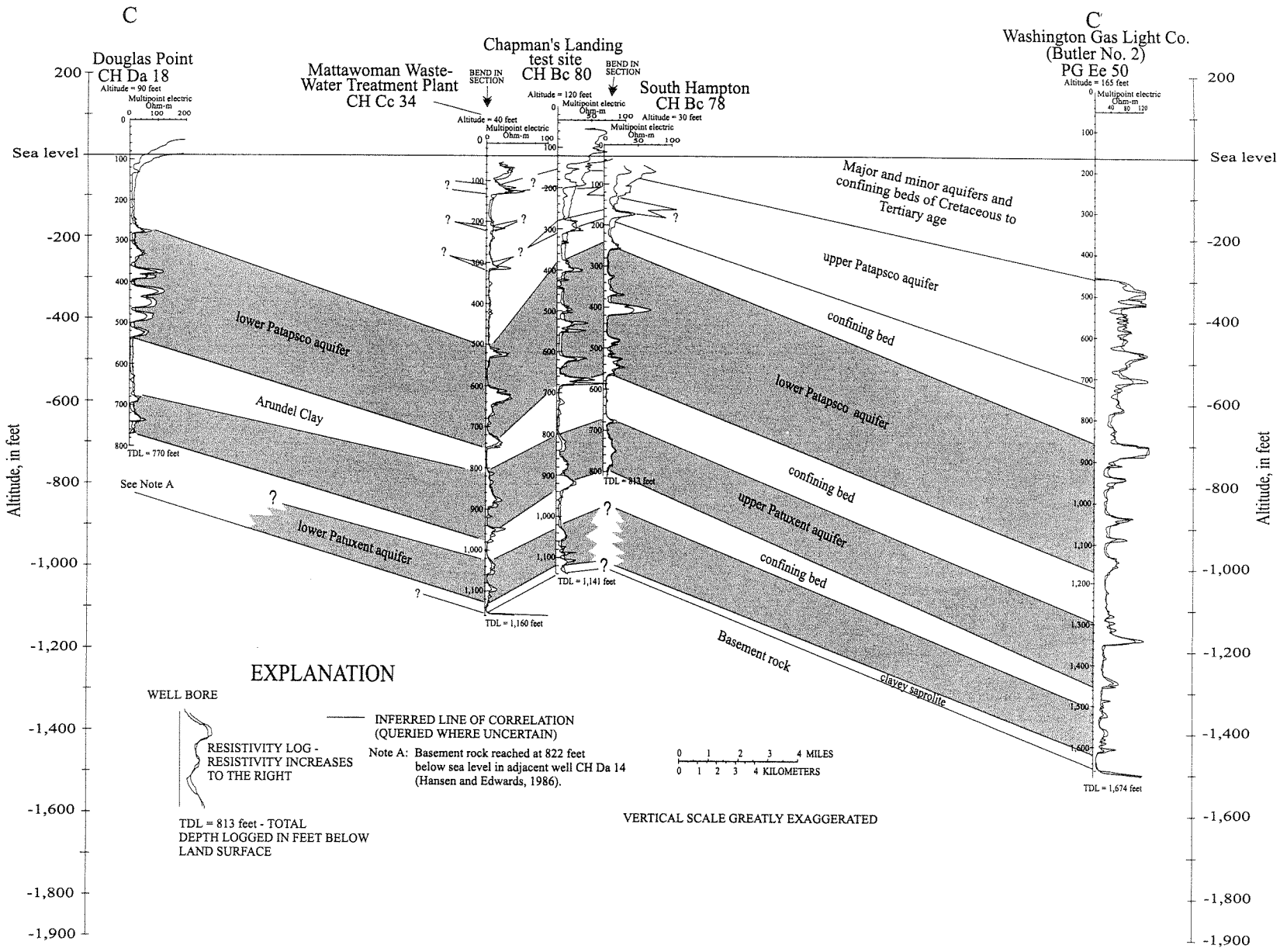


Figure 6. Geohydrologic cross-section C-C′ from Douglas Point to southern Prince George's County, Maryland.

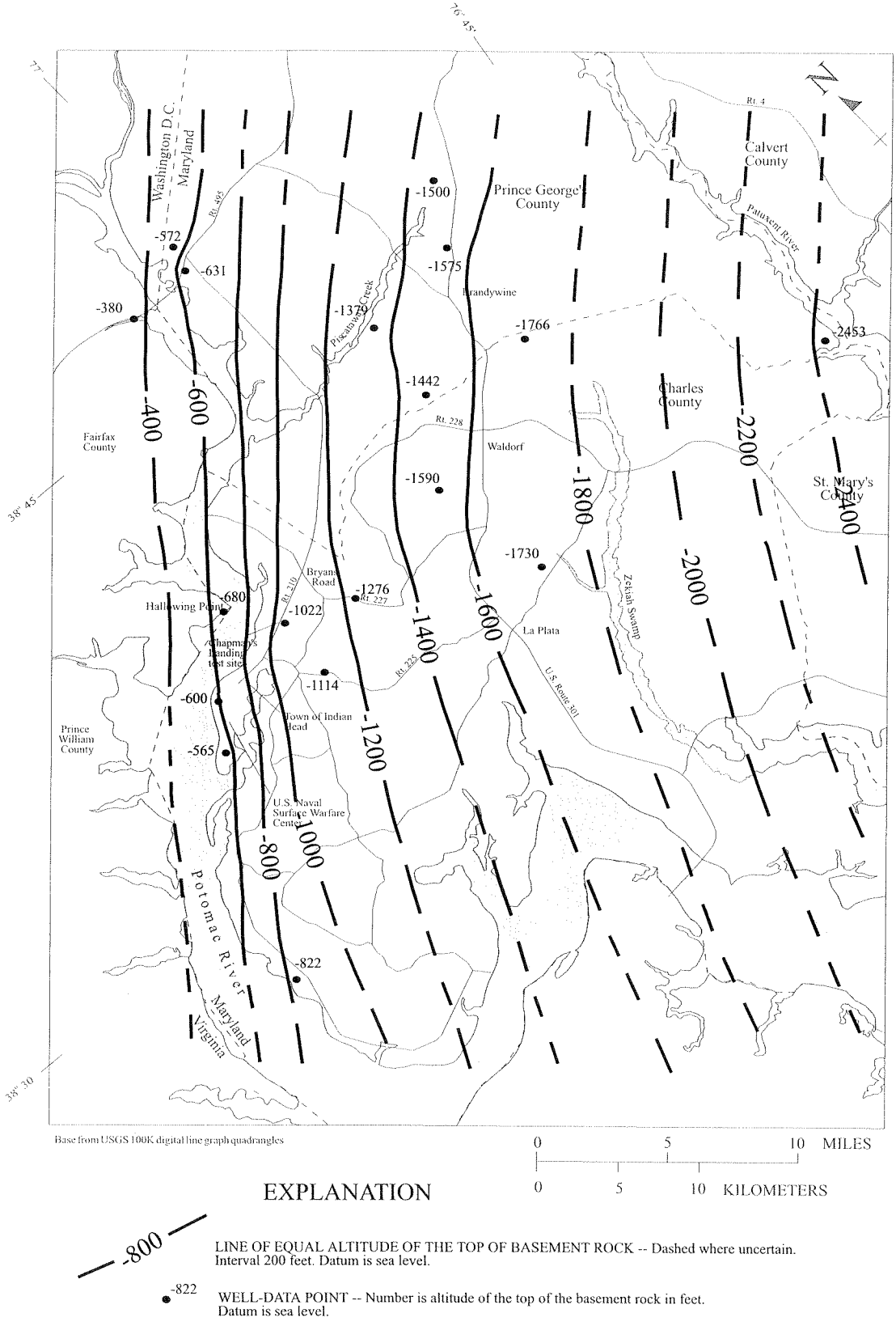


Figure 7. Approximate altitude of the top of the basement rock.

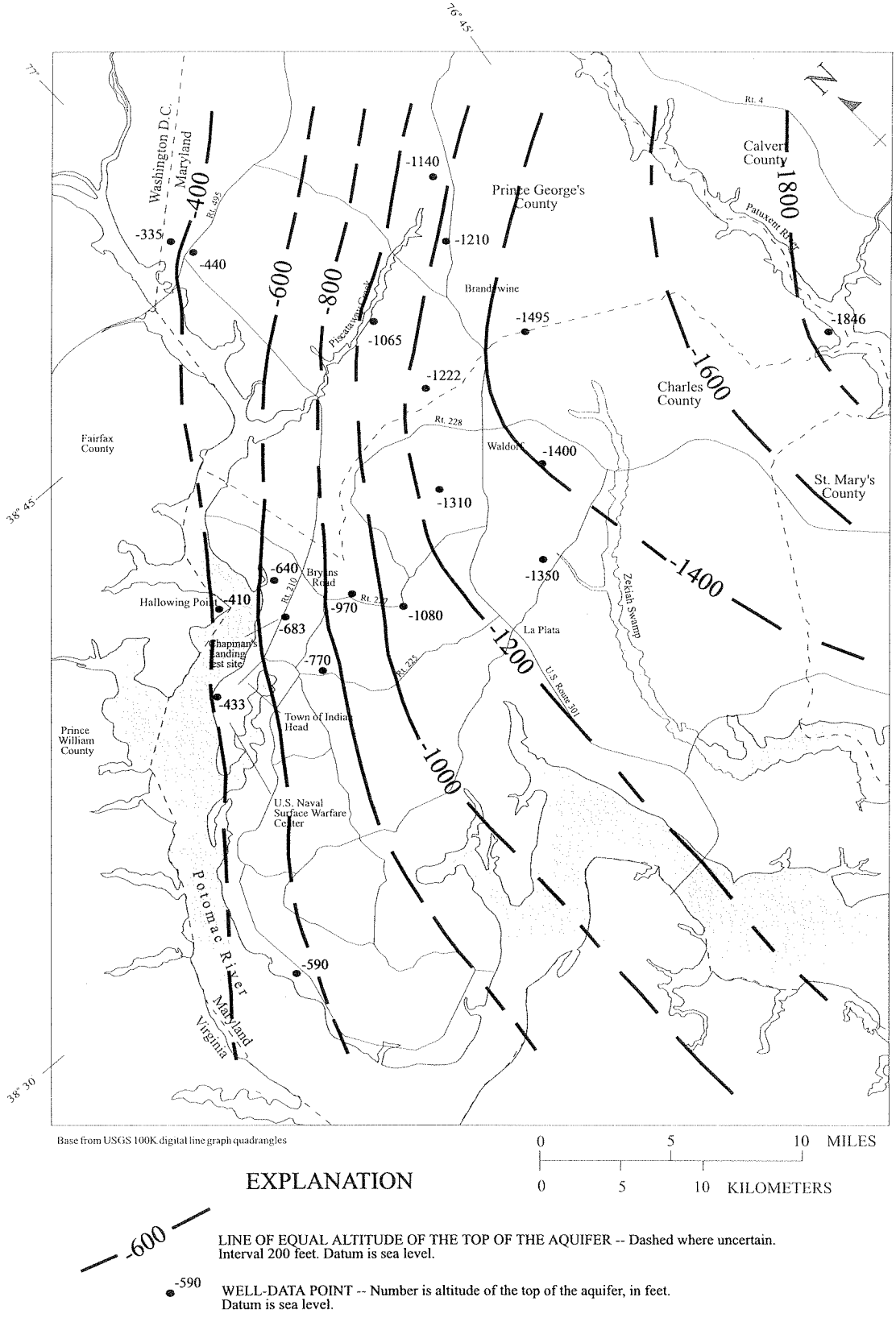


Figure 8. Approximate altitude of the top of the upper Patuxent aquifer.

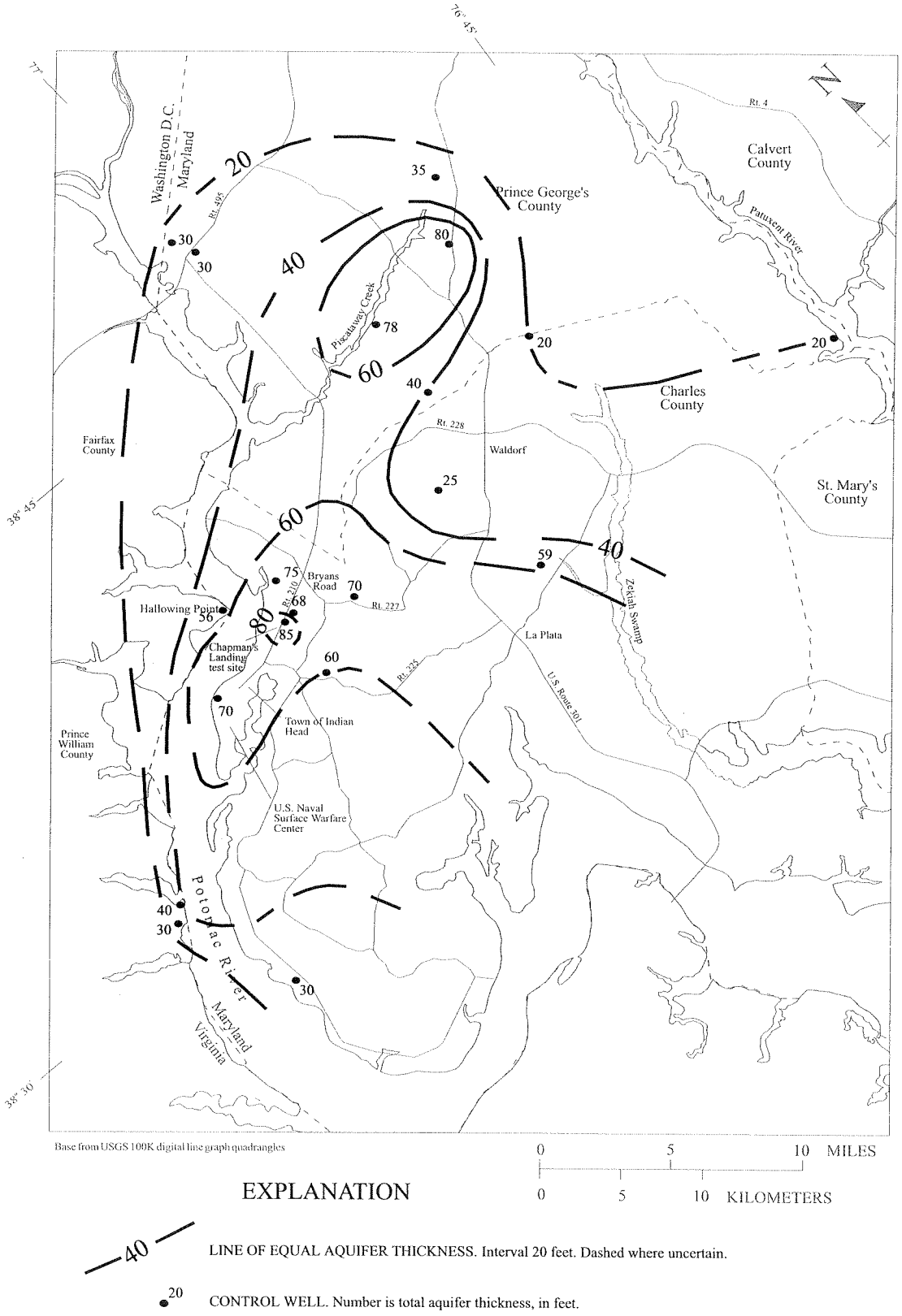


Figure 9. Approximate thickness of the upper Patuxent aquifer.

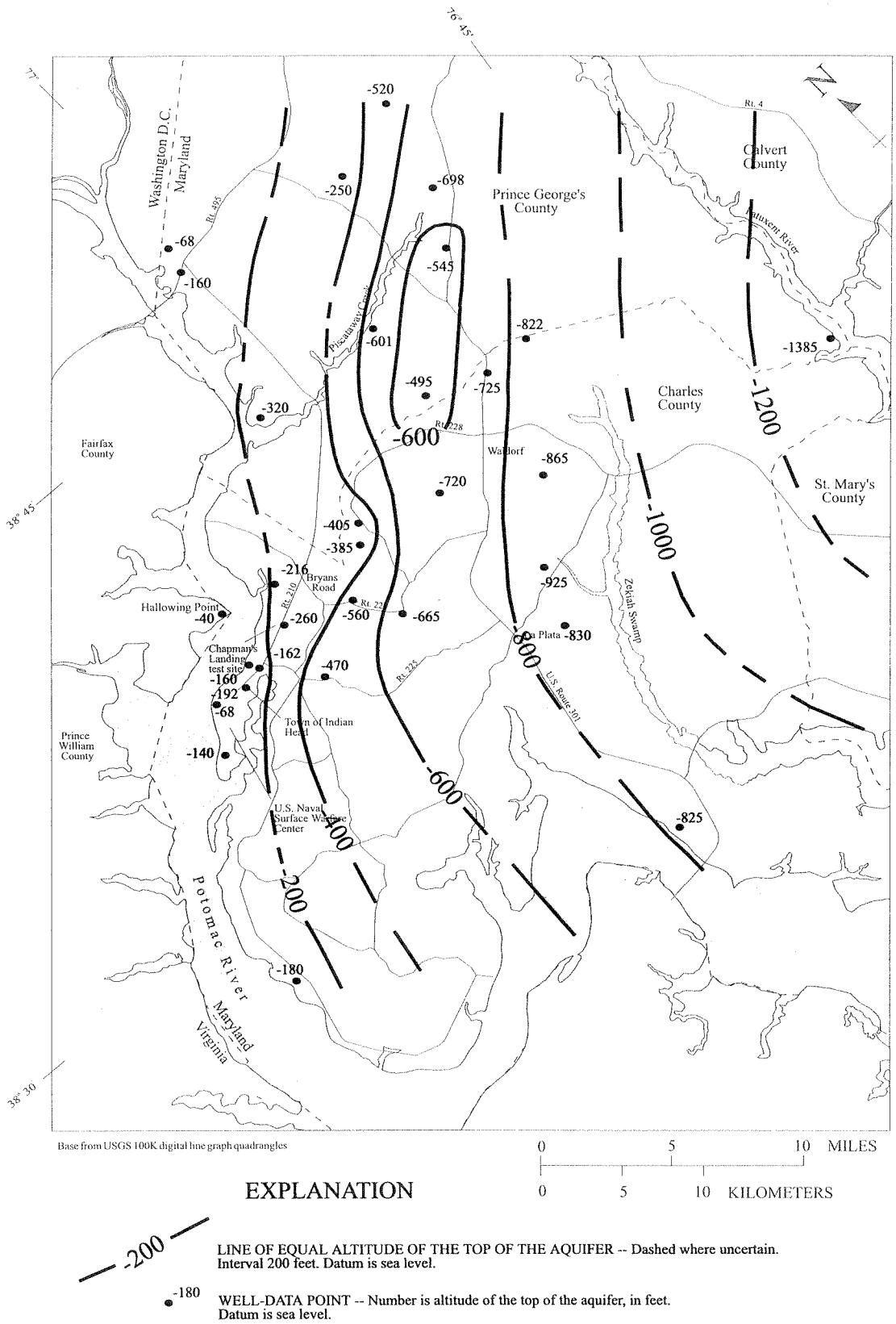


Figure 10. Approximate altitude of the top of the lower Patapsco aquifer.

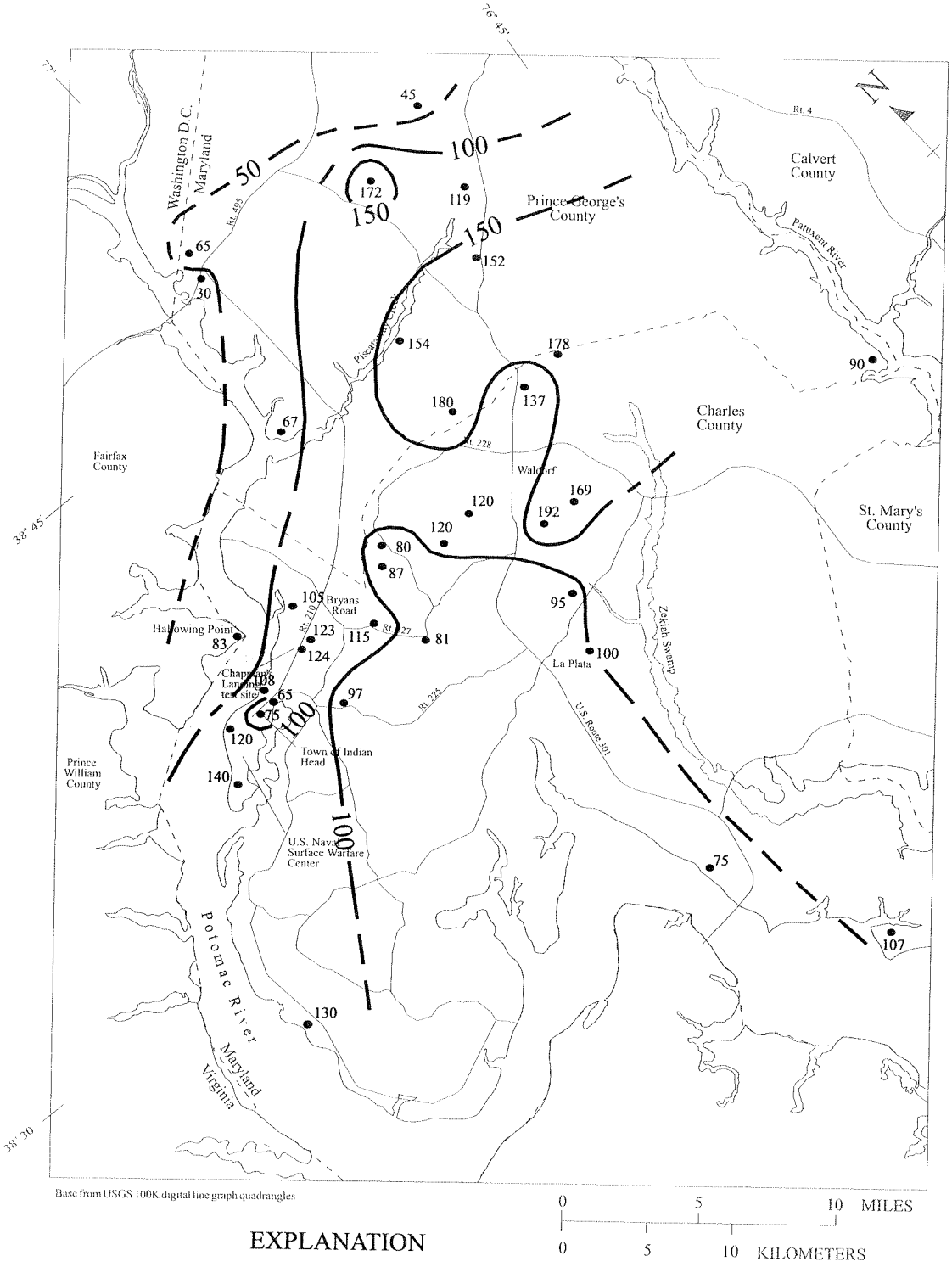


Figure 11. Approximate thickness of the lower Patapsco aquifer.

Counties (Jonathan Edwards, written commun., 1996). Rock chips collected in drill cuttings from CH Bc 75 (located near CH Bc 80) consist of coarse-grained, microcline-quartz granite or granite gneiss and fine-grained, garnetiferous, muscovite-biotite-plagioclase gneiss (Appendix B.).

The Patuxent Formation overlies the basement-rock complex. Contact between the basement rock and the Patuxent Formation is typically marked by 10 to 20 ft of light green, clayey saprolite (weathered rock). Sands within the Patuxent Formation are informally divided into the upper and lower aquifer units. Sand within the lower Patuxent aquifer is generally less abundant and finer-grained than sand in the upper Patuxent aquifer. Also, electric resistivity logs generally show lower values in the lower aquifer, indicating a higher clay content. Visual examination of the cores collected at 1,050 ft and 1,115 ft from well CH Bc 80 shows that the intergranular space is filled with a silt-clay matrix (Appendix C). Sieve analyses of the core samples show a relatively high percentage (19 percent) of silt-clay (Appendix C). The lower Patuxent aquifer is unlikely, therefore, to yield significant quantities of water. The top of the lower Patuxent aquifer is about 550 ft below sea level at Indian Head and increases to about 1,575 ft below sea level at La Plata (fig. 5). In the Indian Head-Bryans Road area, the lower Patuxent aquifer is about 20 to 50 ft thick. The lower Patuxent aquifer is overlain by approximately 20 to 90 ft of dense clay.

The upper Patuxent aquifer consists chiefly of fine to coarse sand separated by dense green and brown clay layers. A core sample collected at 825 ft in well CH Bc 80 indicates that the sand may, in places, contain appreciable amounts of silt and clay (Appendix C). The top of the aquifer varies in depth from about 400 ft below sea level at Indian Head to about 1,350 ft below sea level at Waldorf (figs. 4, 5, and 8). The thickness of the upper Patuxent aquifer is greatest at the Chapman's Landing test site (85 ft) and in an area near Piscataway Creek in southern Prince George's County (80 ft). Generally, however, it is less than 60 ft in the rest of the model area. The increased thickness at the Chapman's Landing test site may be attributed to local stacking of fluvial, channel-sand deposits. In places individual channel-fill deposits may coalesce vertically to form multistory sand bodies (Potter, 1967).

The upper and lower Patuxent aquifers are, at least locally, hydraulically connected through a leaky confining layer. Evidence of this is provided in the response of water levels in the lower Patuxent aquifer to pumpage in the upper Patuxent aquifer at the Chapman's Landing test site (well CH Bc 80).

The upper Patuxent aquifer is separated from the overlying lower Patapsco aquifer by the Arundel Clay. Within the study area, the Arundel Clay is a relatively low permeability clay interbedded with thin beds of fine-grained, gray sand. Drill cuttings from the test holes indicate a dense, red, purple, and brown clay (Appendix B). Cores from test well CH Bc 80 indicate a light gray, reddish-brown, tough clay, interbedded with thin layers of sand (Appendix C). The altitude of the top of the Arundel Clay varies from about 275 ft below sea level at Indian Head (fig. 5) to about 1,500 ft below sea level in the eastern part of Charles County (pl. 2). Total thickness ranges from about 55 ft in the test well at Mattawoman Waste-Water Treatment Plant to more than 300 ft in the southeastern part of Prince George's County. The Arundel Clay is approximately 120 ft thick at the Chapman's Landing test site. The Arundel Clay functions as an effective confining layer separating the upper Patuxent and lower Patapsco aquifers in most areas because it is a relatively thick, low-permeability clay. The hydraulic connection between the Patuxent and Patapsco aquifers is greatest at sites where the Arundel Clay is thinner than normal or unusually sandy.

The lower Patapsco aquifer is composed of alternating layers of fine to coarse, light gray and brown sand, and tough clay. The lower Patapsco aquifer referred to in this report correlates downdip with the La Plata aquifer system (Wilson and Fleck, 1990). The depth to the top of the aquifer ranges from 68 ft below sea level at Indian Head to more than 1,300 ft below sea level in the eastern part of Charles County (fig. 10). Aquifer thickness ranges from approximately 60 ft at Indian Head to more than 150 ft in north-central Charles County and south-central Prince George's County (fig. 11). Most of the wells in the project area previously described as being completed in the Patuxent aquifer (Otton, 1955; Slaughter and Otton, 1968; Hiortdahl, 1997) were reassigned to the lower Patapsco aquifer based on newly obtained test-well data.

The lower Patapsco aquifer is overlain by a relatively thick (up to 300 ft), low permeability clay layer within the Patapsco Formation. This clay layer, separating the lower Patapsco aquifer from the overlying upper Patapsco aquifer, restricts the flow of water between the aquifers. Channeling beneath the Potomac River (either recent channeling or paleochannels) may have reduced the thickness of the clay layer overlying the lower Patapsco aquifer (Hiortdahl, 1997). The extent

to which the confining layer has been eroded adjacent to the Indian Head-Bryans Road area is unknown.

HYDRAULIC PROPERTIES

Transmissivity is the measure of an aquifer's ability to transmit water. Transmissivity of the upper Patuxent aquifer, determined by constant-rate aquifer tests in two test wells drilled during this study, was 656 and 152 feet squared per day (ft^2/d) for wells CH Bd 52 and CH Cc 34, respectively. The recovering water level was plotted against the ratio of time since pumping started divided by time since pumping stopped (fig. 12). Transmissivity was calculated using a formula developed by Theis (1935) and Cooper and Jacob (1946). The wells were pumped at rates of 60 gallons per minute (gpm) in well CH Bd 52 and 50 gpm in well CH Cc 34, both for 8 hours. The calculated transmissivity values are probably lower than the actual transmissivity due in part to the short length of well screen (20 ft), partial penetration of the well screens in the aquifer, and incomplete well development. Transmissivity of the lower Patuxent aquifer was 51 ft^2/d in test well CH Bc 80 (fig. 12). This well was pumped at a rate of 35 gpm for 8 hours.

Transmissivity determined in eight additional wells screened in the upper Patuxent aquifer and three wells screened in both the upper and lower Patuxent aquifers within the model area ranged from 104 to 2,600 ft^2/d (tab. 2). These wells were not screened in all sands of the aquifers, so estimates of total transmissivity were made to account for partial penetration. First, the horizontal hydraulic conductivity of the sand layers screened was estimated by dividing the calculated transmissivity by the length of the well screen. The total sand thickness determined by geophysical and lithologic logs was then multiplied by the horizontal hydraulic conductivity. The estimated transmissivity for the total aquifer thickness ranged from 230 to 4,400 ft^2/d for the wells screened in the upper Patuxent aquifer. Transmissivity is greatest in the area between Bryans Road and Indian Head, as determined by aquifer tests on wells CH Bc 75 and 77 (Chapman's Landing wells 2 and 1, respectively). Transmissivity decreases to the north, south, and east of this area. A possible explanation for the localized area of high transmissivity may be the presence of stacked channel-sand deposits. The transmissivity of the upper Patuxent aquifer in the Indian Head area has not been tested; however, geophysical logs show less sand compared to the Chapman's Landing test site, indicating a lower transmissivity. The distribution of transmissivity values determined by aquifer tests for the upper Patuxent aquifer is shown in figure 13. Regional trends in transmissivity distribution across the model area can not be established given the scarcity of data points.

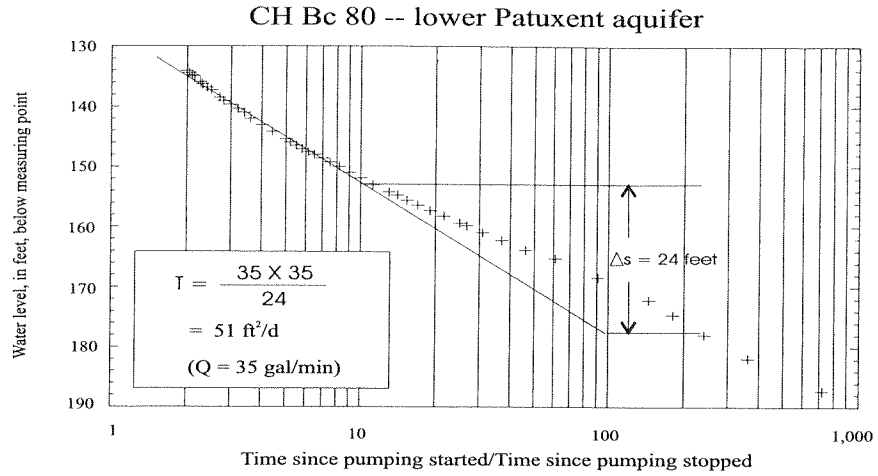
Storage coefficient is a measure of an aquifer's ability to release or take into storage water per unit change in hydraulic head. Storage coefficient of the upper and lower Patuxent aquifers were estimated from the barometric efficiency determined in the test wells using a formula described by Jacob (1940) (cited in Lohman, 1972, p. 9). The resulting storage coefficients for wells CH Bc 80, Bc 77, Bd 52, and Cc 34 were 3.4×10^{-5}, 1.1×10^{-4}, 9.2×10^{-5}, and 1.6×10^{-4}, respectively. The median value is 1.5×10^{-4}. Fleck and Vroblesky (1996) reported storage coefficients of the Patuxent aquifer from 1×10^{-5} to 1×10^{-3} with an average of 2.6×10^{-4}.

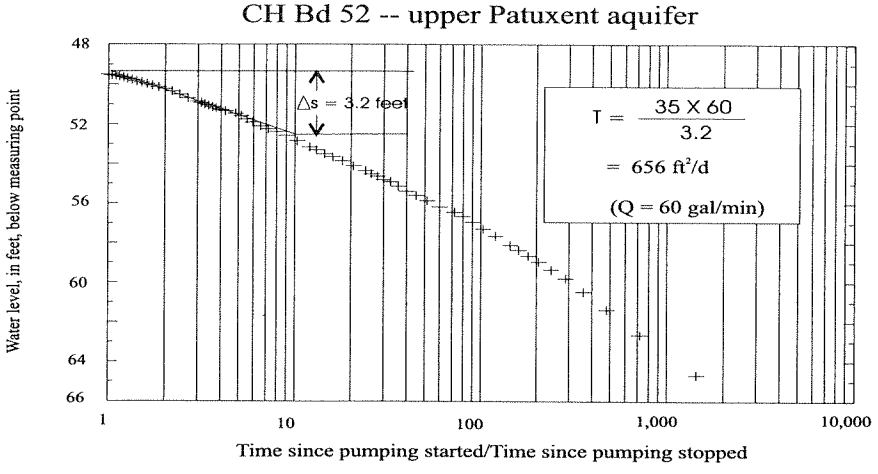
Transmissivity values of the lower Patapsco aquifer determined from aquifer tests range from approximately 190 to 3,500 ft^2/d within the model area (tab. 3). Transmissivity of the full aquifer estimated using the previously described method ranged from 250 to 5,600 ft^2/d. The distribution of transmissivity determined by aquifer tests of the lower Patapsco aquifer is shown in figure 14. In the vicinity of Waldorf and La Plata transmissivity ranges between 500 and 3,500 ft^2/d. In comparison, the transmissivity of the lower Patapsco aquifer is less than 1,200 ft^2/d in the Indian Head-Bryans Road area.

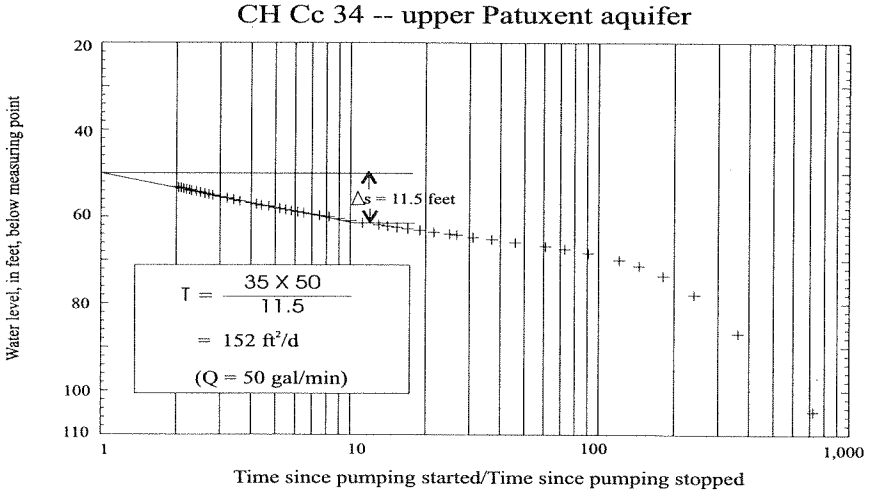
Storage coefficients of the lower Patapsco in southern Maryland are reported to range from 3×10^{-5} to 5×10^{-3} (Mack, 1962; Hansen, 1972; Fleck and Vroblesky, 1996). Slaughter and Otton (1968) reported storage coefficients ranging from 2×10^{-4} to 4×10^{-3} in the Indian Head area.

WATER LEVELS AND DIRECTION OF GROUND-WATER FLOW

The potentiometric surface of the lower Patapsco aquifer during the fall of 1997 is shown in figure 15. Also shown on the map are locations of wells or well fields pumping more than 10,000 gallons per day (gal/d) (annual average). The highest water level occurs in southern Prince George's County at 8 ft above sea level. The potentiometric surface decreases southward toward cones-of-depression centered around well fields in Waldorf and La Plata. The deepest water level, 169 ft below sea level, was measured at Waldorf. A shallower







$$T \text{ (transmissivity)} = \frac{35 \times Q}{\Delta s}$$, in feet squared per day (ft^2/d)

Q = pumping rate, in gallons per minute (gal/min)

△s = drawdown, in feet (ft) per log cycle

Figure 12. Calculation of transmissivity using the Jacob straight-line method for the upper Patuxent aquifer in test wells drilled during this study.

Table 2. Transmissivity data for the upper Patuxent aquifer in Charles County and southern Prince George's County, Maryland and Prince William County, Virginia

[ft = feet; ft/d = feet per day; ft^2/d = feet squared per day]

Well number	Cumulative screen length, (ft)	Total aquifer thickness, (ft)	Horizontal hydraulic conductivity, (ft/d)	Transmissivity, (ft^2/d)	
				Aquifer test analyses	Estimated using total aquifer thickness
[1]Quantico well 2	42	42	--	520	[2]520
[1]Quantico well 4	26	26	--	440	[2]440
CH Bc 75	50	85	52	2,600	4,400
CH Bc 77	30	68	61	1,830	4,100
CH Bc 78	90	75	--	937	[2]937
[3]CH Bc 80	20	40	2	51	80
CH Bd 52	20	65	33	656	2,100
CH Cc 34	20	64	8	152	510
CH Ce 57	60	117	2	104	230
CH Da 18	20	20	--	637	[2]637
[1]PG Eb 2	30	30	--	900	[2]900
[4]PG Ec 41	20	30	70	1,400	2,100
PG Ec 46	20	approx. 30	25	500	750
PG Fd 59	30	approx. 80	4	113	320

[1]Well is screened in both the upper and lower sands of the Patuxent aquifer
[2]Entire aquifer was screened
[3]Well is screened in the lower Patuxent aquifer
[4]Test on well screen set in the upper Patuxent aquifer

cone-of-depression occurs in the vicinity of the Potomac Electric Power Company's (PEPCO) Morgantown Power Plant located in the southern part of Charles County. The highest concentrated pumpage in the Indian Head-Bryans Road area, (0.86 Mgal/d in 1997), is located on the Indian Head peninsula at the U.S. Naval Surface Warfare Center; however, less drawdown (higher water levels) occurs in this area than in other parts of the study area where the pumpage is lower. This is likely the result of a combination of higher transmissivity in this area and a possible interconnection with the Potomac River through channels eroded into the aquifer. A hydraulic interconnection between the aquifer and the Potomac River would result in a recharge boundary, thereby stabilizing water levels.

Current heads in the lower Patapsco aquifer have declined significantly from estimated pre-stressed levels. All pre-stressed heads in the lower Patapsco aquifer had to be equal to or greater than sea level. In an unstressed Coastal Plain aquifer, all heads must be equal to or greater than the altitude of the lowest discharge boundary (ocean or bay at sea-level altitude). Compared to prepumping conditions, heads in the lower Patapsco aquifer have declined by as much as 170 ft at Waldorf and 40 to 105 ft in the Indian Head-Bryans Road area.

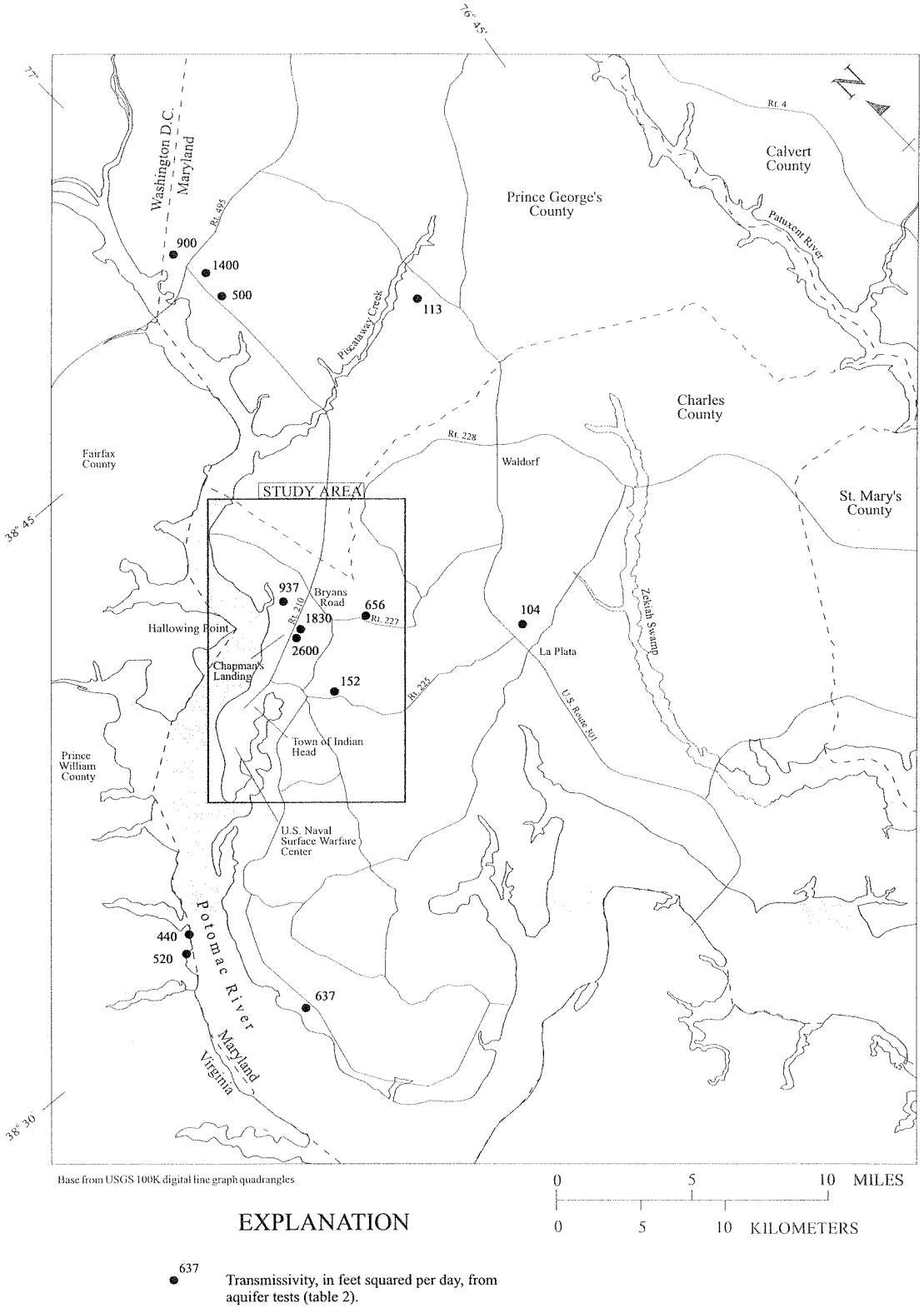


Figure 13. Transmissivity distribution of the upper Patuxent aquifer in Charles County and southern Prince George's County.

Table 3. Transmissivity data for the lower Patapsco aquifer in Charles County and southern Prince George's County

[ft = feet; ft/d = feet per day; ft^2/d = feet squared per day]

Well number	Cumulative screen length, (ft)	Total aquifer thickness, (ft)	Horizontal hydraulic conductivity, (ft/d)	Transmissivity, (ft^2/d)	
				Aquifer test analyses	Estimated using total aquifer thickness
CH Bc 6	50	approx. 110	14	700	1,500
CH Bc 70	50	65	3.8	190	250
CH Bc 72	63	75	7.6	480	570
CH Bc 74	36	approx. 44	24	850	1,100
CH Bc 76	65			1,130	[1]1,130
CH Bd 46	45	80	9	400	700
CH Be 58	151			1,730	[1]1,730
CH Be 64	95	103	12	1,100	1,240
CH Be 66	104	120	20	2,080	2,400
CH Be 67	192			1,650	[1]1,650
CH Bf 147	169			1,000	[1]1,000
CH Bf 150	140			3,000	[1]3,000
CH Ce 43	95	95	37	3,500	3,500
CH Ce 51	90	100	6	500	600
CH Ce 56	125			1,076	[1]1,076
CH Da 19	50	80	44	2,228	3,500
CH Ee 91	55	75	12	633	900
CH Ff 60	84	107	26	2,227	2,800
PG Eb 20	60			1,600	[1]1,600
PG Fc 31	14	approx. 90	62	870	5,600
PG Hf 31	52	90	21	1,085	1,900

[1]Entire aquifer was screened

The general direction of horizontal ground-water flow in the lower Patapsco aquifer is indicated on figure 15. The primary direction of flow is from the north and west toward well fields at Indian Head, Bryans Road, Waldorf, La Plata, and Morgantown. Water entering from the recharge area (located within the aquifer outcrop area) in Virginia and Washington, D.C. flows downdip and is captured by the pumping wells. Part of the ground-water flow bypasses the pumping wells and continues in a downdip direction towards the southeast.

In contrast to water levels in the lower Patapsco aquifer, water levels in the upper Patuxent aquifer are much higher. Water levels in the upper Patuxent aquifer measured in observation wells during the fall of 1997

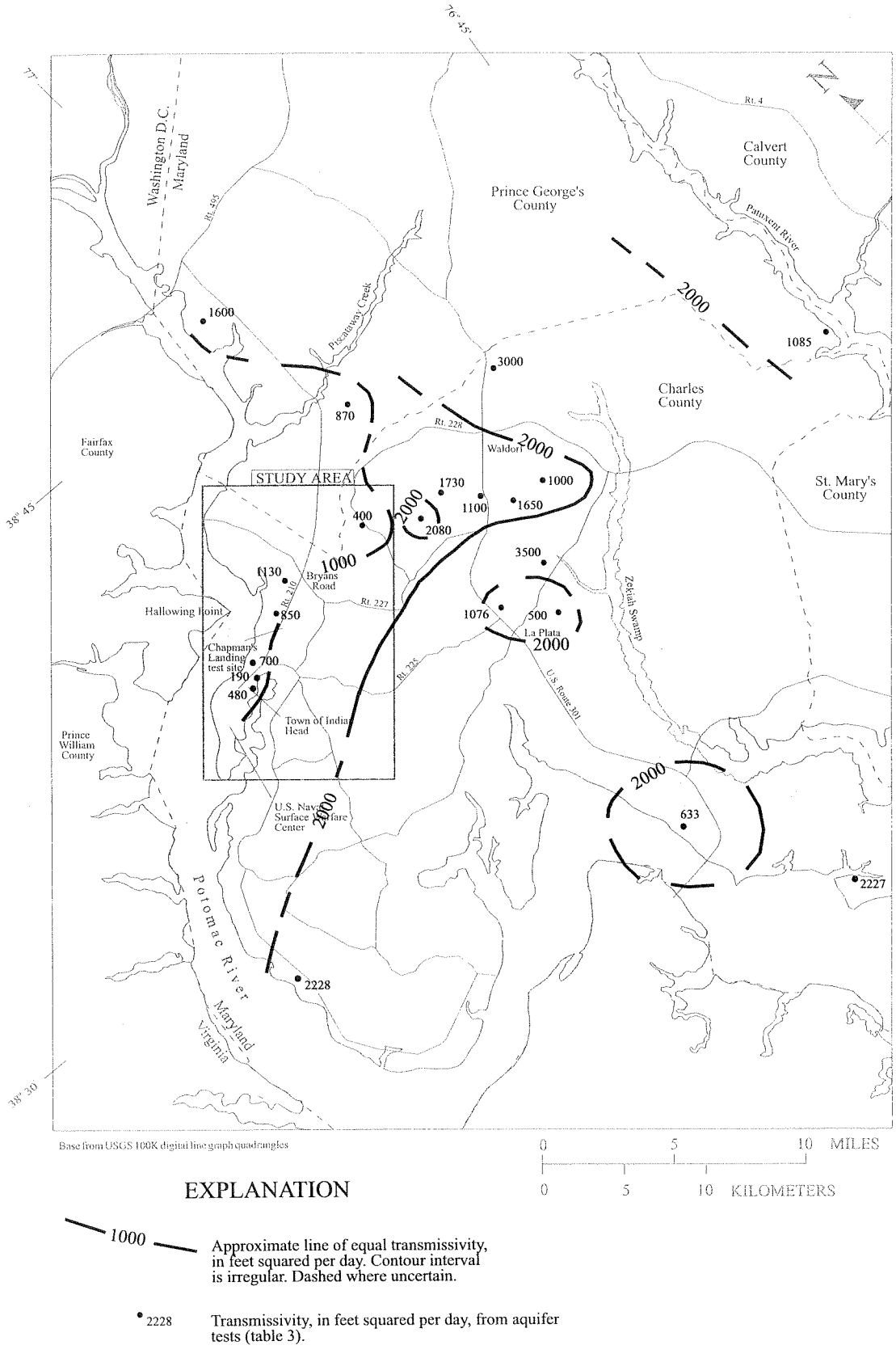


Figure 14. Transmissivity distribution of the lower Patapsco aquifer in Charles County and southern Prince George's County.

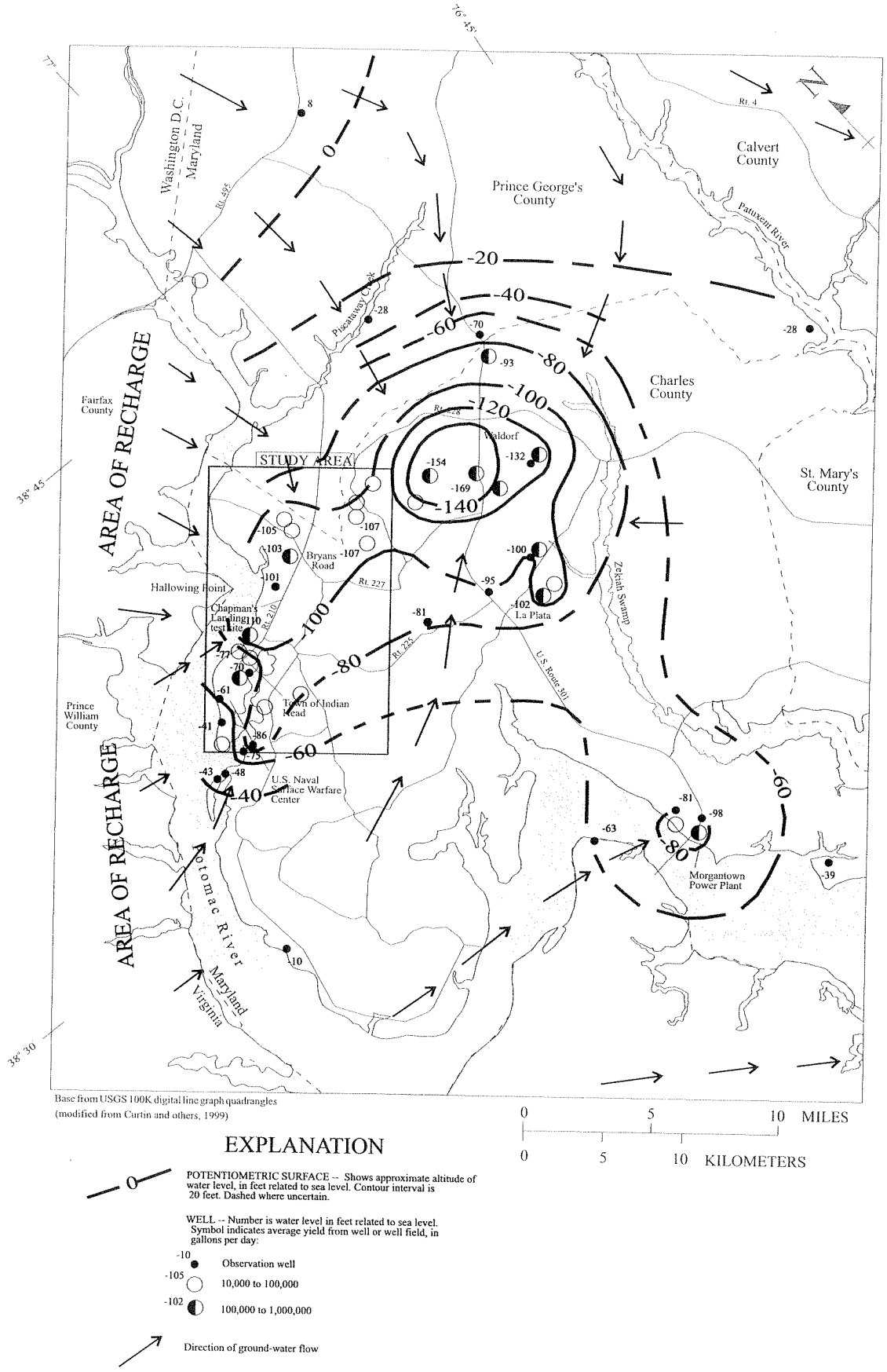


Figure 15. Potentiometric surface of the lower Patapsco aquifer in Charles County and southern Prince George's County during the fall, 1997.

ranged from 8 ft below sea level to 8 ft above sea level (fig. 16). Water levels within the study area are affected by pumping from a production well screened in the upper Patuxent aquifer at South Hampton (CH Bc 78). Prior to the start of pumping at South Hampton in March 1997, water levels measured in the upper Patuxent aquifer were above sea level with the exception of CH Da 18 at Douglas Point and CH Cc 34 at the Mattawoman Waste-Water Treatment Plant. The deeper water levels at those sites may be attributed to leakage upwards to the lower Patapsco aquifer.

EFFECTS OF PUMPAGE ON WATER LEVELS

Regulatory guidelines established by the Maryland Department of the Environment prohibit drawdowns resulting from pumpage to exceed the 80-percent management water level (fig. 3). In the Indian Head-Bryans Road area, the amount of remaining available drawdown under prepumping conditions ranged from 90 to 300 ft for the lower Patapsco aquifer and 350 to 650 ft for the upper Patuxent aquifer. Pumping from the lower Patapsco aquifer has significantly reduced the amount of remaining available drawdown within the study area. The remaining drawdown available in the lower Patapsco aquifer in 1997 ranged from 0 to 200 ft (0 to 60 percent) in the Indian Head-Bryans Road area and 30 to 400 ft (30 to 70 percent) elsewhere in the study area (fig. 17). The 80-percent management level was reached in a small area along the Potomac River shoreline in the central part of the Indian Head peninsula. Less drawdown is available in updip (northwest) areas of the aquifer because the top of the aquifer is relatively shallow. In the vicinity of Waldorf and La Plata, the percentage of available drawdown remaining in the lower Patapsco aquifer ranges from 60 to 70 percent (460 to 700 ft).

The percentage of available drawdown remaining in the upper Patuxent aquifer in 1997 is only slightly less than its original amount because of the small amount of water currently being pumped. Available drawdown remaining in 1997 ranged from 350 to 700 ft in the Indian Head-Bryans Road area (fig. 17).

Long-term water-level data indicate that lower Patapsco water levels have stabilized or recovered slightly at the U.S. Naval Surface Warfare Center (Curtin and Dine, 1995). This is related to a pumpage decrease of approximately 0.5 Mgal/d at the U.S. Naval Surface Warfare Center between 1985 and 1997 (Appendix F). Water levels northeast of Indian Head continue to decline at a rate of approximately 2 to 3 feet per year (ft/yr) as a result of the expanding cone-of-depression centered in the Waldorf area and from increased pumping at the Town of Indian Head and in the Bryans Road area. Pumpage at the Town of Indian Head and in the Bryans Road well field has increased by approximately 0.08 Mgal/d between 1985 and 1997, and 0.04 Mgal/d between 1985 and 1996, respectively. Lower Patapsco pumpage in the Bryans Road well field decreased in 1997 when the upper Patuxent well (CH Bc 78 at South Hampton) began pumping.

Water levels in the upper Patuxent aquifer in two wells, CH Be 57 (Smallwood West near Waldorf) and CH Da 18 (Douglas Point), have been declining at a rate of approximately 1 ft/yr since about 1986 (fig. 18). The downward trend parallels that of water levels in the lower Patapsco in two other wells, CH Da 20 (Douglas Point) and CH Ce 37 (La Plata), which have declined as a result of the increased use of that aquifer in Charles County. The correlation between the water-level trends in the lower Patapsco aquifer and the upper Patuxent aquifer suggests that the two aquifers are hydraulically connected in these areas through relatively thin or sandy sections in the intervening Arundel Clay. This interconnection is probably limited areally, given the general continuity of the Arundel Clay throughout most of Charles County (figs. 4, 5, 6; pl. 2). Appreciable leakage through the confining bed itself is unlikely because in most well borings the Arundel Clay has the characteristics of a thick (100 to 300 ft), dense, impermeable clay bed. Pumpage in the upper Patuxent aquifer probably is not the cause of the declining heads in these wells because the closest significant withdrawals occur at a substantial distance from the observation wells. The City of Bowie in Prince George's County pumped an average of approximately 1 Mgal/d in 1995 from the Patuxent aquifer. This well field is approximately 25 mi north of Charles County. There is no known major pumpage from the Patuxent aquifer adjacent to Charles County in Virginia.

Leakage upward from the upper Patuxent aquifer to the lower Patapsco aquifer may also be occurring in the vicinity of the test well at the Mattawoman Waste-Water Treatment Plant. Water levels measured in that well are deeper relative to the upper Patuxent aquifer water levels measured in other wells within the study area. Also, the Arundel Clay is thinner (55 ft) at that site.

A 5-day aquifer test of the upper Patuxent aquifer was conducted to (1) determine the lateral hydraulic connection between sands within the upper Patuxent

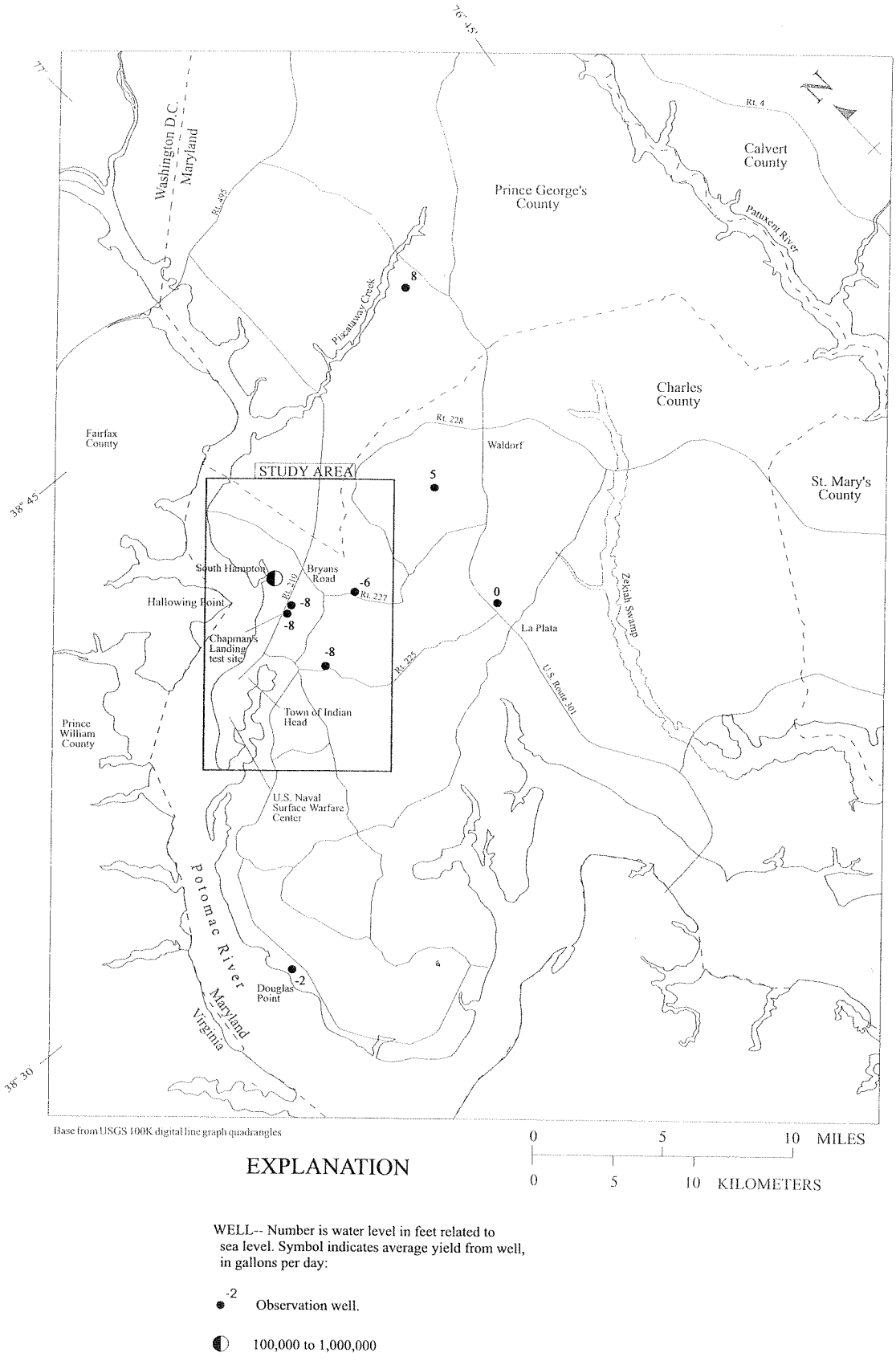


Figure 16. Potentiometric surface of the upper Patuxent aquifer in Charles County and southern Prince George's County during the fall, 1997.

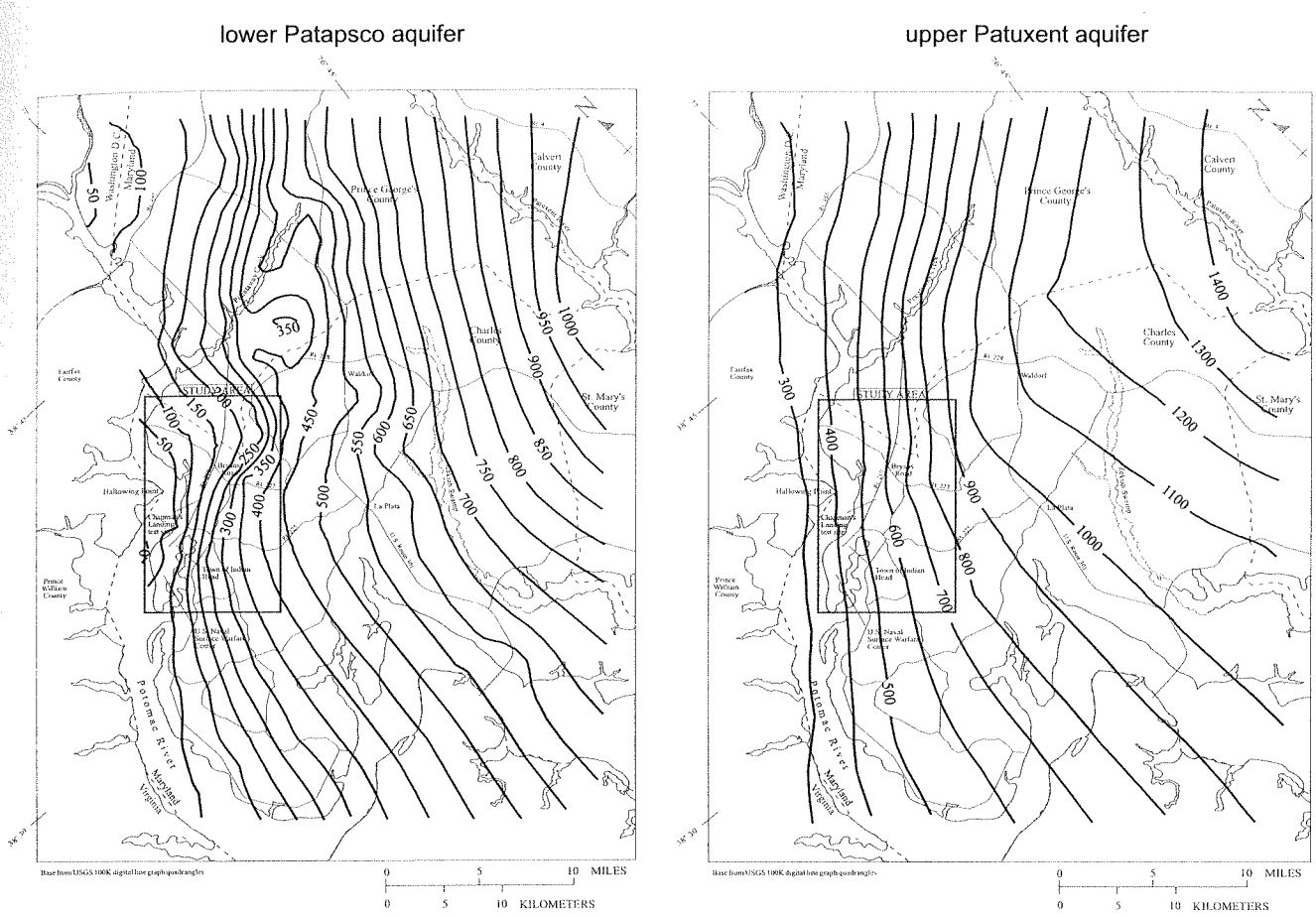


Figure 17. Remaining available drawdown in the lower Patapsco and upper Patuxent aquifers in 1997.

aquifer, (2) determine if pumping from the upper Patuxent aquifer would have short term effects on water levels in the lower Patapsco aquifer, and (3) determine the presence of flow boundaries within the upper Patuxent aquifer. During the test, well CH Bc 75 (Chapman's Landing well 2), screened in the upper Patuxent aquifer, was pumped continuously at a rate of 500 gpm for 5 days (November 19-24, 1996). During and after the test, water levels were observed in wells screened in the upper Patuxent aquifer (wells CH Bc 77, 78, Bd 52, Cc 34, and Da 18) (fig. 19). Water levels were observed in lower Patapsco wells at Montrose Farms (CH Bc 81), Laurel Drive (CH Bc 79, located approximately 0.5 mi northwest of CH Bc 75), Potomac Heights (CH Bc 24), and in a public-supply well at Hallowing Point, Virginia (Hallowing Point well 1A). Although the deepest screen in the Hallowing Point well may be set within the Patuxent aquifer, it was isolated

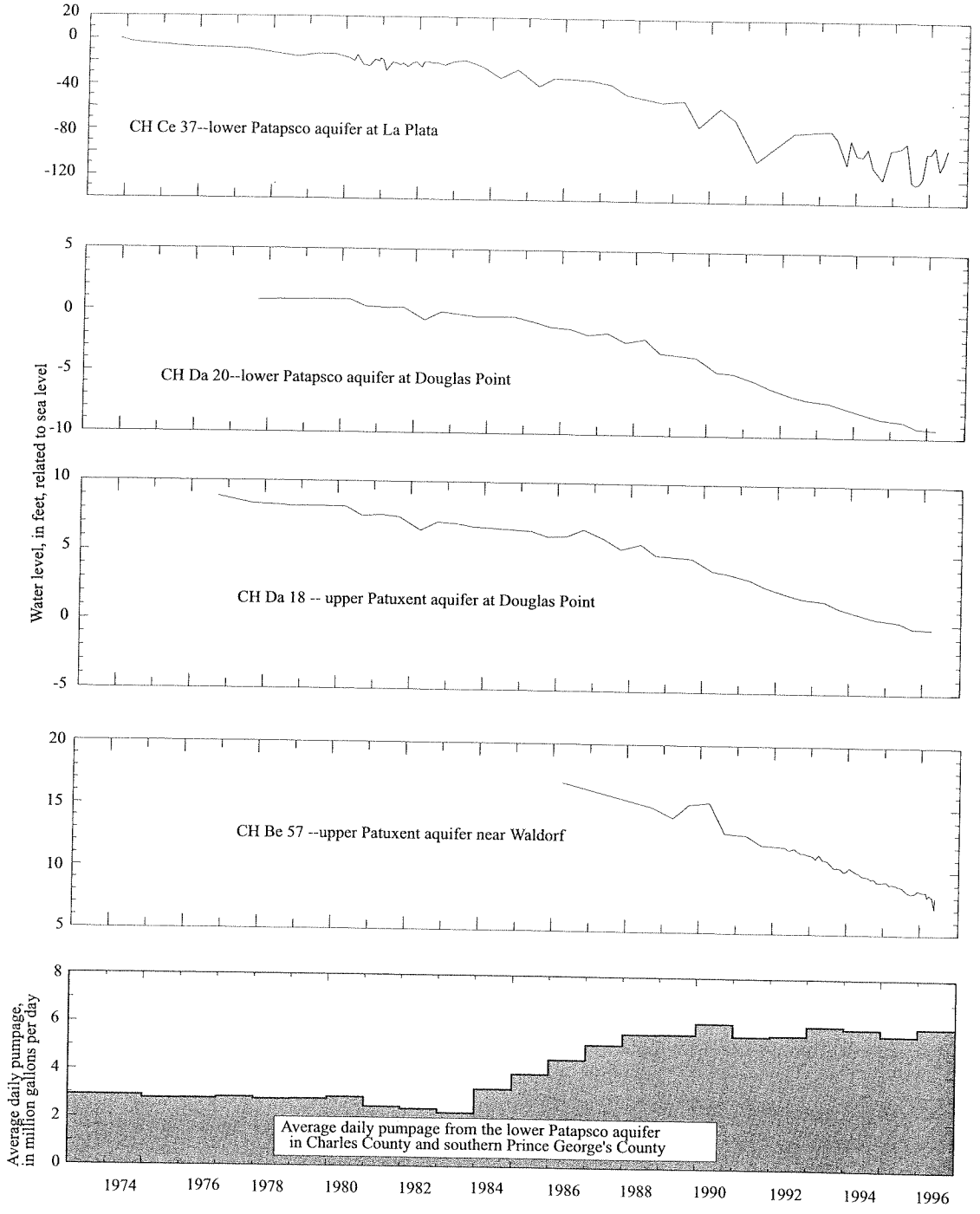
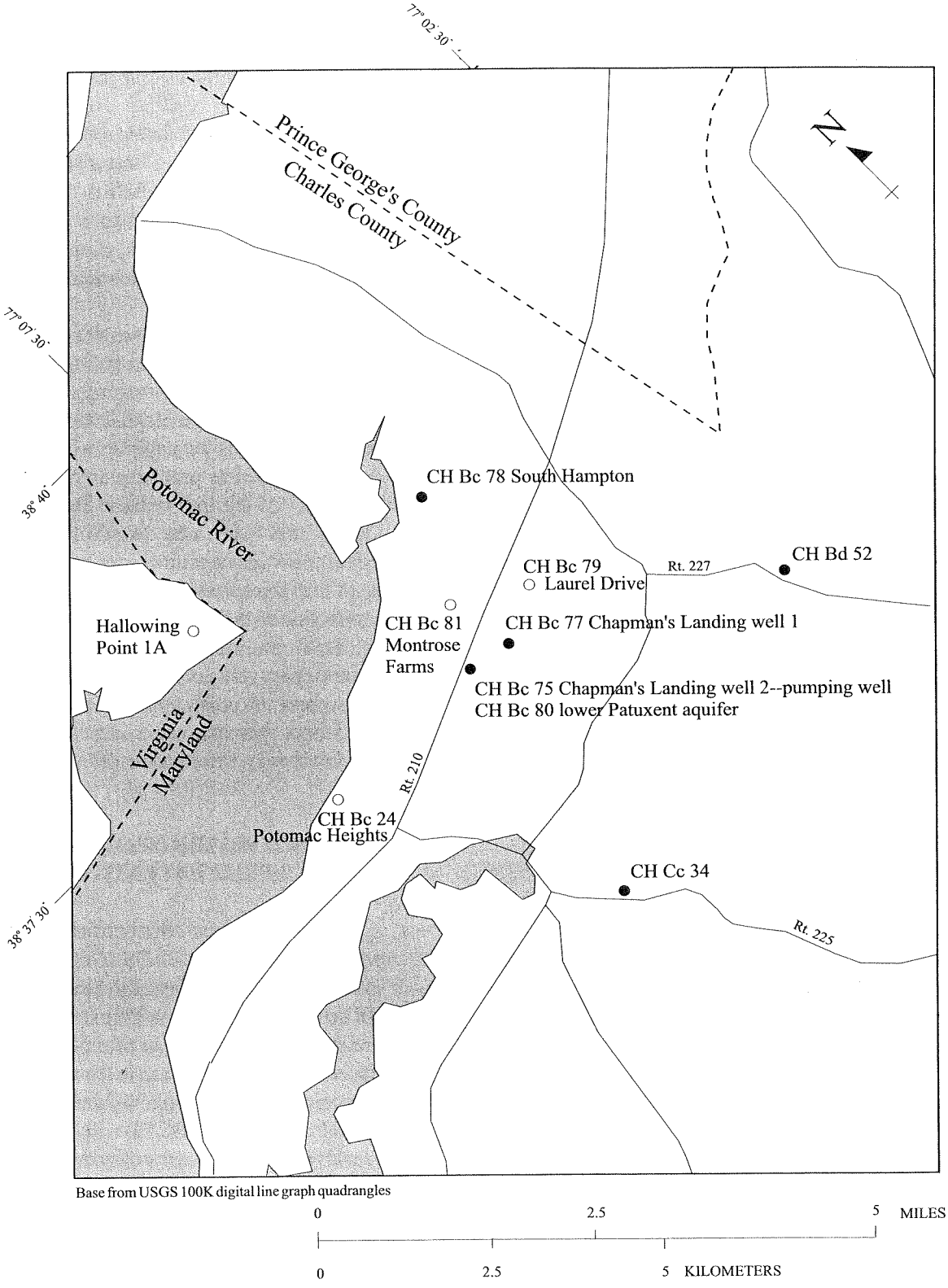


Figure 18. Water levels in the upper Patuxent and lower Patapsco aquifers related to pumpage in the lower Patapsco aquifer in Charles County and southern Prince George's County.



EXPLANATION

CH Bc 81

○ Well screened in the lower Patapsco aquifer. Number next to symbol is the well number.

● Well screened in the upper Patuxent aquifer.

Figure 19. Location of wells monitored during a 5-day aquifer test of well CH Bc 75 (Chapman's Landing well 2).

from the upper screens by a packer. Of the few other wells inventoried in adjacent areas of Virginia, all had well screen positions above the Patuxent aquifer.

The results of the testing showed hydraulic continuity between sands in the upper Patuxent aquifer in the study area (fig. 20). All of the wells screened in the upper Patuxent aquifer showed some decline in head as a result of the pumping. The water level in the pumping well (CH Bc 75) at the end of the 5-day period was approximately 80 ft below sea level. Drawdown ranged from approximately 80 ft at the pumping well to less than 1 ft at test wells CH Bd 52 and CH Cc 34, located about 2.5 mi to the southeast and south, respectively. Water levels generally recovered slowly after the pumping stopped; however, in test wells CH Bd 52 and CH Cc 34, there was no appreciable recovery 6 weeks after the test ended. The water level in test well CH Bc 80, screened in the lower Patuxent aquifer and located 56 ft from the pumping well, declined approximately 1 ft, indicating that the upper and lower Patuxent aquifers are hydraulically connected. The effect of pumping on water levels in the Patuxent aquifer across the Potomac River in Virginia could not be determined.

Water levels observed in the lower Patapsco aquifer were not affected by the pumping. This indicates that the Arundel Clay is, at least in the short term, an effective confining bed.

The first continuous withdrawal of water for public supply in the study area from the upper Patuxent aquifer occurred at South Hampton (CH Bc 78) in March 1997. The effect of this pumping on water levels within the study area is shown in figure 21. During the period March 1997 though February 1998, the well at South Hampton pumped an average of 0.094 Mgal/d. As a result, water levels in wells screened in the upper Patuxent aquifer within the study area declined 4.5 to 8 ft. Prepumping water levels were generally about at sea level, and pumping levels were as deep as 8.5 ft below sea level. Water-levels declined less in wells screened in the upper Patuxent aquifer outside the study area. The water level in well CH Be 57 (Smallwood West), located approximately 7.5 mi. from South Hampton, declined 1.5 ft. Water-level declines at more distant observation wells CH Ce 57 and CH Da 18 (9.5 and 15 mi from South Hampton, respectively) were less than 1 ft. During September and October, when pumpage at South Hampton was held constant at 0.15 Mgal/d, water levels began to flatten out or reach equilibrium with respect to pumpage. During November, when the well at South Hampton was turned off, water levels recovered in well CH Bc 77, but showed little recovery in the other wells.

During the same period (March 1997 to February 1998), water levels in the lower Patapsco aquifer observed at Montrose Farms 1.3 mi. from South Hampton did not respond to upper Patuxent aquifer pumpage. The water levels did, however, respond to pumpage from the lower Patapsco aquifer at the Bryans Road well field (fig. 21).

To summarize, pumpage in the lower Patapsco aquifer has reduced the remaining available drawdown from 90 to 300 ft under prepumping conditions to 0 to 200 ft in 1997 in the Indian Head-Bryans Road area. In contrast, the remaining available drawdown in the upper Patuxent aquifer is near prepumping conditions, 350 to 700 ft in 1997 in the Indian Head-Bryans Road area. Outside the study area near Waldorf and at Douglas Point, slow leakage upwards from the upper Patuxent aquifer to the lower Patapsco aquifer has caused water levels to decline slightly over time in the upper Patuxent aquifer. In the study area, short-term pumpage effects do not propagate across the confining layer (Arundel Clay) separating the upper Patuxent and lower Patuxent aquifers. Upper Patuxent water levels in the study area recover slowly with the cessation of pumping.

GROUND-WATER-FLOW BARRIER IN THE UPPER PATUXENT AQUIFER

A ground-water-flow barrier was detected during aquifer tests of wells CH Bc 75 (Chapman's Landing well 2) and CH Bc 78 (South Hampton well 2), which are both screened in the upper Patuxent aquifer. Water levels related to the logarithm of time (since pumping started) show a distinct increase in the rate of drawdown after approximately 1,000 and 200 minutes of pumping in wells CH Bc 75 and Ch Bc 78, respectively (fig. 22). Water levels that plot above the drawdown curve in well CH Bc 75 shortly after 1,000 minutes were caused by two brief intervals during which the pump stopped. The increased rate of drawdown occurs when the expanding cone-of-depression developed around the pumping wells reach an impervious boundary (Heath, 1987).

The barrier effect could be caused by a pinchout (updip thinning) of the aquifer, or a vertical offset in the aquifer caused by faulting. Sands of the Patuxent Formation were deposited in a shifting, fluvial-deltaic environment which typically produces laterally discontinuous (lensoidal) deposits. This type of deposit contains pinchouts that disrupt the lateral hydraulic

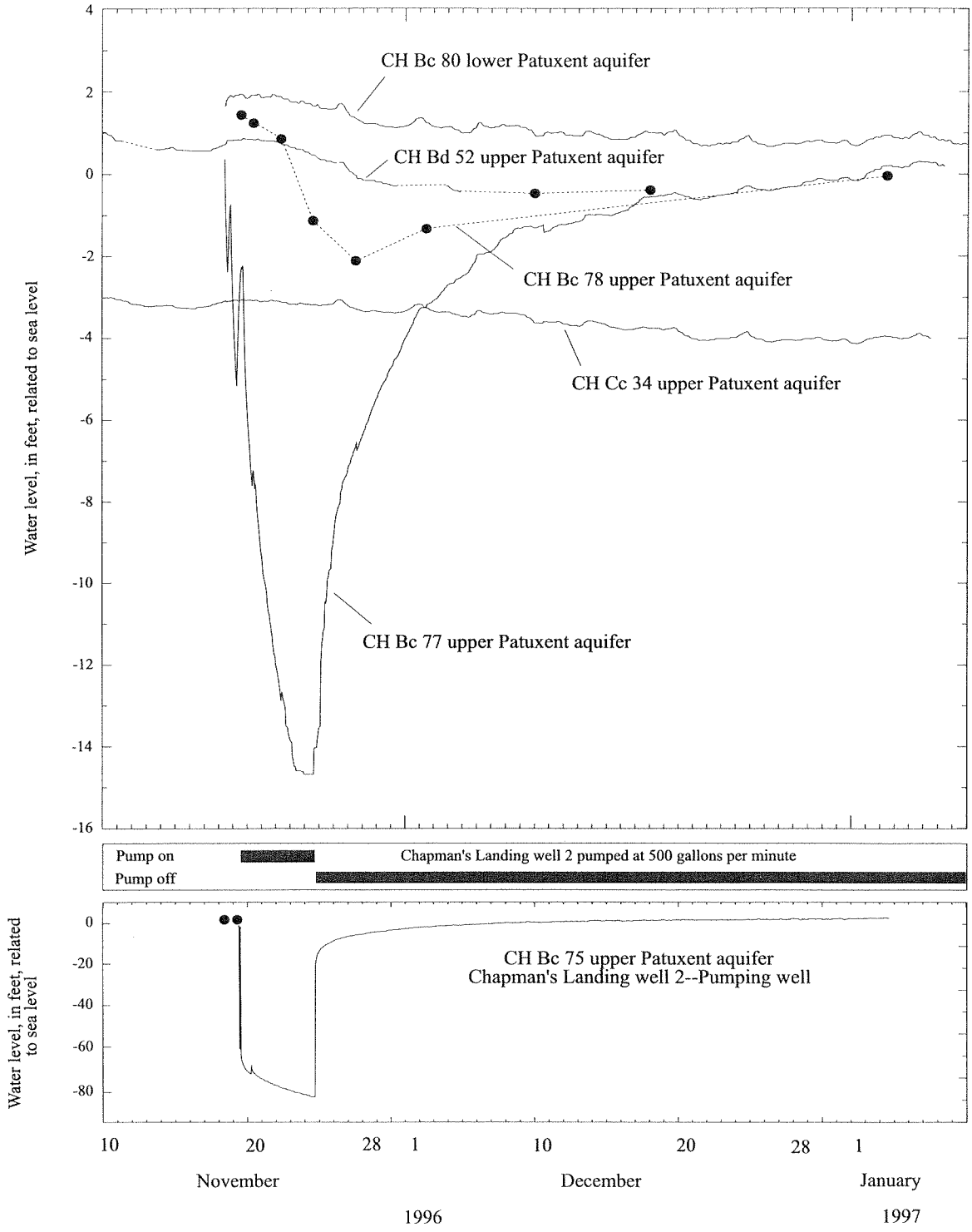


Figure 20. Water-level fluctuations in the upper and lower Patuxent aquifers during a 5-day aquifer test conducted November 19-24, 1996 on the upper Patuxent aquifer in well CH Bc 75 (Chapman's Landing well 2).

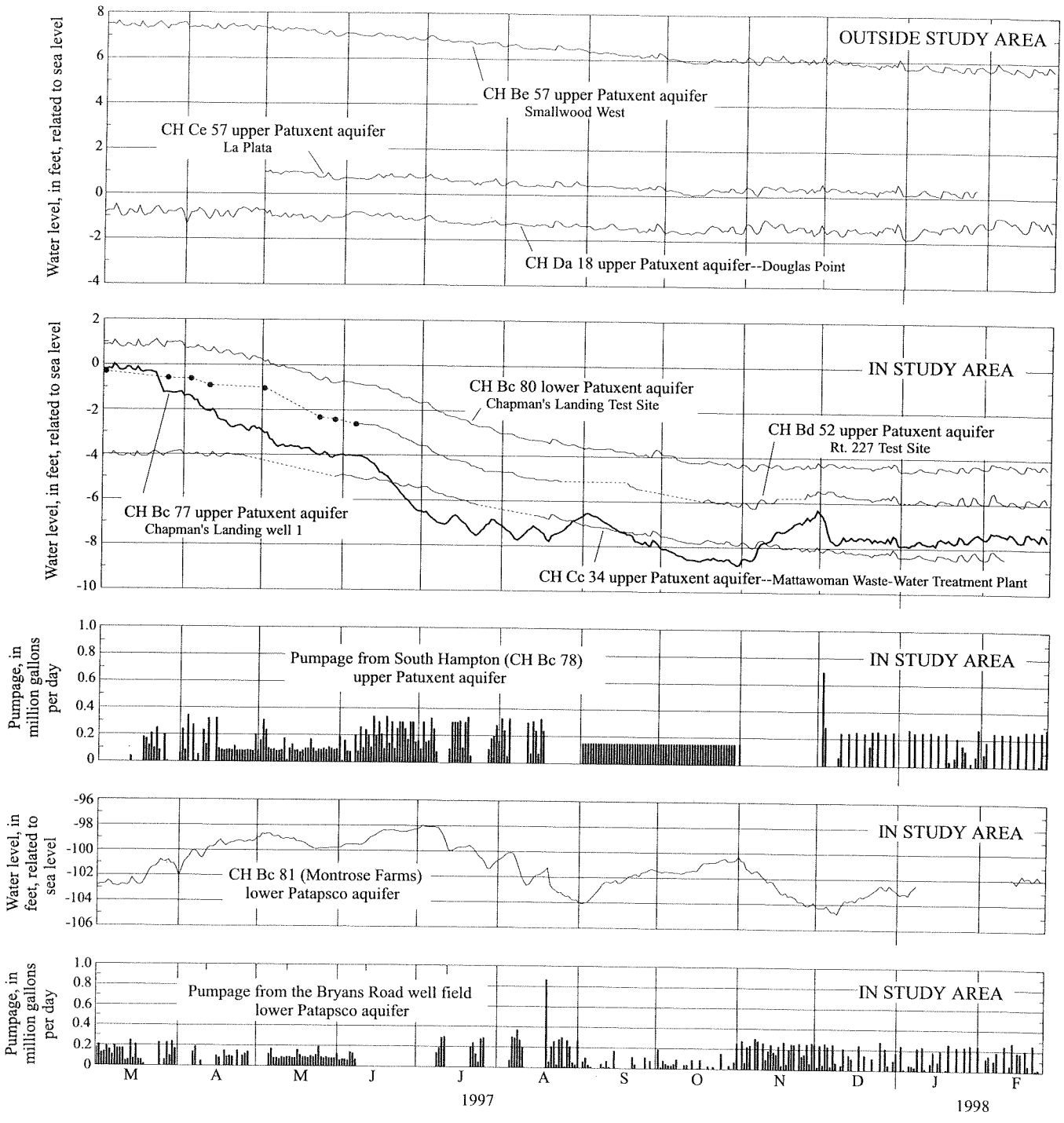
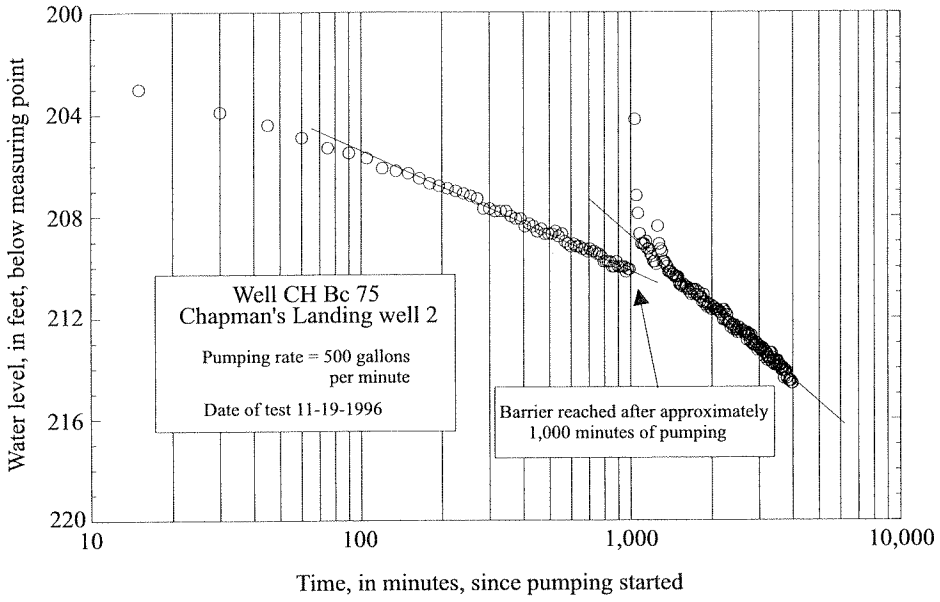


Figure 21. Water-level fluctuations in the upper and lower Patuxent and lower Patapsco aquifers related to upper Patuxent pumpage at South Hampton and lower Patapsco pumpage at Bryans Road.



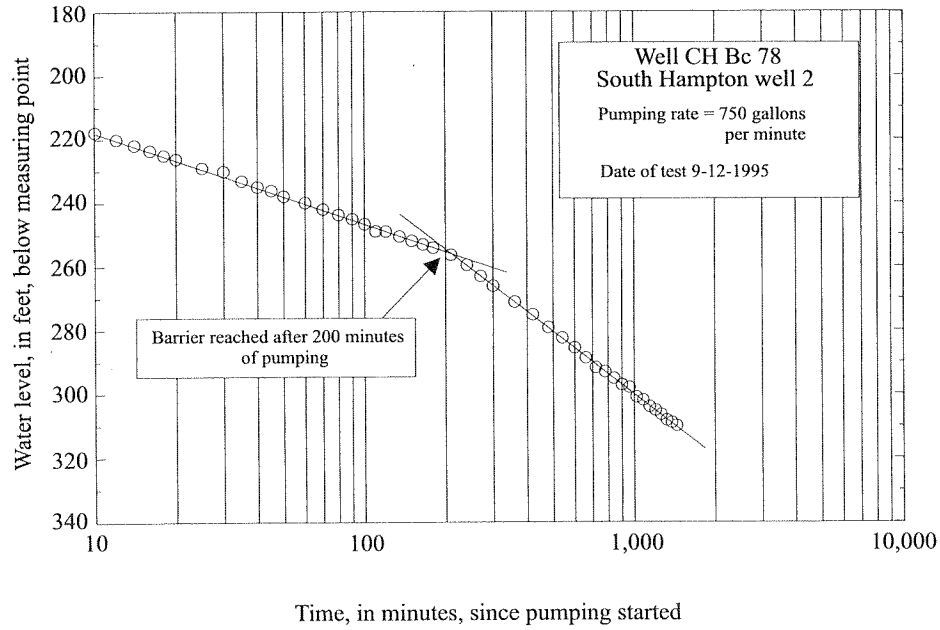


Figure 22. Semi-log plots of drawdown in wells CH Bc 75 and CH Bc 78 showing ground-water-flow barrier.

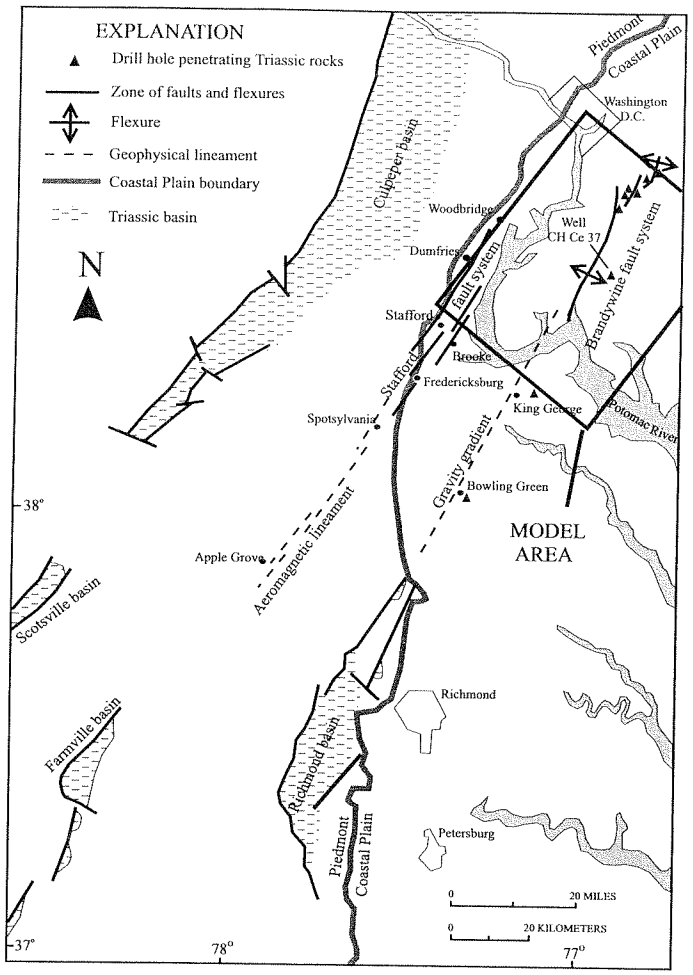


Figure 23. Alignment of the Stafford and Brandywine fault systems proposed by Mixon and Newell (1977).

continuity of the aquifer. Faults can also disrupt lateral hydraulic continuity by vertically displacing sand layers. The occurrence of faults in the underlying basement rock has been documented by previous investigators. Using seismic data, Jacobeen (1972) described a series of *en echelon*[2], high-angle reverse faults (Brandywine fault system) in southern Prince George's County. Wilson and Fleck (1990) presented evidence of the continuation of that fault system southward toward Waldorf, and described the geohydrologic implications of the faulting in Charles County. A series of *en echelon*, northeast-striking, northwest-dipping, high-angle reverse faults (Stafford fault system) was mapped southwest of the study area in Virginia by Mixon and Newell (1977) and Mixon and others (1988) (fig. 23). The Stafford fault system parallels the northeast-trending reach of the Potomac River and may extend into the project area. The displacement across the faults in Virginia attains a maximum of 200 ft and decreases upward through the Potomac Group sediments (Mixon and Newell, 1977).

The location of the barrier indicated by the aquifer-test data could not be determined without additional observation wells. Also, subsurface lithologic control is insufficient to identify and map the barrier. The estimated location of the barrier is probably updip from South Hampton and the Chapman's Landing test site based on the following observations: (1) As previously discussed, the upper Patuxent aquifer is hydraulically

[2]Faults having overlapping or staggered alignments.

continuous within the study area and eastward to the Waldorf, La Plata, and Douglas Point areas. The hydraulic connection with sands of the upper Patuxent aquifer updip in Virginia, however, has not been determined; (2) this location coincides with the trend of the Stafford fault system; and (3) the Coastal Plain sediments updip from the well sites in Charles County thin considerably toward the Fall Line in Virginia. Flow barriers in the upper Patuxent aquifer could reduce its productivity, at least locally, by restricting the amount of lateral ground-water flow.

WATER QUALITY OF THE UPPER AND LOWER PATUXENT AQUIFERS

Chemical analyses were conducted on water from wells screened in the lower Patuxent aquifer (CH Bc 80), and upper Patuxent aquifer (CH Bc 75, CH Bd 52, and CH Cc 34). Results indicate that the water from both aquifers is a sodium bicarbonate type of good quality. Table 4 lists the constituents analyzed. All reporting levels for dissolved constituents are within the recommended limits set by the U.S. Environmental Protection Agency (1986). Dissolved solids, pH (field), and specific conductance (laboratory) range from 214 to 378 milligrams per liter (mg/L), 7.7 to 7.9, and 322 to 627 microsiemens per centimeter (μS/cm), respectively. Fluoride concentrations range between 0.8 to 1.3 mg/L, which provide natural fluoridation (Kula and Hansen, 1989). Dissolved iron concentrations range from 17 to 100 micrograms per liter (μg/L). The lowest value for iron (17 μg/L) is from CH Bc 75 and the highest value (100 μg/L) is from CH Cc 34. Dissolved chloride, ranging from 16 to 43 mg/L, exceeds the typical background concentrations found in overlying, confined aquifers. For example, Chapelle and Drummond (1983) and Wilson and Fleck (1990) reported that the concentration of naturally occurring chloride in the Aquia, Magothy, and Patapsco aquifers is less than 4 mg/L in southern Maryland.

GROUND-WATER USE

Stress on the Magothy and upper Patapsco aquifers caused by the water demands of a growing population in the northern and central parts of Charles County has resulted in increased use of the deeper lower Patapsco aquifer, particularly in the vicinity of Waldorf. Ground-water use for large users (average pumpage greater than 10,000 gal/d) from the lower Patapsco aquifer in the model area increased from less than 0.5 Mgal/d prior to 1920 to 2.9 Mgal/d in 1975 (Appendixes E and F). In 1997, the amount withdrawn from the lower Patapsco in the model area equaled 5.5 Mgal/d (Appendix D, Part I). The majority of this pumpage (2.6 Mgal/d) occurred in the Waldorf area (fig. 24).

Ground-water use for large users (average pumpage greater than 10,000 gal/d) from the lower Patapsco aquifer in the Indian Head-Bryans Road area increased from less than 0.5 Mgal/d prior to 1920 to 1.8 Mgal/d in 1975 (Appendixes E and F). In 1997, the amount withdrawn from the lower Patapsco in the Indian Head-Bryans Road area equaled 1.6 Mgal/d (Appendix D). The decline in pumpage between 1975 and 1997 is attributed mainly to a decrease in pumpage at the U.S. Naval Surface Warfare Center.

Individual, residential wells screened in the lower Patapsco aquifer within the study area pumped an estimated 0.16 Mgal/d; the majority of the residential wells in the study area occur outside of the Indian Head-Bryans Road area which is serviced almost exclusively by public-supply wells. This figure is based on approximately 550 wells pumping an average of 300 gal/d. The well count was made by comparing well depths for wells completed between 1970 and 1992 to the altitude of the lower Patapsco aquifer (Maryland Department of the Environment, per. commun., 1998). The majority of residential pumpage from the lower Patapsco aquifer is in the area north of the Indian Head-Bryans Road area. South of the Indian Head-Bryans Road area, most residential wells are screened in the upper Patapsco aquifer.

The largest ground-water users in 1997 in the Indian Head-Bryans Road area were the U.S. Naval Surface Warfare Center and the Town of Indian Head, which pumped approximately 0.9 and 0.3 Mgal/d, respectively, from the lower Patapsco aquifer. Included in this amount are production wells CH Bc 67 (Town of Indian Head well 3) and CH Cb 35 (U.S. Naval Surface Warfare Center well 16A) that withdrew 0.12 Mgal/d from a sandy zone considered to be part of the Arundel Clay.

The only ground-water appropriation permits issued for the upper Patuxent aquifer in the study area are for a well at South Hampton operated by the Charles County Department of Facilities (Maryland Department of the Environment Ground-Water

Table 4. Chemical analyses of water from the upper and lower Patuxent aquifers sampled in test wells CH Bc 80, Bd 52, and Cc 34, and production well CH Bc 75

[mg/L = milligrams per liter; µg/L = micrograms per liter; µS/cm = microsiemens per centimeter at 25°C; deg. C = degrees Centigrade]

Well number	Aquifer	Alkalinity, laboratory (mg/L as $CaCO_3$)	Bromide, dissolved (mg/L)	Calcium, dissolved (mg/L)	Chloride, dissolved (mg/L)	Fluoride, dissolved (mg/L)	Iron, dissolved (µg/L)	Iron, total (µg/L)
CH Bc 75	upper Patuxent	129	--	0.47	16	0.90	17	30
CH Bc 80	lower Patuxent	252	0.16	.48	43	.90	48	580
CH Bd 52	upper Patuxent	192	.10	.83	20	.80	80	250
CH Cc 34	upper Patuxent	151	.090	.29	21	1.3	100	--

Well number	Magnesium, dissolved (mg/L)	Manganese, dissolved (µg/L)	Manganese, total (µg/L)	Nitrogen, NO_2 + NO^3 total (mg/L)	pH, field	pH, laboratory	Potassium, dissolved (mg/L)	Phosphorus, total (mg/L)
CH Bc 75	0.08	2	10	--	7.9	8.2	1.8	2
CH Bc 80	.23	8	20	--	7.8	8.2	3.3	--
CH Bd 52	.15	9	10	--	7.7	8.0	2.4	--
CH Cc 34	.11	13	--	0.090	7.8	8.0	2.5	1.30

Well number	Silica, dissolved (mg/L)	Specific conductance, field (µS/cm)	Specific conductance, laboratory, (µS/cm)	Sodium, dissolved (mg/L)	Dissolved solids residue at 180 deg. C, dissolved (mg/L)	Sulfate, dissolved (mg/L)	Tempera-ture, (deg. C)
CH Bc 75	22	306	322	68	214	7.7	19.5
CH Bc 80	16	593	627	150	378	7.8	21.3
CH Bd 52	34	425	443	98	278	8.4	20.3
CH Cc 34	38	373	381	85	244	9.0	21.4

Appropriation Permit CH95G023) and for private wells at Chapman's Landing (Permit CH93G029). The yearly average amounts appropriated are 0.16 Mgal/d and 0.39 Mgal/d for South Hampton and Chapman's Landing, respectively (Appendix D, Part II). In March 1997, South Hampton well 2 (CH Bc 78) was put into production. Average daily discharge based on monthly totals ranged from 0.045 to 0.19 Mgal/d for the period March 1997 through February 1998 (Charles County Department of Utilities, written commun., 1998). This pumpage is the first confirmed use of the upper Patuxent aquifer within the study area. Aside from water withdrawn during aquifer tests, the wells at Chapman's Landing (CH Bc 75 and CH Bc 77) have not been pumped.

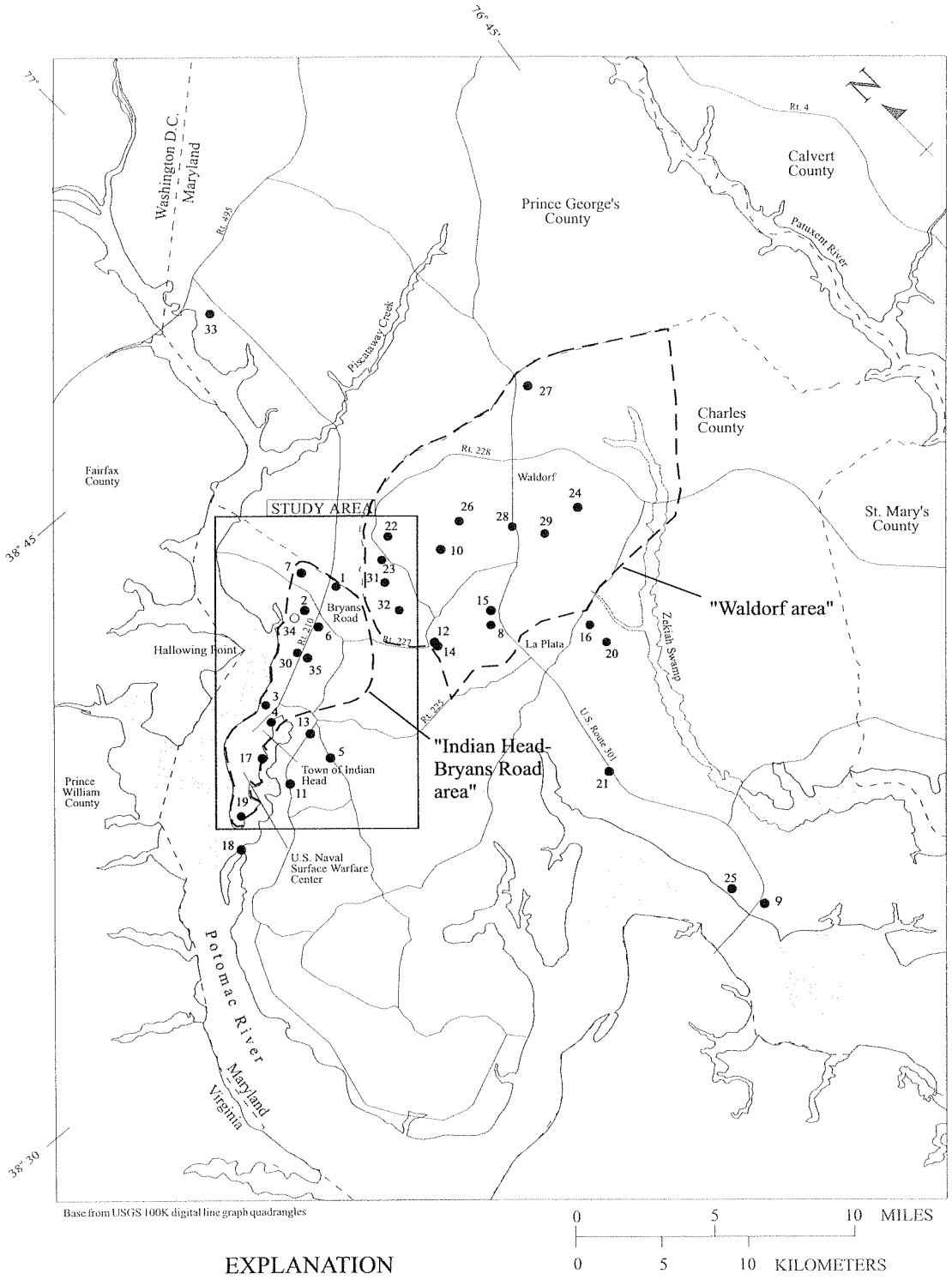


Figure 24. Locations of appropriated water use in 1997 greater than 10,000 gallons per day in the lower Patapsco and upper Patuxent aquifers.

Appendix A. Selected well records

[ft = feet; in. = inches; m-d-y = month, day, year; gal/min = gallons per minute; (gal/min)/ft = gallons per minute per foot;
Charles County DPF = Charles County Department of Facilities; PEPCO = Potomac Electric Power Company; WSSC = Washington Suburban Sanitary Commission; USGS = U.S. Geological Survey;
-- = not reported; Lppsc = lower Patapsco aquifer; Uppsc = upper Patapsco aquifer; Uptxn = upper Patuxent aquifer; Lptxn = lower Patuxent aquifer.]

Well number	State permit number	Owner or location	Driller	Completion year	Altitude of land surface (ft)	Total depth drilled (ft)	Diameter (in.)		Screen position (ft below land surface)	Aquifer	Water level (ft below land surface)		Date measured (m-d-y)	Yield (gal/min) (date)	Hours pumped	Specific capacity (gal/min/ft)
							Casing	Screen			Static (date)	Pumping				
CH Bb 6	--	US Navy, Group 1, Well 6	--	1915	38.3	398	8	8	251-261 301-311 376-397	Lppsc	--	212	12- -60	100	--	--
CH Bb 7	--	US Navy, Group 1, Well 7	--	1915	38.9	419	8	8	255-265 308-317 377-399	Lppsc	117 (7- -60)	240	12- -60	95 (3- -61)	--	--
CH Bb 9	--	US Navy, Group 1, Well 9	--	1915	32.1	399	8	8	185-195 235-245 285-294 355-376	Lppsc	150 (10- -60)	246	8- -60	110 (12- -60)	--	--
CH Bb 12	CH-01-3284	Town of Indian Head	Shannahan Artesian Well Co.	1953	95	515	10	10	238-245 248-260 288-298	Lppsc	149	204	12-10-53	220	8	4.0
CH Bb 17	--	US Navy, Well B	Sydnor Pump & Well Co.	1957	52	330	16, 10	10	240-294	Lppsc	105 (2- -57)	--	10- -60	450	--	--
CH Bb 19	CH-72-0122	US Navy, Well 2	Layne-Atlantic Co.	1972	90	405	20, 12	12	270-380	Lppsc	150	248	9-14-72	500	24	5
CH Bb 20	CH-71-0057	US Navy	Layne-Atlantic Co.	1971	50	408	6	6	199-224	Lppsc	83	182	2-10-71	250	24	2.5
CH Bb 22	CH-88-0847	US Navy	U.S. Geological Survey	1989	98	700	2	2	200-205	Lppsc	130	--	- -90	--	--	--
CH Bc 3	--	US Navy, Group 2, Well 12	--	1918	19	390	8	--	--	Lppsc	--	251	12- -60	115	--	--
CH Bc 5	--	US Navy, Group 2, Well 14	--	1918	39	430	8	--	--	Lppsc	--	234	12- -60	130	--	--
CH Bc 6	--	Potomac Heights	Layne-Atlantic Co.	1941	55	417	18, 8	8	362-412	Lppsc	174.5	238.5	5-5-45	385 (5- -41)	--	--
CH Bc 17	CH-01-1905	US Navy, Well 21	Washington Pump & Well Co.	1952	73	450	8	7.5	345-361	Lppsc	158.5	--	5-11-61	--	--	--

Appendix A. Selected well records--Continued

Well number	State permit number	Owner or location	Driller	Completion year	Altitude of land surface (ft)	Total depth drilled (ft)	Diameter (in.)		Screen position (ft below land surface)	Aquifer	Water level (ft below land surface)		Date measured (m-d-y)	Yield (gal/min) (date)	Hours pumped	Specific capacity (gal/min/ft)
							Casing	Screen			Static (date)	Pumping				
CH Bc 23	CH-03-0288	Town of Indian Head, Well 2	Shannahan Artesian Well Co.	1958	65	352	16, 10, 8	8	229-250 262-270 280-292 305-311	Lppsc	141	206	4-15-58	240	24	3.7
CH Bc 24	CH-02-0874	Potomac Heights, Well 2	Layne-Atlantic Co.	1955	72	446	10	10	384-399 415-435	Lppsc	122	135	10-10-55	250	4	19.2
CH Bc 29	CH-01-3628	Warder, James A.	Shannahan Artesian Well Co.	1953	172	442	4, 2	2	210-215 383-388 423-428	Lppsc	97	160	11-3-53	4.5	6	.07
CH Bc 46	CH-01-9008	Jenkins, John W., Jenkins Lane	Shannahan Artesian Well Co.	1955	182	639	4, 2	2	Unknown	Lppsc	170	245	6-5-55	30	4	.4
CH Bc 61	CH-05-6515	Potomac Heights, Test well	Layne-Atlantic Co.	1964	70	875	4, 2	2	439-444	Lppsc	122	--	4-10-64	6	48	--
CH Bc 62	CH-66-0049	Potomac Heights	Layne-Atlantic Co.	1966	50	470	6	6	376-406	Lppsc	170	270	3-24-66	160	20	1.6
CH Bc 64	CH-66-0049	Potomac Heights	Layne-Atlantic Co.	1966	48	540	6	6	414-424 444-464 494-514	Lppsc	125	250	8-30-66	200	8	1.6
CH Bc 65	CH-66-0043	Jenkins Lane Water Co.	Shannahan Artesian Well Co.	1966	176	622	6, 4	4	589-619	Lppsc	192	220	3-30-66	24	8	0.9
CH Bc 67	CH-72-0053	Town of Indian Head, Well 3	Shannahan Artesian Well Co.	1971	30	522	10, 5	5	488-498 511-522	Lppsc	102	181	12-12-71	300	24	3.8
CH Bc 68	CH-67-0051	Potomac Heights, Well 3	Layne-Atlantic Co.	1967	75	540	20, 8	8	414-424 444-464 494-514	Lppsc	148	288	2-24-67	517	24	3.7
CH Bc 70	CH-73-2329	Town of Indian Head, Well 4	CZ Enterprises	1979	35	483	8	8	372-392 412-442	Lppsc	80	306	8-1-79	96	24	.4
CH Bc 71	CH-73-2415	Town of Indian Head	CZ Enterprises	1979	28	410	2	2	400-410	Lppsc	82	250	8-1-79	17	5	.1

Appendix A. Selected well records--Continued

Well number	State permit number	Owner or location	Driller	Completion year	Altitude of land surface (ft)	Total depth drilled (ft)	Diameter (in.)		Screen position (ft below land surface)	Aquifer	Water level (ft below land surface)		Date measured (m-d-y)	Yield (gal/min) (date)	Hours pumped	Specific capacity (gal/min/ft)
							Casing	Screen			Static (date)	Pumping				
CH Bc 72	CH-81-0992	Town of Indian Head, Well 5	Sydnor Hydrodynamics, Inc.	1984	34	498	20, 12, 6	6	224-254 284-304 334-347	Lppsc	95.8 99	155.8 156	9-24-84 10-18-84	160 160	-- 24	-- 2.8
CH Bc 74	CH-81-2919	Montrose Farms	Shannahan Artesian Well Co.	1988	150	748	4, 2	3	550-566 574-589 637-642	Lppsc	231	256	9-20-88	53	24	2.1
CH Bc 75	CH-92-0500	Chapman's Landing, Well 2	Sydnor Hydrodynamics, Inc.	1993	125	1164	8	8	820-825 860-880 898-923	Uptxn	121	205	6-25-93	500	72	5.9
CH Bc 76	CH-88-1638	Charles Co. DPF, Bryans Road, Well 3	Sydnor Hydrodynamics, Inc.	1991	171	817	22, 16, 8	8	540-605	Lppsc	262	351	6-6-91	400	24	4.5
CH Bc 77	CH-88-1028	Chapman's Landing, Well 1	Branham Well Drillers	1990	98	990	16, 8, 6	6	925-955	Uptxn	94	174	8-10-90	270	24	3.4
CH Bc 78	CH-94-0394	Charles Co. DPF, South Hampton Well 2	Sydnor Hydrodynamics, Inc.	1995	34	815	10, 6	6	675-685 710-790	Uptxn	16	310	9-15-95	750	24	2.6
CH Bc 79	CH-04-9202	Laurel Water Co.	Shannahan Artesian Well Co.	1962	170	729	4, 2	3	714-729	Lppsc	186	215	12-7-62	8	5	.3
CH Bc 80	CH-94-0897	Maryland Geological Survey, Chapman's Landing	A.C. Schultes of Maryland	1996	123	1142	4	4	1085-1095 1105-1115	Lptxn	129	275	8-30-96	37	12	.2
CH Bc 81	CH-88-0482	Montrose Farms	Shannahan Artesian Well Co.	1990	150	656	6, 4	4	556-588 642-646	Lppsc	238	260	3-19-90	75	24	3.4
CH Bc 82	CH-94-1401	Potomac Heights, Observation well	Sydnor Hydrodynamics, Inc.	1997	75	520	8, 4	4	406-436 460-490	Lppsc	195	205	7-2-97	37	16	3.4

Appendix A. Selected well records--Continued

Well number	State permit number	Owner or location	Driller	Completion year	Altitude of land surface (ft)	Total depth drilled (ft)	Diameter (in.)		Screen position (ft below land surface)	Aquifer	Water level (ft below land surface)		Date measured (m-d-y)	Yield (gal/min) (date)	Hours pumped	Specific capacity (gal/min/ft)
							Casing	Screen			Static (date)	Pumping				
CH Bc 83	CH-94-1402	Potomac Heights, Production well	Sydnor Hydrodynamics, Inc.	1997	75	550	18, 10	10	400-445 455-490 507-532	Lppsc	193	256	11-19-97	400	24	6.3
CH Bd 16	CH-01-6856	Indian Head Manor, Well 1	Shannahan Artesian Well Co.	1954	180	506	4, 2	2	412-422 455-460	Lppsc	160	205	11-15-54	25	4	.6
CH Bd 17	CH-01-6857	Indian Head Manor, Well 2	Shannahan Artesian Well Co.	1954	170	460	4, 2	2	411-416 455-460	Lppsc	160	220	11-15-54	27	4	.4
CH Bd 18	CH-02-2911	Indian Head Manor, Well 3	Shannahan Artesian Well Co.	1956	178	673	6, 4	4	662-673	Lppsc	168	276	5-24-56	63	4	.6
CH Bd 22	CH-02-1161	Charles Co. DPF, Bryans Road, Wooster Drive	Shannahan Artesian Well Co.	1956	175	651	6, 4	4	628-644	Lppsc	179	255	4-14-56	60	4	0.8
CH Bd 29	CH-04-2481	Charles Co. DPF, Bryans Road, Well 2	Shannahan Artesian Well Co.	1961	170	626	6, 4	4	570-620	Uppsc	180	220	6-6-61	126	4	3.2
CH Bd 32	CH-67-0085	J C Parks School	East Coast Well Drilling, Inc.	1967	175	660	6	6	648-660	Lppsc	190	410	10-23-67	30	3	.1
CH Bd 33	CH-66-0079	Charles Co. DPF, Strawberry Hill Well 1	Layne-Atlantic Co.	1966	180	654	18, 10	10	536-556 561-586	Lppsc	194	250	8-30-66	400	8	7.1
CH Bd 35	CH-72-0050	Charles Co. DPF, Strawberry Hill Well 2	Layne-Atlantic Co.	1973	170	666	20, 10	10	595-645	Lppsc	205	259	4-9-73	300	8	5.6
CH Bd 38	CH-73-2270	Charles Co. DPF, Eutaw Forest	Sydnor Hydrodynamics, Inc.	1980	200	721	6, 4	4	696-721	Lppsc	205	--	1-12-80	--	--	--
CH Bd 40	CH-73-2417	Charles Co. DPF, Eutaw Forest	Shannahan Artesian Well Co.	1979	185	904	4, 2	3	736-741 825-846	Lppsc	212	249	8-21-79	26	12	.7

Appendix A. Selected well records--Continued

Well number	State permit number	Owner or location	Driller	Com-ple-tion year	Altitude of land surface (ft)	Total depth drilled (ft)	Diameter (in.)		Screen position (ft below land surface)	Aquifer	Water level (ft below land surface)		Date measured (m-d-y)	Yield (gal/min) (date)	Hours pumped	Specific capacity (gal/ min/ft)
							Casing	Screen			Static (date)	Pumping				
CH Bd 44	CH-73-2500	Charles Co. DPF, Eutaw Forest	Sydnor Hydrodynamics, Inc.	1980	180	840	12, 6, 4	4	799-822	Lppsc	208	402	2-28-80	91	24	.5
CH Bd 46	CH-81-1714	Charles Co. DPF, Eutaw Forest	Sydnor Hydrodynamics, Inc.	1986	180	859	12, 6, 4	4	700-730 805-820	Lppsc	233	288	6-26-86	90	--	1.6
CH Bd 47	CH-88-0124	Charles Co. DPF, Laurel Branch	Sydnor Hydrodynamics, Inc.	1989	160	900	8, 6	6	734-779 843-858	Lppsc	305	377	1-5-89	140	8.5	1.9
CH Bd 48	CH-88-0765	Charles Co. DPF, Laurel Branch	Sydnor Hydrodynamics, Inc.	1990	130	843	8, 6	6	648-688 747-762 805-815	Lppsc	243	290	5-30-90	200	24	4.2
CH Bd 49	CH-93-0385	Charles Co. DPF, Dutton's Addition	Sydnor Hydrodynamics, Inc.	1994	183	1054	16, 8, 6	6	820-860 995-1040	Lppsc	280	370	10-21-94	223	32	2.5
CH Bd 50	CH-88-2044	Charles Co. DPF, Bryans Road, Well 4	Sydnor Hydrodynamics, Inc.	1991	180	724	16, 8, 6	6	591-606 618-638	Lppsc	263	414	12-31-91	280	24	1.8
CH Bd 51	CH-94-0037	Charles Co. DPF, Settle Woods	Sydnor Hydrodynamics, Inc.	1995	185	1057	8, 6	6	897-912 934-944 972-987 1010-1035	Lppsc	281	346	3-25-95	275	24	4.2
CH Bd 52	CH-94-0899	Maryland Geological Survey, Route 227	A.C. Schultes of Maryland	1996	47.50	1328	4	4	1043-1053 1085-1095	Uptxn	48	99	10-1-96	60	12	1.2
CH Be 57	CH-81-1194	Charles Co. DPF, Smallwood West	Layne-Atlantic Co.	1985	210	1806	6, 4	4	1666-1696	Uptxn	200	286	6-12-85	36	--	.4
CH Be 58	--	Charles Co. DPF, Smallwood West	Layne-Atlantic Co.	1985	210	1170	16, 8	8	925-964 1048-1160	Lppsc	237	350	8-29-85	550	24	4.9
CH Be 64	CH-88-0341	Charles Co. DPF, Billingsley Rd.	Sydnor Hydrodynamics, Inc.	1989	210	1201	24, 18, 8	8	895-900 915-925 948-958 1077-1102 1118-1163	Lppsc	298	473	5-15-89	550	36	3.1

Appendix A. Selected well records--Continued

Well number	State permit number	Owner or location	Driller	Completion year	Altitude of land surface (ft)	Total depth drilled (ft)	Diameter (in.)		Screen position (ft below land surface)	Aquifer	Water level (ft below land surface)		Date measured (m-d-y)	Yield (gal/min) (date)	Hours pumped	Specific capacity (gal/min/ft)
							Casing	Screen			Static (date)	Pumping				
CH Be 66	CH-94-1043	Charles Co. DPF, Brookwood	A.C. Schultes of Maryland	1996	215	1233	8, 6	6	951-965 995-1003 1022-1078 1101-1109 1135-1153	Lppsc	337	385	12-12-96	325	24	6.8
CH Be 67	CH-94-0464	Charles Co. DPF, Cleveland Park	A.C. Schultes of Maryland	1996	190	1422	16, 8	8	970-975 985-990 1014-1022 1033-1043 1072-1084 1102-1120 1148-1158 1166-1202 1218-1238 1260-1276 1286-1298 1346-1358 1372-1400	Lppsc	318	436	2-1-96	600	24	5
CH Bf 146	CH-81-0593	Charles Co. DPF, St. Paul	Sydnor Hydrodynamics, Inc.	1983	193	1654	6	6	1059-1069 1073-1083 1161-1166 1170-1180 1184-1189 1195-1205 1244-1249 1252-1262 1298-1328 1342-1417	Lppsc	200	249	12-23-83	165	8	3.4
CH Bf 147	CH-81-0738	Charles Co. DPF, St. Paul	Sydnor Hydrodynamics, Inc.	1984	195	1440	20, 12	12	1059-1069 1073-1083 1161-1166 1170-1180 1184-1189 1195-1205 1244-1249 1252-1262 1298-1328 1342-1417	Lppsc	207	317	2-29-84	510	24	4.6

Appendix A. Selected well records--Continued

Well number	State permit number	Owner or location	Driller	Completion year	Altitude of land surface (ft)	Total depth drilled (ft)	Diameter (in.)		Screen position (ft below land surface)	Aquifer	Water level (ft below land surface)		Date measured (m-d-y)	Yield (gal/min) (date)	Hours pumped	Specific capacity (gal/min/ft)
							Casing	Screen			Static (date)	Pumping				
CH Bf 150	CH-81-1195	Charles Co. DPF, White Oak Drive	Sydnor Hydrodynamics, Inc.	1985	215	1347	24, 16, 8	8	797-800 890-898 938-970 1154-1176 1204-1240 1276-1285 1306-1336	Lppsc	228	313	7-24-85	554	72	6.5
CH Cb 7	CH-01-1908	US Navy, Well 19	Washington Pump and Well Co.	1952	36	400	8	7.5	144-167	Lppsc	67 86	140 159	3-3-52 --	200 200	24 24	2.7 2.7
CH Cb 11	--	US Navy, Well 43SN	Washington Pump and Well Co.	1945	5	454	--	--	--	Lppsc	30	157	1945	80 (1953)	--	--
CH Cb 18	CH-01-5753	US Navy, Well 17	Shannahan Artesian Well Co.	1954	30	452	16, 10	8	261-295	Lppsc	77 125	210 221	4-20-54 10- -60	350 332	12 --	2.6 3.5
CH Cb 19	CH-01-3185	US Navy, Well 18	Shannahan Artesian Well Co.	1954	32	605	16, 10, 8	8	208-220 274-302	Lppsc	95 100	187 175	5-15-54 10- -60	363 300	24 --	3.9 4
CH Cb 28	CH-04-1102	US Navy, Well 2012SN	Layne-Atlantic Co.	1961	5	331	24, 10	10	190-200 230-240 280-290	Lppsc	65	200	1-17-61	275	40	2.0
CH Cb 29	--	US Navy, Well 24A or A	Sydnor Pump & Well Co.	1957	12.4	350	16, 10	10	228-239 269-286	Lppsc	100	--	1957	383	--	--
CH Cb 35	CH-81-0572	US Navy, Well 16A	East Coast Well and Pump	1984	25	503	6, 4	4	433-461 467-486	Uptxn	84	255	12-6-84	226	24	1.3
CH Cb 38	--	U.S. Navy, Rum Point	Calvert Well Drilling	1978	4	235	4	2	220-235	Lppsc	18	100	5-30-78	20	5	.2
CH Cb 39	CH-73-2804	Sweden Point Marina, General Smallwood State Park	Shannahan Artesian Well Co.	1980	10	426	6, 4	4	301-311 373-383	Lppsc	79	166	12-17-80	32	24	0.4

Appendix A. Selected well records--Continued

Well number	State permit number	Owner or location	Driller	Com-ple-tion year	Altitude of land surface (ft)	Total depth drilled (ft)	Diameter (in.)		Screen position (ft below land surface)	Aquifer	Water level (ft below land surface)		Date measured (m-d-y)	Yield (gal/min) (date)	Hours pumped	Specific capacity (gal/ min/ft)
							Casing	Screen			Static (date)	Pumping				
CH Cb 43	CH-92-0116	U.S. Navy, Well 15R	A.C. Schultes of Delaware	1992	24	310	26, 10	10	190-202 228-240 252-282	Lppsc	76	177	7-31-92	217	24	2.1
CH Cc 19	CH-03-9279	Red Hill Estates	R. Leatherbury	1960	140	216	2, 1.25	1.25	205-216	Lppsc	55	75	6-17-60	4	4	.2
CH Cc 20	CH-04-1715	Red Hill Estates	Suburban Pump & Well Co.	1961	130	348	6	4	343-348	Lppsc	134	158	7-7-61	22	12	.9
CH Cc 25	CH-68-0044	Du-Mar Estates Water Co., Inc.	Shannahan Artesian Well Co.	1968	75	406	6, 4	4	391-406	Lppsc	120	143	4-30-68	20	8	.9
CH Cc 28	CH-05-6912	Red Hill Estates	Willard Ward	1964	130	353	4	4	343-353	Lppsc	96	104	7-24-64	25	8	3.1
CH Cc 30	CH-69-0058	Lackey High School	Layne-Atlantic Co.	1969	95	494	8	8	273-278 314-329	Lppsc	129	220	3-17-69	76	8	.8
CH Cc 31	CH-73-1416	Dravo Corporation	Sydnor Hydrodynamics, Inc.	1977	35	563	6, 4	4	438-453 480-505 544-554	Lppsc	75	185	4-26-77	125	24	1.1
CH Cc 32	CH-73-0898	Red Hill Estates	Shannahan Artesian Well Co.	1976	135	375	4, 2	3	343-353	Lppsc	142	182	3-17-76	10	8	.2
CH Cc 34	CH-94-0898	Maryland Geological Survey, Mattawoman Waste-Water Treatment Plant	A.C. Schultes of Maryland	1996	41.82	1170	4	4	874-884 945-955	Uptxn	48.58 51	190.17 192	7-19-96 7-25-96	50 50	12 12	0.4 .3
CH Cd 24	CH-03-3114	US Navy	Sydnor Pump & Well Co.	1955	175	1003	6, 4.5	5.5	885-900 960-970	Lppsc	178	345	3-3-55	65	48	.4
CH Cd 30	CH-68-0042	Utilco, Inc., Pomfret Estates	Sydnor Pump & Well Co.	1968	193	1346	12, 6, 4	4	936-946 1085-1100 1108-1118 1310-1330	Lppsc	175	282	6-28-68	68	12	.6

Appendix A. Selected well records--Continued

Well number	State permit number	Owner or location	Driller	Completion year	Altitude of land surface (ft)	Total depth drilled (ft)	Diameter (in.)		Screen position (ft below land surface)	Aquifer	Water level (ft below land surface)		Date measured (m-d-y)	Yield (gal/min) (date)	Hours pumped	Specific capacity (gal/min/ft)
							Casing	Screen			Static (date)	Pumping				
CH Cd 33	CH-69-0105	Charles Co. Vocational Tech Center	Shannahan Artesian Well Co.	1969	190	917	4, 2	2	390-395 415-420 449-454 472-482 501-511	Lppsc	149	303	9-9-69	5	36	.03
CH Cd 42	CH-92-0025	Preswicke Hills Subdivision	Calvert Well Drilling Co.	1992	185	1020	4.5, 2	2	930-945	Lppsc	250	400	3-19-92	20	6	.1
CH Ce 8	CH-00-1398	Town of La Plata	Sydnor Pump and Well Co.	1947	149.4 m	1094	10, 8, 6	8	1040-1075	Lppsc	135	420	11-19-47	100	24	.4
CH Ce 35	CH-65-0013	Town of La Plata, Well 6	Sydnor Pump and Well Co.	1964	165	1252	10, 6	6	1058-1114	Lppsc	165	430	1-29-65	240	--	.9
CH Ce 37	CH-73-0219	U.S. Geological Survey	Sydnor Hydrodynamics, Inc.	1973	185	2014	16, 6, 4	4	1174-1184 1250-1260 1330-1340	Lppsc	187	217	11-12-73	120	24	4.0
CH Ce 42	CH-73-0575	Charles Co. DPF, Ellenwood Estates	Patuxent Pump & Well	1974	165	1090	6, 4	5	1030-1055 1070-1080	Lppsc	152	239	11-21-74	90	8	1.0
CH Ce 43	CH-73-0764	Town of La Plata, Well 8	A.C. Schultes, Inc.	1975	185	1345	12, 6	6	1113-1116 1131-1146 1165-1188 1233-1250 1305-1342	Lppsc	190	266	7-11-75	513	24	6.8
CH Ce 51	CH-81-0828	Town of La Plata, Well 9	Layne-Atlantic Co.	1984	150	1509	12	12	1250-1340	Lppsc	185	375	11-2-84	450	--	2.4
CH Ce 55	CH-94-1110	Town of La Plata, Well 10, Heritage Green	Sydnor Hydrodynamics, Inc.	1997	190	1304	18, 8	8	870-880 893-908 945-950 956-961 980-1000 1030-1035 1057-1062 1090-1130 1172-1192 1204-1219 1238-1263	Lppsc	28.8	344	6-27-97	576	48	10.2

Appendix A. Selected well records--Continued

Well number	State permit number	Owner or location	Driller	Completion year	Altitude of land surface (ft)	Total depth drilled (ft)	Diameter (in.)		Screen position (ft below land surface)	Aquifer	Water level (ft below land surface)		Date measured (m-d-y)	Yield (gal/min) (date)	Hours pumped	Specific capacity (gal/min/ft)
							Casing	Screen			Static (date)	Pumping				
CH Ce 56	CH-94-1111	Town of La Plata, Observation well, Heritage Green	Sydnor Hydrodynamics, Inc.	1997	196	1307	14, 6, 4	4	896-906 945-950 957-962 993-1008 1024-1029 1037-1042 1094-1134 1166-1186 1204-1214 1248-1258	Lppsc	287	--	3-24-97	100	4	--
CH Ce 57	CH-94-1112	Town of La Plata, Observation well, Heritage Green	Sydnor Hydrodynamics, Inc.	1997	193.47	1871	6, 4	4	1406-1421 1500-1515 1668-1698	Uptxn	200	371	2-20-97	40	48	.2
CH Ce 58	CH-88-0856	Charles Co. DPF, Carmel Estates	Delmarva Drilling Co.	1989	184	1316	6	6	1225-1278	Lppsc	243	373	11-28-89	60	24	0.5
CH Ce 59	CH-92-0969	Turkey Hill Water Co.	Sydnor Hydrodynamics, Inc.	1994	198	988	6	6	585-595 640-650 672-677 805-840	Lppsc	266	438	6-15-94	40	48	.2
CH Da 18	CH-73-0586	PEPCO, Douglas Point Observation well	A.C. Schultes Co.	1975	90	772	8	8	684-694 730-740	Uptxn	81	--	--	--	--	--
CH Da 19	CH-73-0585	PEPCO, Douglas Point	A.C. Schultes Co.	1974	90	535	6	6	414-424 441-456 482-492 520-535	Lppsc	90	163	11-4-74	240	72	3.3
CH Da 20	CH-73-0590	PEPCO, Douglas Point Observation well	A.C. Schultes Co.	1974	90	522	6	6	420-425 444-449 481-486 517-522	Lppsc	68	--	--	--	--	--
CH De 39	CH-73-1803	Offutt Farm Assoc., Chapel Point	Shannahan Artesian Well Co.	1978	175	766	4, 2	3	703-713 739-744	Lppsc	172	208	7-21-78	10	3	.3

Appendix A. Selected well records--Continued

Well number	State permit number	Owner or location	Driller	Completion year	Altitude of land surface (ft)	Total depth drilled (ft)	Diameter (in.)		Screen position (ft below land surface)	Aquifer	Water level (ft below land surface)		Date measured (m-d-y)	Yield (gal/min) (date)	Hours pumped	Specific capacity (gal/min/ft)
							Casing	Screen			Static (date)	Pumping				
CH De 40	CH-73-1804	Offutt Farm Assoc., Chapel Point	Shannahan Artesian Well Co.	1978	170	762	6, 4	4	450-468 503-511 542-547 602-611 712-720	Lppsc	164	415	8-22-78	10	2	.04
CH De 41	CH-73-2073	Offutt Farm Assoc., Chapel Point	Shannahan Artesian Well Co.	1978	175	901	6, 4	4	673-681 695-720 738-745 790-797 826-832	Lppsc	162	218	9-3-78	41	12	0.7
CH Ee 68	CH-67-0080	PEPCO, Morgantown	Shannahan Artesian Well Co.	1967	22	1152	4, 2	2	1079-1099	Lppsc	10	28	6-20-67	30	24	1.7
CH Ee 69	CH-69-0089	PEPCO, Morgantown	Shannahan Artesian Well Co.	1970	22	1152	10, 8	6	1073-1104	Lppsc	22	184	1-16-70	372	24	2.3
CH Ee 70	CH-67-0081	PEPCO, Morgantown Plant	Shannahan Artesian Well Co.	1967	22.83	1132	2	2	1090-1100 1105-1115	Lppsc	10	21	7-15-67	25	24	2.3
CH Ee 71	CH-69-0090	PEPCO, Morgantown Plant	Shannahan Artesian Well Co.	1970	22	1113	10, 8	8	1072-1108	Lppsc	29	162	5-20-70	358	24	2.7
CH Ee 72	CH-69-0087	PEPCO, Morgantown	Shannahan Artesian Well Co.	1970	22	1117	10, 8	8	1081-1117	Lppsc	44	280	6-17-70	254	24	1.1
CH Ee 78	CH-73-1965	Charles Co. DPF, Clifton-on-the-Potomac	Leazer Pump & Well Co.	1979	70	1220	7	7	1148-1168 1189-1199	Lppsc	126	240	10-31-79	117	24	1.0
CH Ee 91	CH-81-0761	Charles Co. DPF, St. Anne's well at Clifton-on-the-Potomac	Layne-Atlantic Co.	1984	68	1214	12, 6	6	1000-1010 1033-1066 1084-1096	Lppsc	103	295	1-25-84	317	24	1.7
CH Ff 60	CH-81-0762	Swan Point	Layne-Atlantic Co.	1984	12	1100	10, 6	6	808-830 920-982	Lppsc	24	80	3-30-84	506	24	9.0

Appendix A. Selected well records--Continued

Well number	State permit number	Owner or location	Driller	Completion year	Altitude of land surface (ft)	Total depth drilled (ft)	Diameter (in.)		Screen position (ft below land surface)	Aquifer	Water level (ft below land surface)		Date measured (m-d-y)	Yield (gal/min) (date)	Hours pumped	Specific capacity (gal/min/ft)
							Casing	Screen			Static (date)	Pumping				
CH Ff 62	CH-81-1970	Swan Point	Sydnor Hydrodynamics, Inc.	1986	12	1010	18, 10, 6	6	698-723 798-808 819-824 838-848 856-866 873-878 914-944 954-959 965-980	Lppsc	27	93	11-20-86	525	24	8.0
PG Eb 1	--	WSSC, Forest Heights, Well 1	Layne-Atlantic Co.	1945	20	603	18, 10, 8	8	357-377 568-588	Uptxn & Lptxn	100	340	12-18-45	439	48	1.8
PG Eb 2	PG-00-0339	WSSC, Forest Heights Well 2	Layne-Atlantic Co.	1946	22	630	20, 10, 8	10, 8	277-282 347-352 521-526 550-560 600-605	Uptxn & Lptxn	102	224	9-10-46	540	24	4.4
PG Eb 20	PG-02-5527	WSSC, Fort Foote Village	Layne-Atlantic Co.	1956	151	828	6	6	192-212 352-372 557-577	Lppsc	135 153 110	190 -- 320?	10-3-56 10-11-56 10-24-56	50 300 230	2 2 2	.9 -- 1.1
PG Eb 22	PG-01-0418	Potomac Vista Corp.	Columbia Pump & Well Co.	1952	100	275	6	6	275-285	Lppsc	110	200	7-25-52	34	8	.4
PG Eb 23	PG-02-0466	Potomac Vista Corp.	Layne-Atlantic Co.	1955	115	331	6	6	295-300 315-320	Lppsc	124	200	9-8-55	150	5	2.0
PG Ec 41	PG-03-8527	WSSC, Southlawn	Layne-Atlantic Co.	1960	179	875	6	6	241-261 630-650	Lppsc, Ptxn, & Uptxn	150 147	225 200	6-24-60 6-24-60	320 275	6 6	4.3 5.2
PG Ec 46	PG-03-9072	WSSC, (Kerby Hill Pumping Station)	Layne-Atlantic Co.	1960	71	804	6	6	577-597	Uptxn	46	210	9-22-60	285	8	1.7
PG Ed 34	PG-01-0424	Morningside Village Water Co.	Washington Pump and Well Co.	1952	270	793	8	--	773-793	Lppsc	236	315	11-5-52	135	12	1.7
PG Fb 13	--	Ft. Washington	Sydnor Pump & Well Co.	1942	176	654	14, 10, 8	8	575-618	Lppsc	155	287	11-28-42	342	49	2.6

Appendix A. Selected well records--Continued

Well number	State permit number	Owner or location	Driller	Completion year	Altitude of land surface (ft)	Total depth drilled (ft)	Diameter (in.)		Screen position (ft below land surface)	Aquifer	Water level (ft below land surface)		Date measured (m-d-y)	Yield (gal/min) (date)	Hours pumped	Specific capacity (gal/min/ft)
							Casing	Screen			Static (date)	Pumping				
PG Fc 17	PG-12	Washington Gas Light Co., Thorne No. 2	Eakle & Holder Drilling Co.	1955	59	1728	6	--	712-716	Lppsc	28.62	--	10-27-55	--	--	--
PG Fc 31	PG-48904	Henry G. Ferguson Elem. School	Columbia Pump & Well Co. and Douglas & Dickinson, Inc.	1962	104	710	8	8, 2	677-681 689-699	Lppsc	97	120	10-12-62	120	12	5.2
PG Fd 59	PG-00-0004	Washington Gas Light Co. Moore No. 2	Eakle & Holder Drilling Co.	1955	172	1517	--	--	--	Uptxn?	--	--	12- -55	60	--	--
PG Fd 62	PG-10	Washington Gas Light Co., Robinson No. 2	Eakle & Holder Drilling Co.	1956	230	1812	--	--	1545-1580	Uptxn?	184	--	8-15-56	--	--	--
PG Hf 31	PG-73-0065	PEPCO, Chalk Point	Shannahan Artesian Well Co.	1973	10.02	2453	6, 4	4	1007-1034 1516-1541	Lppsc	6 above land surface	25	7-7-73	93	24	3.0
PG Hf 32	PG-73-0065	PEPCO, Chalk Point	Shannahan Artesian Well Co.	1973	10	1545	3, 2.5, 2	3	1025-1030 1525-1530	Lppsc	4 above land surface	45	5-30-73	15	4	.3
SM Df 84	SM-81-0119	Maryland Geological Survey Test well	A.C. Schultes & Sons, Inc.	1983	108.4	2679	6, 4	4	829-854 860-865 895-910	Uppsc[1]	115.7	161.4	1-4-83	193	24	4.2

[1]Screened interval called Mattaponi(?) aquifer in Hansen and Wilson (1984)

Appendix B. Descriptive log of washed drill cuttings from test holes drilled during this study.

CH Bc 80 CHAPMAN'S LANDING TEST SITE

Altitude of land surface = 123 feet

Depth, feet below land surface	Description
MINOR AQUIFERS AND CONFINING BEDS OF TERTIARY AGE (Undifferentiated)	
0-10	Sand, fine, brown, iron-stained quartz
10-60	Gravel, quartzose, subangular with fine-grained brown sand
60-70	Missed sample
70-100	Clay, silty, dark greenish-gray, with some weathered shell fragments
100-110	Clay, as above with increased weathered shell content
110-140	Clay, silty, light greenish-gray, glauconitic with some white silt
140-150	Clay, olive brown, slightly glauconitic; driller logged multi-colored clay from 143 feet -153 feet
UPPER PATAPSCO AQUIFER AND CONFINING BEDS	
150-160	Clay, white
160-190	Sand, very fine, clayey, reddish-brown
190-200	Sand, fine, tan, with some medium-grained, purple quartz
200-210	Sand, very fine, quartzose, light tan; driller logged very hard, red clay from 202 feet to 213 feet
205	Bit sample: Clay, dense, reddish-brown with thin, light gray laminations
210-220	Clay, silty, beige with some occasional medium-grained sand
220-240	Clay, silty, light reddish-brown
240-250	Missed sample
250-290	Clay, dense, red, white, yellow and gray
290-300	Clay, silty, yellowish-brown with some red and white clay
300-310	Sand, very fine to fine, silty, light brown
310-320	Sand, medium, light gray, clear and purple quartz grains
320-330	Clay, silty, light brown and gray
330-340	Sand, fine, clayey, light tan
340-360	Missed sample
360-370	Clay, silty, light tan
LOWER PATAPSCO AQUIFER	
370-380	Clay, white
380-390	Sand, fine, light gray
390-400	Clay, silty, light gray and tan
400-410	Sand, fine, light tan
410-420	Sand, fine to silty, light tan
420-430	Clay, gray with some silty sand
430-500	Clay, light green with some silty sand
500-510	Sand, fine to medium, gray
510-520	Clay, gray with some silty sand
520-530	Clay, light green and red
530-540	Sand, fine to very coarse, subangular, light tan
540-550	Missed sample
550-560	Sand, medium to coarse, light gray, purple and pink quartz
560	Bit sample: Clay, dense, gray and reddish-brown
560-590	Clay, gray
590-600	Clay, dense, red and white
600-610	Clay, dense, red, green and brown
610-620	Clay, red and green with fine, silty sand
620-640	Sand, medium, light gray, clear and purple quartz
640-650	Clay, olive gray, with some fine sand
650-660	Missed sample
660-670	Sand, fine, light gray with occasional coarse grains
670-690	Sand, fine to coarse, poorly sorted, light gray

CH Bc 80 CHAPMAN'S LANDING TEST SITE--CONTINUED

Depth, feet below land surface	Description
ARUNDEL CLAY	
690-825	Clay, red, light green and gray; difficult drilling from 790 feet to 810 feet
UPPER PATUXENT AQUIFER	
825-830	Sand, fine, reddish brown, silty
830-840	Sand, medium, light gray, clear and purple quartz
840-860	Sand, fine, light gray
860-870	Sand, medium, light gray
880-890	Sand, medium, light tan
890-920	Missed sample
CONFINING BED	
Note: Drill cuttings returns from 920 to 1,000 feet were sandy; however, geophysical logs indicate clay	
Driller's description from 920-1,000:	
920-930	Sand with layers of clay
930-938	Hard clay
938-948	Soft green clay with sand
948-988	Medium to coarse sand with green clay
988-1,000	Medium and hard green clay
1,000-1,040	Clay, gray and reddish-brown
LOWER PATUXENT AQUIFER	
1,040-1,050	Sand, fine, light gray with some gray and reddish-brown clay
1,050-1,060	Clay, brown with some silty sand
1,060-1,070	Sand, very fine, light gray, with red, reddish-brown and gray clay
1,070-1,080	Clay, gray, with some silty sand
1,080-1,090	Sand, very fine, light green with green clayey matrix
1,090-1,100	Sand, fine to medium, light gray with occasional coarse grains; driller logged rock from 1,095 feet to 1,096 feet
1,100-1,110	Sand, medium to coarse, light tan, composed predominantly of clear quartz
1,110-1,115	Sand with thin clay layers (driller's description)
1,115-1,137	Clay and layers of sand (driller's description)
1,137-1,138	Hard layer (driller's description)
1,138-1,140	Clay, "gummy" (driller's description)
BASEMENT ROCK	
1,140-1,142	Bed rock (driller's description)

Thin Section Analysis of Basement Cuttings from Well CH Bc 75 Located 56 feet from CH Bc 80

(Jonathan Edwards, written commun.)

Altitude = 123 feet above sea level

Depth Interval: 1,142 to 1,165 feet

Coarse-grained chips in the basement sample:

Microcline-quartz granite to granite gneiss

Biotite	Trace
Muscovite	1-2%
Microcline	10-20%
Quartz	78-88%

Grades in composition up to a sheared sillimanite- and microcline-bearing quartzite

Sillimanite	Trace
Microcline	1-2%
Quartz	98%

Fine-grained chips in the basement sample:

Fine-grained, garnetiferous, muscovite-biotite-plagioclase-quartz gneiss

Garnet	2%	(Corroded porphyroblasts up to 1 mm in size)
Muscovite	1-2%	(Occurs in amounts ranging from as little as a trace up to 10% in some chips)
Biotite	2-5%	
Microcline	Trace up to 5-10%	
Plagioclase	30-35%	
Quartz	50%	

CH Bd 52 RTE. 227 TEST SITE

Altitude of land surface = 48 feet

Depth, feet below land surface	Description
MINOR AQUIFERS AND CONFINING BEDS OF TERTIARY AGE (Undifferentiated)	
0-20	Clay, orange and gray interbedded with quartz sand and gravel
20-30	Silt, greenish-gray with small weathered shell fragments; drilled logged pink clay
30-40	Silt, greenish-gray, slightly micaceous with large shell fragments constituting more than 50 percent of sample
AQUIA AQUIFER	
40-50	Silty sand, orange and light green
60-70	Silt, dark green, slightly micaceous with some small weathered shell fragments
70-80	As above
80-90	Silt, light green with abundant small weathered shell fragments
90-100	As above
100-110	Clay, silty, orange and light green
110-120	As above
120-130	Silt, sandy, dark green, glauconitic, with small weathered shell fragments
BRIGHTSEAT(?) CONFINING BED	
130-140	Clay, silty, dark green, slightly micaceous with occasional small weathered shell fragments
140-150	Clay, slightly silty, dark green, slightly micaceous
UPPER PATAPSCO AQUIFER AND CONFINING BEDS	
150-160	Silt, sandy, orange and light green
160-170	Clay, silty, green with occasional, small iron concretions
170-180	Sand, silty, tan with occasional glauconite or goethite grains
180-190	Silt, sandy, orange and light green
190-200	Sand, fine, reddish-brown, composed of quartz and limonite
200-210	Sand, fine, reddish-brown, quartzose with occasional pink and purple quartz grains
210-220	Sand, fine to medium, tan with occasional small pods of limonite
220-230	Sand, silty, drab tan with occasional coarse clean pink and purple quartz grains; driller logged hard brown and gray clay
230-240	Missed sample; driller logged white and gray clay with layers of sand
240-250	Sand, silty; drab tan with some lignite and small pods of yellow silt
250-260	Clay, silty, light brown, with small pods of white and yellow clay
260-270	Silt, clayey, drab tan, with small pods of gray and yellowish-orange silt or clay and lignite
270-280	Sand, fine to silty, quartzose with some pink and purple fine sand grains and black silt
280-290	Silt, orange to tan with occasional pods of limonite
290-300	Silt, yellowish-tan, with small pods of white clay
300-310	Sand, very fine, light tan
310-320	Sand, very fine, light tan, with silt-size limonite
320-330	Sand, medium, light tan, clear, pink and purple quartz grains
330-340	Sand, medium, light tan, abundant purple quartz grains
340-350	Sand, fine to medium, light tan
350-360	Clay, silty, light brown with small pods of white and yellow silty clay

Appendix B. Descriptive log of washed drill cuttings from test holes drilled during this study--Continued

CH Bd 52 RTE. 227 TEST SITE--CONTINUED

Depth, feet below land surface	Description
360-370	As above, with the addition of some red clay
370-390	As above; driller logged hard layers
390-400	Clay, silty, tan with significant amounts of white, yellow and red clay
400-410	Sand, medium to coarse, light gray
410-420	Sand, medium to very coarse, light gray
420-430	Missing sample
430-440	Sand, medium to very coarse, clear, pink and purple, subangular quartz grains
440-450	As above, with predominantly clear and purple quartz grains
450-460	Sand, fine to coarse, light gray with silty matrix
460-470	Clay, silty, brown
470-480	Sand, fine to medium, light tan
480-490	Clay, silty, light brown with small pods of reddish-orange, white and yellow clay and occasional medium to coarse quartz grains
490-500	As above
500-510	Sand, fine to very coarse, light brown, silty clay matrix with small pods of reddish-orange clay
510-520	As above; driller logged hard multi-colored clay
520-530	Sand as in interval 500-510
530-540	As above
540-550	Clay, silty, light tan with small pods of light green silty clay
550-560	Clay, silty, light brown with small pods of reddish-orange and dark green silty clay
560-570	Clay, light brown and white
570-580	As above
580-590	Clay, white and red
590-600	As above
600-610	Clay, silty, white, red, brown and gray
610-620	Clay, white, red, and yellow; driller logged hard clay
620-630	Clay, light green; driller logged hard layers
LOWER PATAPSCO AQUIFER	
630-640	Silt, light brown
640-650	Silt, light brown with small pods of dark gray and white clay
650-660	As above
660-670	Sand, silty, light brown
670-680	Sand, fine to medium, clear and purple quartz grains
680-690	Missing sample
690-700	Clay, brown, light green and red
700-710	Clay, brown and light green
710-720	Sand, silty, light brown with light green and reddish-brown clay
720-730	Clay, silty, light brown
730-740	Sand, fine, light brown
740-750	Clay, light brown and light green; driller logged hard brown clay
750-770	As above
770-780	Clay, light green and reddish-brown; driller logged hard sandy clay
780-790	Sand, fine, light gray
790-800	Clay, silty, reddish-brown
800-810	Sand, fine to medium, light gray, white and purple quartz grains with occasional coarse sand; driller logged hard brown and gray clay
810-820	Missing sample
820-830	Sand, medium to coarse, light gray, white and purple quartz grains
830-840	Sand, as above, without coarse grains

CH Bd 52 RTE. 227 TEST SITE--CONTINUED

Depth, feet below land surface	Description
840-850	Sand, very fine to medium, light gray, white and purple quartz grains
850-860	Sand, fine, light tan
860-870	Sand, silty to fine, light tan with occasional medium sand
870-880	Sand, silty to coarse, poorly sorted, reddish-brown with some small pods of reddish-brown clay
880-890	Sand, silty to coarse, light gray
890-900	Sand, fine, light gray
ARUNDEL CLAY	
900-910	Sand, fine, light gray with small pods of gray clay
910-920	Clay, silty, light green and brown; driller logged hard multi-colored clay
920-930	Clay, light brown; driller logged hard clay
930-940	Clay, light green, light brown, white and reddish-brown; driller logged hard brown clay
940-950	Clay, light brown, white, reddish-brown with occasional very coarse quartz grains; driller logged hard brown clay
950-960	Clay, green, white and reddish-brown
960-970	Clay, as in interval 940-950
970-980	Clay, silty, reddish-brown
980-990	Sand, medium, light gray, well sorted
990-1,000	Sand, fine, light gray
1,000-1,010	Sand, silty to very coarse, dark gray, poorly sorted; driller logged hard red clay
1,010-1,020	Sand, silty, reddish-brown; driller logged hard red clay with layers of sand
UPPER PATUXENT AQUIFER	
1,020-1,040	Clay, silty, reddish-brown, light green and white
1,040-1,050	Sand, silty and clayey, light brown, light green clay
1,050-1,060	Silt, reddish-brown, with small pods of light green clay
1,060-1,070	Sand, fine to medium, light gray and purple quartz grains
1,070-1,080	Clay, silty, light brown and green
1,080-1,090	Missing sample
1,090-1,100	Sand, silty to very fine, light brown with some light green clay
1,100-1,120	Missing sample
1,120-1,130	Clay, silty, reddish-brown with minor amounts of fine sand; driller logged very hard brown clay
1,130-1,140	Missing sample
1,140-1,150	Clay, silty, reddish-brown and light green
1,150-1,160	Missing sample
1,160-1,170	Silt, reddish-brown
1,170-1,180	Sand, fine to medium, light gray and purple quartz grains; driller logged layers of rock
1,180-1,190	Clay, silty, white, light gray and brown
CONFINING BED	
1,190-1,210	As above
1,210-1,220	Clay, silty, light brown with minor amounts of fine sand
1,220-1,240	Clay, light brown and red
LOWER PATUXENT AQUIFER	
1,240-1,250	Sand, fine, tan with small pods of red clay or limonite
1,250-1,260	Sand, silty and clayey, light brown and green; driller logged very gray and red clay

CH Bd 52 RTE. 227 TEST SITE--CONTINUED

Depth, feet below land surface	Description
1,260-1,280	Clay, silty, light green and brown
1,280-1,290	Clay, silty and sandy, light green and brown
1,290-1,300	Clay, silty, light brown and green with minor amounts of medium quartz sand; driller logged rock from 1,301 feet to 1,318 feet and hard rock from 1,318 feet to 1,323 feet
1311	Bit sample: Clay, dense, dark greenish-gray with silty light green clay
BASEMENT ROCK	
1,323-1,328	Fine-grained, biotite-plagioclase-quartz gneiss chips resembling the basement rock described in well CH Cc 34 (Jonathan Edwards, Jr., written commun., 1996)

CH Cc 34 MATTAWOMAN WASTE-WATER TREATMENT PLANT

Altitude of land surface = 42 feet

Depth, feet below land surface	Description
MINOR AQUIFERS AND CONFINING BEDS OF TERTIARY AGE (Undifferentiated)	
0-10	Clay, pale yellow and white
10-20	Gravel, pale yellow, angular to subangular
20-30	Clay, light green and pale yellow with some angular gravel
30-40	Clay, silty, dark greenish-gray, glauconitic
40-50	Sand, fine to very coarse, angular, dark greenish-gray clayey matrix, with minor amounts of weathered shell; difficult drilling
50-60	Shell hash, weathered dark greenish-gray, clayey matrix
AQUIA AQUIFER	
60-70	As above
70-90	Shell hash, weathered, dark green glauconitic silt matrix
90-100	Sand, silty to very fine, dark green, composed of equal amounts of dark green glauconite and clear quartz with some weathered shell fragments
BRIGHTSEAT FM(?) CONFINING BED	
100-110	Silt, dark green with some weathered shell
UPPER PATAPSCO AQUIFER AND CONFINING BEDS	
110-120	Missed sample
120-130	Sand, fine to medium, tan, clear, pink and purple quartz grains
130-140	Sand, medium, light gray, clear, white, pink and purple quartz grains
140-150	Sand, silty to very fine, re-circulated (?) glauconitic silt, and silt-size to fine-grained limonite
150-160	Clay, silty, light gray, with fine-grained particles of limonite
160-180	Clay, sandy, light gray
180-190	Sand, medium to coarse, light gray, clear, white and purple quartz grains
190-200	Clay, silty, drab gray
200-210	Clay, silty, drab gray and yellow
210-220	Sand, coarse, light gray and purple quartz
220-230	Clay, light gray and yellow, with fine-grained limonite
230-240	Missed sample
240-260	Clay, light gray
260-280	Clay, light to dark gray, yellow and red
280-320	Missed sample
320-330	Sand, fine, light gray
330-340	Missed sample
340-350	Clay, drab gray, red, and yellow
350-360	As above, with some medium sand
360-370	Clay, drab gray
370-380	Clay, as in interval 340-350
380-390	Clay, gray
390-400	Clay, gray, yellow, red
400-410	Clay, gray, white, and red, dense
410-450	Clay, gray and white
450-470	Clay, gray, red, yellow and white
LOWER PATAPSCO AQUIFER	
470-510	Clay, red, gray and white with some fine sand
510-520	Clay, white, with some medium to coarse sand
520-530	Clay, silty, white
530-540	Sand, fine to medium with white clay
540-550	Sand, fine to coarse, light brown
550-560	Sand, fine, light gray with some light gray clay
560-580	Clay, white and gray
580-590	Missed sample

CH Cc 34 MATTAWOMAN WASTE-WATER TREATMENT PLANT--CONTINUED

Depth, feet below land surface	Description
590-620	Clay, reddish-brown and light green
620-630	Sand, medium tan, well sorted
630-640	Sand, fine to medium, tan with some coarse grains
640-650	Sand, fine to coarse, light gray
650-660	Clay, light green and reddish-brown, with some medium to coarse sand
660-670	Sand, fine, tan
670-680	Missed sample
680-690	Sand, fine to medium, tan with some occasional coarse quartz grains
690-700	Missed sample
700-710	Clay, silty, reddish-brown and green
710-720	Sand, fine to medium, tan
720-730	Clay, light gray, red and white
730-740	Sand, fine to medium, gray
740-750	Sand, fine to medium, gray, with some small angular pebbles
750-760	Sand, medium to coarse, gray, with some clay
ARUNDEL CLAY	
760-810	Clay, brown and gray
810-820	Clay, brown and gray with some fine sand
UPPER PATUXENT AQUIFER	
820-830	Sand, fine with some brown, red, and gray clay
830-840	Clay, sandy, green and reddish-brown
840-860	Clay, sandy, light green
860-870	Clay, silty, light green and white
870-880	Sand, fine to medium, light gray
880-890	Clay, sandy, light green
890-900	Clay, dense, green
900-910	Clay, dense, white and light green, with some clayey white sand
910-920	Missed sample
920-930	Sand, fine to medium, tan, angular, with some reddish-brown clay
930-940	Clay, reddish-brown and green
940-950	Sand, fine, light gray, white and purple quartz grains
950-960	Sand, medium, white, iron-stained, and purple quartz grains
960-990	Sand, fine to medium, grain coloration as above
CONFINING BED	
990-1,000	Clay, reddish-brown and light green
1,000-1,020	Clay, as above with some fine-grained sand
1,020-1,030	Clay, light green and white
1,030-1,040	Clay, silty, light green and reddish-brown
LOWER PATUXENT AQUIFER	
1,040-1,050	Sand, coarse, well sorted, subangular, white, clear and purple quartz grains
1,050-1,060	Sand, fine to medium, white
1,060-1,080	Clay, silty, gray
1,080-1,090	Clay, silty, light gray and reddish brown
1,090-1,100	Sand, fine to coarse, light gray, subangular
1,100-1,110	Sand, fine to medium, clayey, light green
1,110-1,120	Sand, medium to coarse, clear quartz grains
BASEMENT ROCK	
1,120-1,130	Clay, light green; driller logged rock from 1,126 feet to 1,127 feet
1,130-1,170	Clay, white, micaceous, silty with angular quartz grains and green, crystalline material; drilled like rock between 1,150 feet and 1,154 feet; driller logged hard rock from 1,154 feet to 1,162 feet

CH Cc 34 MATTAWOMAN WASTE-WATER TREATMENT PLANT--CONTINUED

Depth, feet below land surface	Description
1,170	Fine-grained, biotite (20%)-plagioclase (30%)-quartz (50%) gneiss chips resembling the Oella Formation, a crystalline rock that outcrops in the Piedmont of Baltimore and Howard Counties (Jonathan Edwards, Jr., written commun., 1996)

Appendix C. Core descriptions and sieve analyses--Well CH Bc 80 (Chapman's Landing Test Site)

Core descriptions--Well CH Bc 80 (Chapman's Landing Test Site)

Altitude of land surface: 123 feet
Date collected: August 8, 1996
(ft = feet; in. = inches)

LOWER PATAPSCO AQUIFER

1.	Depth cored:	564 ft
	Length of core:	13 in.
	Description:	Clay; grayish green, mottled reddish brown; cohesive and tough

ARUNDEL CLAY

2.	Depth cored:	700 ft
	Length of core:	24 in.
	Description:	Clay; reddish brown with light gray mottling; includes thin sandy layers; cohesive and tough

UPPER PATUXENT AQUIFER

3.	Depth cored:	825 ft
	Length of core:	7 in.
	Description:	Sand, fine to coarse; gray; with thin, very clayey layers; more friable in lower portion
4.	Depth cored:	830 ft
	Length of core:	4 in.
	Description:	Sand, fine to coarse; light gray; slightly clayey; cohesive when wet
5.	Depth cored:	920 ft
	Length of core:	3 in.
	Description:	Sand, fine to coarse; light gray; friable

CONFINING BED BETWEEN THE UPPER AND LOWER PATUXENT AQUIFER

6(a).	Depth cored:	1,000 ft
	Length of core:	About 2 in.
	Description:	Clay, with scattered sand grains; light greenish gray, mottled reddish brown; cohesive and tough

Apprendix C. Core descriptions and sieve analyses--Well CH Bc 80 (Chapman's Landing Test Site)--Continued

CONFINING BED BETWEEN THE UPPER AND LOWER PATUXENT AQUIFER--CONTINUED

6(b). Depth cored: 1,000 ft (second attempt)
Length of core: 9 in. (4 in. may be contamination)
Description: Clay, with scattered sand grains; light greenish gray, mottled reddish; cohesive and tough

LOWER PATUXENT AQUIFER

7. Depth cored: 1,050 ft
Length of core: 16 in.
Description: Sand, fine to medium with silty and clayey matrix; light gray; cohesive

8. Depth cored: 1,115 ft
Length of core: 14 in.
Description: Sand with clayey matrix; light greenish gray; alternating cohesive and friable

Sieve Analyses--Well CH Bc 80 (Chapman's Landing Test Site)
(ft = feet; mm = millimeters)

		Pebbles and granules	Very coarse sand	Coarse sand	Medium sand	Fine sand	Very fine sand	Silt	Clay
		WEIGHT PERCENTAGE							
Depth (ft)	Aquifer	>2mm	1-2 mm	0.5-1 mm	0.25-0.5 mm	0.125-0.25 mm	0.063-0.125 mm	0.0039-0.063 mm	<0.0039 mm
825	upper Patuxent*	0.00	0.63	9.44	18.67	8.57	10.31	26.99	25.39
1,050	lower Patuxent	0.00	0.00	1.88	54.30	18.41	6.06	9.75	9.60
1,115	lower Patuxent	8.10	17.97	32.24	13.98	5.17	3.05	9.75	9.75

* Representative of clayey portions of core

Appendix D (Part I). Appropriated ground-water use (1997) over 10,000 gallons per day in the lower Patapsco aquifer in the model area

[MGS = Maryland Geological Survey; USGS = U.S. Geological Survey;
Mgal/d = million gallons per day; PEPCO = Potomac Electric Power Company]

Site number[1]	Well owner or name-Charles County	Ground-water appropriation permit number (GAP)	MGS/USGS well no.	Model cell (column, row, layer)	Average amount appropriated (Mgal/d)	Yearly average pumpage reported in 1997 (Mgal/d)
1	Indian Head Manor	CH54G003	CH Bd 16 CH Bd 17 CH Bd 18	38,28,2 38,28,2 38,28,2	0.014	0.024[2]
2	Charles County Bryans Road	CH55G003	CH Bc 76 CH Bd 22 CH Bd 29 CH Bd 50	32,34,2 35,33,2 33,32,2 35,34,2	.273	.097[2]
3	Potomac Heights	CH55G008	CH Bc 6 CH Bc 24 CH Bc 68	25,50,2 25,50,2 25,50,2	.225	.177[2] no pumpage reported from July to Dec.
4	Town of Indian Head	CH57G003	CH Bc 23 CH Bc 67[3] CH Bc 70 CH Bc 72	23,58,2 24,54,2 26,54,2 25,55,2	.338	.293[2]
5	Red Hill Estates	CH60G004	CH Cc 19 CH Cc 20 CH Cc 28 CH Cc 32	29,61,2 29,61,2 29,61,2 29,61,2	.014	.009 no pumpage reported from July to Dec.
6	Jenkins Lane	CH65G008	CH Bc 46 CH Bc 65	33,35,2 33,35,2	.014	.008[2]
7	Charles County. Strawberry Hill	CH66G005	CH Bd 33 CH Bd 35	32,27,2 32,27,2	.120	.075[2]
8	Charles County, Carmel Estates	CH66G108	CH Ce 58	61,36,2	.023	.011
9	PEPCO, Morgantown	CH67G011	CH Ee 68 CH Ee 69 CH Ee 71 CH Ee 72	68,85,2 68,85,2 68,85,2 68,85,2	.820	.575
10	Charles County, Brookwood	CH67G109	CH Be 66	58,22,2	.045	.017
11	Du-Mar Estates (Marbury)	CH68G002	CH Cc 25	29,65,2	.013	.005
12	Utilco, Inc. (Pomfret Estates)	CH68G004	CH Cd 30	57,39,2	.013	.009
13	Lackey High School	CH68G009	CH Cc 30	34,56,2	.010	.010
14	Charles County Vo-Tech	CH69G005	CH Cd 33	57,40,2	.015	.0035
15	Turkey Hill Water Co.	CH70G001[4]	CH Ce 59	61,33,2	.016	.009
16	Town of La Plata	CH70G003	CH Ce 35 CH Ce 43 CH Ce 51 CH Ce 55	63,46,2 63,34,2 64,42,2 62,38,2	.640	.570

Appendix D (Part I). Appropriated ground-water use (1997) over 10,000 gallons per day in the lower Patapsco aquifer in the model area–Continued

[MGS = Maryland Geological Survey; USGS = U.S. Geological Survey;
Mgal/d = million gallons per day; PEPCO = Potomac Electric Power Company]

Site number[1]	Well owner or name-Charles County	Ground-water appropriation permit number (GAP)	MGS/USGS well no.	Model cell (column, row, layer)	Average amount appropriated (Mgal/d)	Yearly average pumpage reported in 1997 (Mgal/d)
17	U.S. Naval Surface Warfare Center (main base)	CH71G005	CH Bb 6 CH Bb 7 CH Bb 9 CH Bb 19 CH Bb 20 CH Bc 3 CH Cb 18 CH Cb 19 CH Cb 43 CH Cb 29	24,62,2 24,62,2 24,62,2 21,61,2 20,66,2 25,60,2 23,70,2 23,65,2 22,74,2 24,64,2	1.24	0.861[2]
18	U.S. Naval Surface Warfare Center (Stump Neck)	CH71G105	CH Cb 11 CH Cb 28	23,77,2 21,78,2	0.025	0.020
19	U.S. Naval Surface Warfare Center (industrial supply)	CH71G205	CH Cb 35[3]	21,72,2	.020	.066[2]
20	Charles County, Ellenwood	CH75G002	CH Ce 42	65,39,2	.035	.018
21	Chapel Point Subdivision	CH76G011	CH De 39 CH De 40 CH De 41	64,64,2 64,64,2 64,64,2	.024	.020
22	Charles County, Laurel Branch	CH77G036	CH Bd 47 CH Bd 48	48,20,2 48,20,2	.15	.122
23	Charles County, Eutaw Forest	CH78G015	CH Bd 38 CH Bd 44 CH Bd 46	48,23,2 48,23,2 48,23,2	.080	.061
24	Charles County, St. Paul	CH83G012	CH Bf 147	63,16,2	.60	.505
25	Charles County, St. Anne	CH83G014	CH Ee 91	67,83,2	.075	.043
26	Charles County, Smallwood West	CH83G112	CH Be 58	60,18,2	.600	.596
27	Charles County, White Oak Drive	CH83G212	CH Bf 150	62,9,2	.600	.559
28	Charles County, Billingsley Road	CH83G312	CH Be 64	62,18,2	.800	.439
29	Charles County, Cleveland Park	CH83G412	CH Be 67	63,20,2	.800	.265
30	Montrose Heights	CH88G003	CH Bc 74	32,40,2	.041	0
31	Charles County, Settle Woods	CH89G032	CH Bd 51	47,27,2	.300	.033
32	Duttons Addition	CH94G003	CH Bd 49	50,31,2	.008	.019 (estimated)

Appendix D (Part I). Appropriated ground-water use (1997) over 10,000 gallons per day in the lower Patapsco aquifer in the model area--Continued

[MGS = Maryland Geological Survey; USGS = U.S. Geological Survey;
Mgal/d = million gallons per day; PEPCO = Potomac Electric Power Company]

Site number[1]	Well owner or name-Prince George's County	Ground-water appropriation permit number (GAP)	MGS/USGS well no.	Model cell (column, row, layer)	Average amount appropriated (Mgal/d)	Yearly average pumpage reported in 1997 (Mgal/d)
33	Potomac Vista Corporation	PG52G004	PG Eb 22 PG Eb 23	16,7,2 16,7,2	0.015	0.018

[1]Sites are located on figure 23
[2]In the Indian Head-Bryans Road area
[3]Screened in the upper Patuxent aquifer or sands in the Arundel Clay
[4]One well out of four which pump under this permit is screened in the lower Patapsco aquifer

Appendix D (Part II). Appropriated ground-water use (1997) over 10,000 gallons per day in the upper Patuxent aquifer in the model area

[MGS = Maryland Geological Survey; USGS = U.S. Geological Survey;
Mgal/d = million gallons per day]

Site number[1]	Well owner or name-Charles County	Ground-water appropriation permit number (GAP)	MGS/USGS well no.	Model cell (column, row, layer)	Average amount appropriated (Mgal/d)	Yearly average pumpage reported in 1997 (Mgal/d)
34	Charles County, South Hampton	CH95G023	CH Bc 78	30,34,3	0.16	0.094[2]
35	Legend Properties, Inc.	CH93G029	CH Bc 75 CH Bc 77	32,42,3 34,41,3	0.39	0[2]

[1]Sites are located on figure 24
[2]In the Indian Head-Bryans Road area

NAVY CLOSED, TRANSFERRED, TRANSFERRING, ACTIVE, AND INACTIVE RANGE SURVEY

January 2000

SURVEY CERTIFICATION

Because the information collected by this survey will be used for a variety of purposes, including compliance with environmental regulations, the data must be as accurate as possible. To streamline the data collection process, the installation property owner is responsible for the completion and certification of this survey for all ranges, past and present, that meet the definitions outlined in this survey. Therefore, the property owner's Commanding Officer (CO) is required to certify that all information provided in the range survey is accurate and complete. In the case of regionalized installations, the CO of the installation must also sign the certification form. However, tenant commands must ensure that any ranges that they operate or have operated are included in the owner's response. In the case of property in caretaker status, the appropriate Naval Facilities Engineering Command organization is responsible for data collection and certification.

Responsible COs and Regional Commanders, as applicable, must sign and return the Certification Notice below with the completed survey to their Major Claimants for endorsement and submittal to the Navy Ordnance Environmental Support Office no later than 30 April 2000. Mail a copy of the completed and certified surveys to:

Navy Ordnance Environmental Support Office (OESO)
Attn: Code N57, Bldg D-327
23 Strauss Ave
Indian Head, MD 20646 or Fax to: 301-744-6749

Please direct any questions you may have to: Ms. Sherry McCahill, mccahillsm@ih.navy.mil, or Ms. Lois Bohne, bohnels@ih.navy.mil at 301-744-4355 or 4534

CERTIFICATION NOTICE

Installation Name: INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER

Regional Command (if applicable)

Installation Major Claimant: COMNAVSEASYSCOM WASHINGTON DC

Range Information is:

☑ Attached ☐ Not applicable to my activity (i.e. no ranges

I Certify that the information contained herein is accurate and complete to the best of my knowledg

Signature of Commanding Officer _____ Date _____

Signature of Regional Commander (if applicable) _____ Date _____

NAVY CLOSED, TRANSFERRED, TRANSFERRING, ACTIVE, AND INACTIVE RANGE SURVEY

JANUARY 2000

This survey applies to conventional munitions only. Please refer to Attachment One for the definition of terms used in this survey.

Part One: General Information for all ranges

I. Installation Information

A. Name INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTE

B. Address 101 STRAUSS AVE.
INDIAN HEAD, MD 20640-5000

C. UIC

D. Regional Commander

E. Major Claimant COMNAVSEASYSCOM WASHINGTON DC

II. General Range Information

A. Does or did the installation ever have a range (i.e. outdoor designated land or water area set aside, managed, and used to conduct research on, or to develop, test, and evaluate military munitions or to

◉ **Yes** ○ **No**

B. If yes, identify each range by name and status below (Note: See Attachment I for the definitions of active, inactive, and CTT ranges).

Table One - Range Status (select one)

No.	Range Name	Closed	Transferred	Transferring	Active	Inactive
1	Range 2	☐	☐	☐	☑	☐
2	Range 3	☐	☐	☐	☑	☐

For each CLOSED, TRANSFERRED, OR TRANSFERRING range identified in Table One above, complete Part Two. For each ACTIVE OR INACTIVE range, complete Part Three.

Part Three: Active & Inactive Range Information

Complete this section separately for each active and inactive range identified in Table One of Part One.

I. Primary Points of Contact:

	Range POC	Environmental POC
Name	AOC Marc Bond	Jack Meyers
Title/Code	Range Safety Supervisor/Code 6012	Environmental Manager/Code AC-4
Address	NAVEODTECHDIV	NAVEODTECHDIV
	2008 Stump Neck Road	2008 Stump Neck Road
	Indian Head, MD 20640-5070	Indian Head, MD 20640-5070
PhoneNumber	(301) 744-6867	(301) 744-6871/6872
Email Address	Bond@eodmgate.navsea.navy.mil	Meyers@eodmgate.navsea.navy.mil

II. Range Characteristics:

A. Range Name: **Range 2**

B. Range Status:

☑ Active ☐ Inactive

C. Range Classification (check each that applies):

☐ Small Arms Range (.50 cal. & under)
☐ Firing Range (projectile, torpedoes, etc.)
☑ Testing
☐ Training
☐ Open Burning/Open Detonation
☐ Other (Please Describe):

D. Range Type (check each that applies):

☐ Air to Air ☐ Land to Air ☐ Water to Air
☐ Air to Land ☐ Land to Land ☐ Water to Land
☐ Air to Water ☐ Land to Water ☐ Water to Water
☐ OB/OD (RCRA permitted or interim status unit)
☐ OB/OD (Training and/or emergency ops)
☑ Other (Please Explain): R & D Hypervelocity (high speed photography) of small explosive devices (<5lbs).

E. Where is/was the range located? (Include installation, town/city, county, state)

Installation: IHDIVNAVSURFWARCEN, STUMP NECK ANNEX

City or Town: Indian Head County: Charles State: MD

Longitude: 77 14 21W Latitude: 38 32 70N

F. What is the area of the range (in acres for land, square nautical miles for water)?

a. Impact area: Land portion 0 Water portion 0

b. Entire range (includes impact area): Land portion 2 Water portion 0

G. If wetlands are present at the range, what is the area of wetlands in each of the following (in acres)?

Impact area: 0 acres

Entire range (includes impact area 1 acres

H. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.)

☐ Less than 3 ☐ Between 3 and 12 ☐ Between 12 and 200 ☐ Over 200

I. If the range or portion of the range is within 3 miles of the shore, do any ordnance items enter the water in that portion of the range?

☐ Yes ☑ No ☐ Unknown ☐ Not Applicable

J. The enclosed geographical map shows the following:

☑ Range location ☑ Range bounderies ☐ Target locations

☐ Range areal extent including:

☐ Counties ☐ Tribal reservations ☐ Independent cities/towns/states

III. Range Ownership:

A. Who is the current owner of the land/range? (Select one. Be as specific as possible.)

☑ Navy ☐ Other Federal Agency ☐ Other

Identify: IHDIVNAVSURFWARCEN

B. If the land is not owned by the Navy, when does the lease or agreement to use the land expire?

C. Is the range or a portion of the range scheduled to be closed in accordance with the Base Realignment and Closure Act (BRAC)?

☐ Yes ☑ No

D. Who is the cognizant authority/range manager?

Name	AOC Marc Bond
Command	NAVEODTECHDIV
Title/Position	Range Safety Supervisor
Address	2008 Stump Neck Road
	Indian Head, MD 20640-5070
Phone #	(301) 744-6867
Email	Bond@eodmgate.navsea.navy.mil

E. Who are the primary users of the range? List training groups, squadrons, other services, foreign countries, etc.

No.	User Name
1	NAVEODTECHDIV
2	Federal or DOD Agencies

IV. Range Access:

A. How is access currently controlled? (Select all that apply.)

☐ No controls
☑ Signs
☐ Log-in book
☐ Office check in
☐ Guard at gate
☐ Fences
☐ Access key maintained by security/range officer
☑ Barricaded during operations
☑ Siren/notification during operations
☑ Patrolled by security officer or other official
☐ Patrolled by vessel
☐ Patrolled by aircraft
☐ Other

B. Have there been any documented instances of unauthorized access to the range by the public?

☑ None ☐ 1-2 instances per year ☐ Unknown
☐ 3-5 instances per year ☐ More than 5 instances

Please provide specific information for ranges with more than 3 instances per year.

V. Range Use:

A. When was the range last used? Oct 1999

B. When was the range established? Sep 1976

C. Is the range scheduled for closure ☐ Yes ☑ No

If Yes, what is the scheduled closure date?

D. Does a range manual/instruction (or operating guide) exist? ☑ Yes ☐ No

If Yes, please list title/date and provide documen elocity Test Facility Site 2 (Range 2) SOP Oct 1997

E. How often is the range used? (Select one)

☐ Daily ☐ Weekly ☑ Monthly ☐ Unknown
☐ Other

F. Do records exist that can be considered accurate and complete?

☑ Yes ☐ No ☐ Unknown

If Yes, please describe the records including the years for which they exist.

The range operating logs are dated from 1975 to 1985 and 1997 to present. From 1985 to 1997 Range 2 was active but not used.

G. If records of the range's use are kept, who maintains them?

Name	AOC Marc Bond
Command	NAVEODTECHDIV
Title/Position	Range Safety Supervisor
Address	2008 Stump Neck Road
	Indian Head, MD 20640-5070
Phone #	(301) 744-6867
Email	Bond@eodmgate.navsea.navy.mil

H. What type of range records are maintained? (Check all that apply)

☑ Munitions expenditures including:
☑ Types ☑ Quantities ☐ Locations ☐ Estimated dud rates
☐ Munitions mishaps attributed to UXO that occurred either on or off-range
☐ UXO clearance operations conducted on range
☐ All areas containing known or suspected UXO on range maps or installation master planning map
☐ Information on any rounds landing off-range that were unrecoverable or not loc
☑ List of personnel, squadrons, other services, foreign countries, etc. that use/used the range
☑ Other (please explain) Date and time.

I. What type of ordnance is/was used at the range? (Select all that apply)

☑ Small Arms Ammunition (.50 cal or under
☐ Hand Grenades
☐ Rifle Grenades
☐ Projected Grenades
☐ Mortars
☐ Bombs
☐ Rockets
☐ Large rocket motors (> 1,000 lbs)
☐ Warheads
☐ Projectiles
☐ Guided Missiles
☐ Ballistic Missiles
☐ Submunitions
☐ Torpedoes
☐ Mines
☐ Depth Charges
☐ Riot control agents
☑ Bulk propellant, propellant charges
☑ Bulk high explosives, demolition charges
☐ Pyrotechnics (flares, signals, simulators)
☑ Primers, detonators, fuzes, squibs
☐ CADs/PADs
☐ Other

J. If possible, please provide the NSNs, DODICs (i.e. NALCs), and standard nomenclature of these items as well as the number used at the range per year:

No.	Dodic/NALC	NSN	Nomenclature	Number Used CY97	CY98	CY99
1	A363	1305003085810	9mm Ammunition	0	0	11
2	M023	1375007247040	C-4	3	0	0
3	M984	1375010360447	Deta Sheet, 25"	0	0	0
4	None	None	Shock Tube (open purchase - listed as feet vice pou	0	0	300
5	None	None	RP-80 Detonator (open purchase)	3	2	0

K. On average, how much ordnance was used at the range annually? Please provide this information in total

Total Weight (lbs): 2 NEW

L. What types of targets were/are used at the range? ☐ Stationary ☐ Mobile ☑ None ☐ Unknown

If targets are/were used, please provide details including types and locations:

M. What range use reports are/were forwarded to a higher command?

If yes, please provide details including requirement referenc

Annual - Navy - P2ADS - OPNAVINST 5090.1B; Biennial - EPA - 40 CFR; Biennial - MDE (Maryland Department of Environment) - COMAR Title 26. Operations conducted at Range 2 are combined with the annual report submissions for Range 3.

VI. Range Clearance:

A. Does the range have an established maintenance schedule?

☑ Yes ☐ No ☐ Unknown

If Yes, please provide details:

On an as needed basis: contract grass mowing 1 or 2 times a month; and trash removal.

B. Does/did the range have an established UXO, range debris, or target clearance schedule?

☐ Yes ☑ No ☐ Unknown

If Yes, please provide details (including technologies used for detection, retrieval and destruction):

C. Are/were range debris moved from the range?

☑ Yes ☐ No ☐ Unknown

D. If yes, how is/was the range debris decontaminated?

☑ 100% visual inspectio ☐ Thermally processed - enclosed unit

☐ Thermally processed - pan ☐ Thermally processed - no containment

☐ Thermally processed - hot gas ☐ Washout ☐ Other

Please provide details:

Range 2 debris is in minute amounts and after visual inspection is incorporated with Range 3 debris for disposal.

E. Where does decontamination take place?

☑ On the range ☐ Off the range ☐ Both ☐ Unknown ☐ Not Applicable

F. In the past three years, has the activity recycled metal range debris through a local DRMO?

☐ Yes ☑ No ☐ Unknown ☐ Not Applicable

If Yes, please provide specific details (including the DRMO used and volume per year):

G. In the past three years, has the activity recycled metal range debris through a QRP?

☐ Yes ☑ No ☐ Unknown ☐ Not Applicable

If Yes, please provide specific details (including the types of items recycled, any processing of these items, and volume per year):

H. In the past three years, has the activity recycled metal range debris through direct sales?

☐ Yes ☑ No ☐ Unknown ☐ Not Applicable

If Yes, please provide specific details (including the types of items recycled, any processing of these items, and volume per year):

I. What is the position/title of the certifying individual? Range 2 Branch Head; Range Safety Superviso

VII. Environmental Investigations/Cleanups/Responses:

A. Is the range, including the impact area, undergoing or has already undergone any type of investigation, cleanup, or response action of unexploded ordnance (UXO) or other contamination?

☐ Yes ☑ No

Yes (Please elaborate):

If yes, please attach information including reason for the cleanup, regulatory authority (e.g. CERCLA, RCLA) the cleanup is/was conducted under, and anticipated/actual completion date. Include a copy of the work plan or reports if available.

B. If a response action is being taken or was taken, was it conducted under CERCLA or RCRA authorities?

☐ CERCLA ☐ RCRA ☐ Both ☐ Unknown

Please elaborate:

C. Has any investigation, sampling, or analysis of the range been conducted (i.e. soil, groundwater and surface water monitoring, air emissions assessment, impacts to endangered species and sensitive ecosystems,etc.)?

☐ Yes ☑ No

If Yes, please explain. Include media evaluated, tests conducted, results and subsequent actions taken.

NEPA categorical exclusion for nesting eagles issued to Range 2, Jul 96.

D. Is the range currently being monitored or sampled on a periodic basis for environmental reasons?

☐ Yes ☑ No

If Yes, please provide specific details.

E. Are any investigations, samplings, or analyses planned for the range in the future?

☐ Yes ☑ No

If Yes, please explain. Include estimated time frame, media to be evaluated, tests to be conducted, and potential actions to be taken.

VIII. Costs:

A. How much does it cost to maintain the range on an annual basis? (Please include the source of this funding): Total $ 30000

Security	$	0	Maintenance	$	10000
Safety	$	10000	Permit conditions	$	0
Labor	$	10000	Other	$	0

Comments: Source of funding: Overhead.

B. If the range, including the impact area, is undergoing or has already undergone any type of investigation, cleanup, or response action for unexploded ordnance (UXO) or other contamination, please provide the following cost data as of the end of FY99.

☐ Investigation

		Type of Funds			
☐ Complete	Cost $	☐ ERN	☐ BRAC	☐ O&MN	☐ Other
☐ On-going	Cost $	☐ ERN	☐ BRAC	☐ O&MN	☐ Other
☐ Planned	Cost $	☐ ERN	☐ BRAC	☐ O&MN	☐ Other

Comments:

☐ Response Action Type:

☐ Complete Cost $ ☐ ERN ☐ BRAC ☐ O&MN ☐ Other
☐ On-going Cost $ ☐ ERN ☐ BRAC ☐ O&MN ☐ Other
☐ Planned Cost $ ☐ ERN ☐ BRAC ☐ O&MN ☐ Other
Comments:

C. If any environmental investigations, samplings, or analyses of the range have been conducted or are planned, please provide the following cost data as of the end of FY99.

☐ Environmental investigations, samplings, or analyse

☐ Complete Cost $ ☐ ERN ☐ BRAC ☐ O&MN ☐ Other
☐ On-going Cost $ ☐ ERN ☐ BRAC ☐ O&MN ☐ Other
☐ Planned Cost $ ☐ ERN ☐ BRAC ☐ O&MN ☐ Other
Comments:

D. Please provide any other cost data that may be considered appropriate.

IX. Environmental Considerations:

A. Has the activity received any verbal and/or written notices from regulators regarding surface or ground water contamination associated with range use?

☑ None ☐ 1 ☐ 2-3 ☐ More than 3 ☐ Unknown

Please provide specific information for ranges with any notices.

B. Has the activity received any verbal and/or written notices from the public regarding surface or ground water contamination associated with range use?

☑ None ☐ 1 ☐ 2-3 ☐ More than 3 ☐ Unknown

Please provide specific information for ranges with any notices.

C. Do the activity's natural resource plans include resources located on the range?

☐ Yes ☑ No ☐ Unknown

D. Is there any information indicating the presence of any potential or known threatened/endangered species - flora and fauna - on the range?

☑ Yes ☐ No ☐ Unknown

If Yes, identify species: BALD EAGLES

E. Has the activity received any verbal and/or written notices from regulators regarding the adverse impacts on sensitive ecosystems or natural resources associated with range use?

☑ None ☐ 1 ☐ 2-3 ☐ More than 3 ☐ Unknown

Please provide specific information for ranges with any notices.

F. Has the activity received any verbal and/or written notices from the public regarding the adverse impacts

☑ None ☐ 1 ☐ 2-3 ☐ More than 3 ☐ Unknown

Please provide specific information for ranges with any notices.

G. Has the activity received any verbal and/or written notices from regulators regarding the permitting of range operations under any environmental media?

☑ None ☐ 1 ☐ 2-3 ☐ More than 3 ☐ Unknown

Please provide specific information regarding any such notice and the media in questio

H. Have any NEPA documents that address range operations been prepared?

☑ Yes ☐ No ☐ Unknown

If Yes, please list the titles of these documents.

Record of Categorical Exclusion # 13 for NEPA Project Number 96-021, Hypervelocity Range Operations, for nesting eagles

X. Outside Interest:

A. Describe the degree of public interest in this range:

☑ None ☐ Slightly interested ☐ Very interested ☐ Extremely interested

This interest is generally: ☐ Favorable ☐ Neutral ☐ Negative

Comments

B. Describe the degree of interest of any Federal land managers in the range:

☑ None ☐ Slightly interested ☐ Very interested ☐ Extremely interested

This interest is generally: ☐ Favorable ☐ Neutral ☐ Negative

Comments

C. Describe the degree of interest of any Federal and State regulators, including Indian tribes with regulatory authorities, in the range:

☒ None ☐ Slightly interested ☐ Very interested ☐ Extremely interested

This interest is generally: ☐ Favorable ☐ Neutral ☐ Negative

Comments

D. Are there any environmental justice issues associated with the range?

☐ Yes ☑ No

If Yes, please provide details:

RANGES LOCATED AT IHDIVNAVSURFWARCEN

April 2002 Closed Ranges and Other Sites Datacall

RANGE NUMBER	NAME OF RANGE	ACTIVE *	INACTIVE*	CLOSED, TRANSFERRED, TRANSFERRING	LOCATION OF THE RANGE	PURPOSE AND USE
	Strauss Ave. Thermal Treatment Point	X			Indian Head, MD	Thermal treatment of explosive hazardous waste generated on-site and from off-site Federal facilities and their contractors
	Test Point	X			Indian Head, MD	Destructive explosives testing for RDT&E.
	Range 2	X			NAVEODTECHDIV, Stump Neck Annex, Indian Head, MD	High Speed Photography, flash x-ray for EOD RDT&E
	Range 3	X			NAVEODTECHDIV, Stump Neck Annex, Indian Head, MD	Open burning explosive hazardous waste, EOD Training and EOD RDT&E
	Non-Explosive Magnetic Test Range (MTR)	X			NAVEODTECHDIV, Stump Neck Annex, Indian Head, MD	EOD Ordnance Detection Evaluation
	CBIRF EOD IED (Improvised Explosive Devices) Training Area	X			Partial use of the New Skeet Range at the Stump Neck Annex, Indian Head, MD	Training area for CBIRF (Marine Corps) for Improvised Explosive Devices (IED)
	Medium Caliber Gun Testing Facility		X		Rum Point, Stump Neck Annex, Indian Head, MD	Medium caliber gun testing to determine various gun ballistic information for IHDIVNAVSURFWARCEN personnel
	Range 6		X, Already in IR program as site #61. UXO Issues		Stump Neck Annex, Indian Head, MD	Demolition range for open detonation training
	Old Skeet Range		X, Included in the IR program		Stump Neck Annex, Indian Head, MD	Recreational skeet range (Not included in range datacalls because not a military munition range but a recreational range)
	New Skeet Range		X, has the potential for reuse and may be easily remediated for lead		Stump Neck Annex, Indian Head, MD	Recreational skeet range (Not included in range datacalls because not a military munition range but a recreational range)
	FDR Skeet Range		X, Historical Skeet Range with very little information		Indian Head, MD	This is a possible skeet range in the Nitration area. There are remnants of a trap house, ice house and BBQ pit. FDR allegedly used the facility for recreational purposes. (Not included in range datacalls because not a military munition range)
1	Caffee Road Thermal Treatment Point			Close all operations except the new decon pad which should be renamed. IR landfill underneath.	Indian Head, MD	Thermal decontamination of items that are minutely explosive contaminated generated on-site and from off-site facilities

RANGES LOCATED AT IHDIVNAVSURFWARCEN						
April 2002 Closed Ranges and Other Sites Datacall						
RANGE NUMBER	NAME OF RANGE	ACTIVE *	INACTIVE*	CLOSED, TRANSFERRED, TRANSFERRING	LOCATION OF THE RANGE	PURPOSE AND USE
2	Safety Thermal Treatment Point (Lower Point)			X, included in the FFA as an AOC (SWMU 20)	Indian Head, MD	Thermal treatment of explosives and propellants, resulting from research and testing operations at IHDIVNAVSURFWARCEN. Explosive safety testing for IHDIVNAVSURFWARCEN
3	Small Arms Range (Pistol)			Is already included in IR program as an AOC. SWMU #29. May never reopen due to proximity to Smallwood SP. Advised by NSWC to close all Small Arms and Skeet Ranges.	Stump Neck Annex, Indian Head, MD	Small arms (pistol) range for qualification and practice for various Federal, State and local law enforcement agencies and active duty Navy and Marine Corps
4	Area 8			will probably not use again because new magnetometer is being built. Site approval would difficult. IR site #63	Stump Neck Annex, Indian Head, MD	EODS Range used to train military personnel to defuse explosive devices
5	Improvised Explosive Devices (IED) Practical Training Area			will probably not use again. IR site #64	Stump Neck Annex, Indian Head, MD	Training operations to demonstrate household materials could be used for construct improvised explosive devices (IED), explosive tools demo area behind B 2096.
6	Inert Ordnance Disposal (IOD) Area			will probably not use again. IR site #65. UXO Issues	Stump Neck Annex, Indian Head, MD	Acement bunker where inert ordnance and inert training aids were discarded. Training exercises may have taken place there with the simulated deactivation of unexploded ordnance aboard an aircraft (an aircraft fuselage may have been on top of the IOD pad).
7	Air Blast Pond			will probably not use again. IR site #62	Stump Neck Annex, Indian Head, MD	100 foot pond where explosives were detonated above and in water for testing purposes such as concussion factor
8	Old Demolition Range			will probably not use again. IR site #31. UXO Issues	Stump Neck Annex, Indian Head, MD	Demolition training ground, pre-Range 3 era
9	Marine Rifle Range			Range was identified on 1917 map. Very little information on range operations	Stump Neck Annex, Indian Head, MD	Unknown other than possible rifle range
10	Test Area 1			Range was identified from historic search. Very little information on range operations	Stump Neck Annex, Indian Head, MD	Unknown other than area may have been used for explosive testing similar to air blast pond.

RANGES LOCATED AT IHDIVNAVSURFWARCEN						
April 2002 Closed Ranges and Other Sites Datacall						
RANGE NUMBER	NAME OF RANGE	ACTIVE *	INACTIVE*	CLOSED, TRANSFERRED, TRANSFERRING	LOCATION OF THE RANGE	PURPOSE AND USE
11	Test Area 2			Range was identified from historic search. Very little information on range operations	Stump Neck Annex, Indian Head, MD	Unknown. Area may have been used for ordnance testing and/or training.
12	SN Impact Area and Possible Firing Range Over SN			Already in IR program as Site 30. UXO Issues	Stump Neck Annex, Indian Head, MD	Ordnance was fired from the gun and rocket testing area at the valley to an impact area at Stump Neck
13	The Valley			Already in IR program as Site 29. UXO Issues	Indian Head, MD	Ordnance was fired from the gun and rocket testing area at the marina to the butts of the valley walls, to the impact area at SN and other possible locations.
14	Water Impact Areas			very little information on range operations. Possible UXO	The Potomac River From Chapmans Point to the Chicamuxen Creek and the possibly the Mattawoman Creek	Ordnance may have landed into water from gun and rocket testing from the valley, incidents from large motor test and unknown underwater testing
15	Igniter Area			X	Indian Head, MD	Igniters have washed up during low tide . Source unknown.
16	Battle Range Firing			X	North Bluff of Stump Neck, MD	Historical search revealed a battle firing range using pasteboard targets.
17	Former Pinkwater Treatment Facility			Currently undergoing RCRA Closure.	Stump Neck Annex, Indian Head, MD	Area used for steaming out ordnance. RCRA permitted for treating pinkwater through carbon. RDX found upgradient of site may be from another ordnance source.
18	Torpedo Burial Site			Meets the definition of other sites in the datacall. IR Site 35. UXO Issues	Stump Neck Annex, Indian Head, MD	Inert torpedo shells and associated hardware from a torpedo station near Washington, DC were buried. It is unknown if live ordnance or explosive residues were buried.
19	Single Base Propellant Grains Spill Area			IR Site 10. UXO Issues	Indian Head, MD	Single base propellant grains were spilled along the railroad tracks and around the power dry houses.
20	Causeway			IR Site 37	Stump Neck Annex, Indian Head, MD	The causeway was built up with fill material that may have included old torpedo casings. It is unknown if the casings included any energeic material or their residues.
21	NG Slums Burning Site			IR Site 22	Indian Head, MD	NG Slums generated from the NG plant were open burned. Other explosive wastes may have been burned here since it was operated until operation of the main burning point.
22	Original Burning Ground			IR Site 28	Indian Head, MD	Original burning ground for waste energetics such as smokeless powder
23	Torpedo Casing Disposal Area			Possible UXO	Stump Neck Annex, Indian Head, MD	Alleged torpedo casing disposal area. It is unknown if live ordnance or explosive residues were buried.

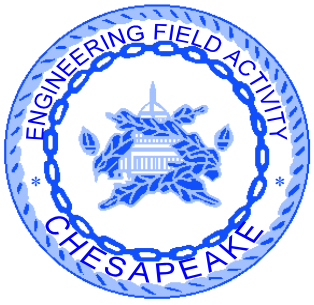
Site Screening Process Report

for

Site 32 – Suspected Tool Burial
Site 33 – Scrap Metal Pit
Site 34 – Tool Burial
Site 36 – Closed Landfill
Site 37 – Causeway
Site 51 – Building 101 Dry Well
Site 52 – Building 102 Dry Well

Indian Head Division
Naval Surface Warfare Center

Indian Head, Maryland



Engineering Field Activity Chesapeake
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888

Contract Task Order 0803

March 2003

050221/P

SITE SCREENING PROCESS REPORT
FOR
SITE 32 – SUSPECTED TOOL BURIAL
SITE 33 – SCRAP METAL PIT
SITE 34 – TOOL BURIAL
SITE 36 – CLOSED LANDFILL
SITE 37 – CAUSEWAY
SITE 51 – BUILDING 101 DRY WELL
SITE 52 – BUILDING 102 DRY WELL

INDIAN HEAD DIVISION
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Engineering Field Activity Chesapeake
1314 Harwood Street SE
Naval Facilities Engineering Command
Washington Navy Yard, D.C. 20374-5018

Submitted by:
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CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0803

MARCH 2003

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TABLE OF CONTENTS

SECTION		PAGE NO.
ACRONYMS		**ix**
EXECUTIVE SUMMARY		**ES-1**
1.0	**INTRODUCTION**	**1-1**
1.1	PURPOSE	1-1
1.2	OBJECTIVE AND SCOPE	1-1
1.3	REPORT ORGANIZATION	1-2
2.0	**BACKGROUND INFORMATION**	**2-1**
2.1	FACILITY LOCATION	2-1
2.2	PREVIOUS INVESTIGATIONS	2-1
2.3	PHYSICAL SETTING	2-2
2.3.1	Topography, Surface Water, and Drainage	2-2
2.3.2	Geology	2-3
2.3.3	Hydrogeology	2-4
2.3.4	Climate	2-4
2.4	SOILS	2-5
2.5	DEMOGRAPHY AND LAND USE	2-6
2.6	ECOLOGY	2-6
2.6.1	Flora	2-6
2.6.2	Wildlife	2-7
2.6.3	Aquatic Life	2-7
2.6.4	Threatened and Endangered Species	2-7
3.0	**GENERAL INVESTIGATIVE PROCEDURES**	**3-1**
3.1	GEOPHYSICAL SURVEYS	3-1
3.2	FIELD SAMPLING	3-1
3.2.1	Temporary Well Point Construction	3-1
3.2.2	Soil Borings and Subsurface Soil Sampling	3-2
3.2.3	Groundwater Sampling	3-2
3.2.4	Surface Water Sampling	3-3
3.2.5	Sediment Sampling	3-3
3.2.6	Quality Control Samples	3-3
3.2.7	Water-Level Measurements	3-3
3.3	LABORATORY ANALYSES	3-3
3.4	INVESTIGATION DERIVED WASTE HANDLING	3-4
3.5	SURVEYING	3-4
4.0	**GENERAL DATA EVALUATION METHODS**	**4-1**
4.1	DATA EVALUATION	4-1
4.1.1	General Data Validation Procedures	4-1
4.1.2	Data/Validation Qualifiers	4-2
4.2	BACKGROUND DATABASE	4-4
4.3	HUMAN HEALTH RISK SCREENING METHODOLOGY	4-5
4.3.1	Selection of Chemicals of Potential Concern	4-6
4.3.2	Exposure Assessment	4-7
4.3.3	Risk Characterization	4-8

TABLE OF CONTENTS (Continued)

SECTION		PAGE NO.
4.4	ECOLOGICAL RISK ASSESSMENT METHODOLOGY	4-9
4.4.1	Problem Formulation	4-9
4.4.2	Exposure Assessment	4-11
4.4.3	Ecological Effects Assessment	4-11
4.4.4	Risk Characterization	4-11
5.0	**SITE 32 – SUSPECTED TOOL BURIAL**	**5-1**
5.1	BACKGROUND	5-1
5.2	SITE CHARACTERISTICS	5-1
5.2.1	Topography	5-1
5.2.2	Surface Water	5-1
5.2.3	Geology/Soils	5-1
5.2.4	Hydrogeology	5-1
5.3	FIELD INVESTIGATION	5-1
5.4	ANALYTICAL RESULTS	5-2
5.5	HUMAN HEALTH RISK SCREENING EVALUATION	5-2
5.6	ECOLOGICAL RISK SCREENING EVALUATION	5-2
5.7	SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	5-2
5.7.1	Summary and Conclusions	5-2
5.7.2	Recommendations	5-2
6.0	**SITE 33 – SCRAP METAL PIT**	**6-1**
6.1	BACKGROUND	6-1
6.2	SITE CHARACTERISTICS	6-1
6.2.1	Topography	6-1
6.2.2	Surface Water	6-1
6.2.3	Geology/Soils	6-1
6.2.4	Hydrogeology	6-1
6.3	FIELD INVESTIGATION	6-2
6.3.1	Geophysical Investigation	6-2
6.3.2	Temporary Well Installation and Groundwater Sampling	6-2
6.3.3	Subsurface Soil Sampling	6-3
6.3.4	Test Pit Activities	6-3
6.4	ANALYTICAL RESULTS AND COPC SELECTION	6-3
6.4.1	Data and Risk-Based Evaluation of Subsurface Soil Contamination	6-4
6.4.2	Data and Risk-Based Evaluation of Groundwater Contamination	6-4
6.5	HUMAN HEALTH RISK SCREENING EVALUATION	6-5
6.5.1	Subsurface Soil	6-6
6.5.2	Groundwater	6-6
6.6	ECOLOGICAL RISK SCREENING EVALUATION	6-6
6.6.1	Data and Risk-Based Evaluation of Groundwater Contamination	6-7
6.7	SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	6-7
6.7.1	Summary and Conclusions	6-7
6.7.2	Recommendations	6-8

TABLE OF CONTENTS (Continued)

SECTION		PAGE NO.
7.0	**SITE 34 – TOOL BURIAL**	**7-1**
7.1	BACKGROUND	7-1
7.2	SITE CHARACTERISTICS	7-1
7.2.1	Topography	7-1
7.2.2	Surface Water	7-1
7.2.3	Geology/Soils	7-1
7.2.4	Hydrogeology	7-1
7.3	FIELD INVESTIGATION	7-2
7.3.1	Geophysical Investigation	7-2
7.3.2	Test Pit Activities	7-2
7.3.3	Temporary Well Installation and Groundwater Sampling	7-3
7.3.4	Subsurface Soil Sampling	7-3
7.4	ANALYTICAL RESULTS AND COPC SELECTION	7-3
7.4.1	Data and Risk-Based Evaluation of Subsurface Soil Contamination	7-4
7.4.2	Data and Risk-Based Evaluation of Groundwater Contamination	7-4
7.5	HUMAN HEALTH RISK SCREENING EVALUATION	7-4
7.6	ECOLOGICAL RISK SCREENING EVALUATION	7-4
7.6.1	Data and Risk-Based Evaluation of Groundwater Contamination	7-5
7.7	SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	7-5
7.7.1	Summary and Conclusions	7-5
7.7.2	Recommendations	7-5
8.0	**SITE 36 – CLOSED LANDFILL**	**8-1**
8.1	BACKGROUND	8-1
8.2	SITE CHARACTERISTICS	8-1
8.2.1	Topography	8-1
8.2.2	Surface Water	8-1
8.3	FIELD INVESTIGATION	8-1
8.3.1	Geophysical Investigation	8-1
8.4	ANALYTICAL RESULTS	8-2
8.5	HUMAN HEALTH RISK SCREENING EVALUATION	8-2
8.6	ECOLOGICAL RISK SCREENING EVALUATION	8-2
8.7	SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	8-2
8.7.1	Summary and Conclusions	8-2
8.7.2	Recommendations	8-2
9.0	**SITE 37 – CAUSEWAY**	**9-1**
9.1	BACKGROUND	9-1
9.2	SITE CHARACTERISTICS	9-1
9.2.1	Topography	9-1
9.2.2	Surface Water	9-1
9.2.3	Geology/Soils	9-1
9.2.4	Hydrogeology	9-1
9.3	FIELD INVESTIGATION	9-2
9.3.1	Temporary Well Installation and Groundwater Sampling	9-2
9.3.2	Subsurface Soil Sampling	9-2
9.3.3	Surface Water and Sediment Sampling	9-3

TABLE OF CONTENTS (Continued)

SECTION		PAGE NO.
9.4	ANALYTICAL RESULTS AND COPC SELECTION	9-3
9.4.1	Data and Risk-Based Evaluation of Subsurface Soil Contamination	9-3
9.4.2	Data and Risk-Based Evaluation of Groundwater Contamination	9-4
9.4.3	Data and Risk-Based Evaluation of Surface Water Contamination	9-5
9.4.4	Data and Risk-Based Evaluation of Sediment Contamination	9-6
9.5	HUMAN HEALTH RISK SCREENING EVALUATION	9-6
9.5.1	Groundwater	9-6
9.5.2	Surface Water	9-7
9.5.3	Sediment	9-7
9.5.4	Exposure to Lead	9-7
9.5.5	Uncertainty Analysis	9-8
9.6	ECOLOGICAL RISK SCREENING EVALUATION	9-9
9.6.1	Groundwater	9-9
9.6.2	Surface water	9-10
9.6.3	Sediment	9-10
9.7	SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	9-11
9.7.1	Summary and Conclusions	9-11
9.7.2	Recommendations	9-11
10.0	**SITE 51 - BUILDING 101 DRY WELL**	**10-1**
10.1	BACKGROUND	10-1
10.2	SITE CHARACTERISTICS	10-1
10.2.1	Topography	10-1
10.2.2	Surface Water	10-1
10.2.3	Geology/Soils	10-1
10.3	FIELD INVESTIGATION	10-2
10.3.1	Geophysical Investigation	10-2
10.3.2	Subsurface Soil Sampling	10-2
10.4	ANALYTICAL RESULTS AND COPC SELECTION	10-3
10.4.1	Data And Risk-Based Evaluation of Subsurface Soil Contamination	10-3
10.5	HUMAN HEALTH RISK SCREENING EVALUATION	10-3
10.6	ECOLOGICAL RISK SCREENING EVALUATION	10-4
10.7	SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	10-4
10.7.1	Summary and Conclusions	10-4
10.7.2	Recommendations	10-4
11.0	**SITE 52 - BUILDING 102 DRY WELL**	**11-1**
11.1	BACKGROUND	11-1
11.2	SITE CHARACTERISTICS	11-1
11.3	FIELD INVESTIGATION	11-1
11.4	ANALYTICAL RESULTS	11-2
11.5	HUMAN HEALTH SCREENING EVALUATION	11-2
11.6	ECOLOGICAL RISK EVALUATION	11-2
11.7	SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	11-2
11.7.1	Summary and Conclusions	11-2
11.7.2	Recommendations	11-2
REFERENCES		**R-1**

TABLE OF CONTENTS (Continued)

APPENDICES

A WELL ABANDONMENT REPORTS AND WELL COMPLETION REPORTS
B TEST PIT AND SOIL BORING LOGS
C SAMPLE LOG SHEETS AND CHAIN OF CUSTODY FORMS
D GEOPHYSICAL REPORT
E GROUNDWATER - LEVEL DATA
F SURVEY DATA
G DATA VALIDATION MEMORANDA
H DATABASE
I HUMAN HEALTH RISK SCREENING CALCULATIONS

TABLES

NUMBER

2-1 Temperature Data for LaPlata, Charles County, Maryland
2-2 Precipitation Data for LaPlata, Charles County, Maryland
2-3 Miscellaneous Weather Data for LaPlata, Charles County, Maryland
4-1 Background Threshold Concentrations
4-2 Human Health Screening Criteria - Soil
4-3 Human Health Screening Criteria - Water
4-4 Ecological Screening Criteria - Sediment
4-5 Ecological Screening Criteria - Surface Water/Groundwater
6-1 Environmental Sampling and Analysis Summary - Site 33
6-2 Summary of Positive Detections - Subsurface Soil - Site 33
6-3 Occurrence, Distribution, and Selection of Human Health COPCs - Subsurface Soil - Site 33
6-4 Summary of Positive Detections - Groundwater - Site 33
6-5 Occurrence, Distribution, and Selection of Human Health COPCs - Groundwater - Site 33
6-6 Summary of Receptor Risks and Hazards for COPCs - Subsurface Soil - Site 33
6-7 Summary of Receptor Risks and Hazards for COPCs - Groundwater - Site 33
6-8 Summary of Receptor Risks and Hazards for COPCs - Filtered Groundwater - Site 33
6-9 Selection of Ecological COPCs - Groundwater - Site 33
7-1 Environmental Sampling and Analysis Summary - Site 34
7-2 Summary of Positive Detections - Subsurface Soil - Site 34
7-3 Occurrence, Distribution, and Selection of Human Health COPCs - Subsurface Soil - Site 34
7-4 Summary of Positive Detections - Groundwater - Site 34
7-5 Occurrence, Distribution, and Selection of Human Health COPCs - Groundwater - Site 34
7-6 Selection of Ecological COPCs - Groundwater - Site 34
9-1 Environmental Sampling and Analysis Summary - Site 37
9-2 Summary of Positive Detections - Subsurface Soil - Site 37
9-3 Occurrence, Distribution, and Selection of Human Health COPCs - Subsurface Soil - Site 37
9-4 Summary of Positive Detections - Groundwater - Site 37
9-5 Occurrence, Distribution, and Selection of Human Health COPCs - Groundwater -Site 37
9-6 Summary of Positive Detections - Surface Water - Site 37

TABLES (Continued)

NUMBER

9-7 Occurrence, Distribution, and Selection of Human Health COPCs - Surface Water - Site 37
9-8 Summary of Positive Detections - Sediment - Site 37
9-9 Occurrence, Distribution, and Selection of Human Health COPCs - Sediment - Site 37
9-10 Summary of Receptor Risks and Hazards for COPCs - Groundwater - Site 37
9-11 Summary of Receptor Risks and Hazards for COPCs - Surface Water - Site 37
9-12 Summary of Receptor Risks and Hazards for COPCs - Sediment - Site 37
9-13 Occurrence, Distribution, and Selection of Ecological COPCs - Groundwater - Site 37
9-14 Occurrence, Distribution, and Selection of Ecological COPCs - Surface Water - Site 37
9-15 Occurrence, Distribution, and Selection of Ecological COPCs - Sediment - Site 37
10-1 Environmental Sampling and Analysis Summary - Site 51
10-2 Summary of Positive Detections - Subsurface Soil - Site 51
10-3 Occurrence, Distribution, and Selection of Human Health COPCs - Subsurface Soil - Site 51

FIGURES

NUMBER

2-1 Vicinity Map
2-2 Site Location Map, Main Area
2-3 Site Location Map, Stump Neck Annex
4-1 Human Health General Conceptual Site Model
4-2 Ecological General Conceptual Site Model
5-1 Site Layout - Site 32
6-1 Site Layout - Site 33
6-2 Sample Location Map - Site 33
6-3 Subsurface Soil COPC Concentrations - Site 33
6-4 Groundwater COPC Concentrations - Site 33
7-1 Site Layout - Site 34
7-2 Sample Location Map - Site 34
8-1 Site Layout - Site 36
8-2 Conductivity Contour Map - Site 36
9-1 Site Layout - Site 37
9-2 Sample Location Map - Site 37
9-3 Groundwater COPC Concentrations - Site 37
9-4 Surface Water COPC Concentrations - Site 37
9-5 Sediment COPC Concentrations - Site 37
10-1 Site Layout - Sites 51 and 52
10-2 Sample Location Map - Sites 51 and 52
10-3 Subsurface Soil COPC Concentrations - Sites 51 and 52

LIST OF ACRONYMS/ABBREVIATIONS

µg/kg	micrograms per kilogram
µg/L	micrograms per liter
µg/dL	micrograms per deciliter
AET	Adverse Effects Threshold
AR	Administrative Record
ARAR	Applicable or Relevant and Appropriate Requirements
ATV	all-terrain vehicle
AWQC	Ambient Water Quality Criteria
B&R Environmental	Brown and Root Environmental
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
BI	background investigation
BTAG	Biological Technical Assistance Group
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
COC	chain-of-custody
COPC	chemical of potential concern
CSM	conceptual site model
CTO	Contract Task Order
DON	Department of the Navy
EEQ	ecological effects quotient
EM	electromagnetic
EOD	explosive ordnance disposal
EPA	United States Environmental Protection Agency
EPC	Exposure Point Concentrations
ERT	Earth Resources Technology, Inc.
FFA	Federal Facilities Agreement
FS	feasibility study
GC/MS	gas chromatography/mass spectrometry
GPR	ground penetrating radar
HI	Hazard Index
HQ	Hazard Quotient
HSA	hollow-stem auger
IAS	Initial Assessment Study

ICP	inductively coupled plasma
ID	inside diameter
IDW	investigation-derived waste
IEUBK	Integrated Exposure Uptake Biokinetic
IHDIV-NSWC	Indian Head Division, Naval Surface Warfare Center
ILCR	Incremental Lifetime Cancer Risk
IHIRT	Indian Head Installation Restoration Team
IR	Installation Restoration
LEL	Lowest Effects Level
MCL	Maximum Contaminant Level
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
mg/L	milligrams per liter
msl	mean sea level
mS/m	millisiemens/meter
NAD	North American Datum
NCP	National Oil and Hazardous Substances Contingency Plan
NFESC	Naval Facilities Engineering Service Center
NGVD	North American Geodetic Vertical Datum
NOAA	National Oceanic and Atmospheric Administration
NOAEL	no observed adverse effect level
NOEL	no observed effect level
NSWC	Naval Surface Warfare Center
NTU	nephelometric turbidity units
OSHA	Occupational Safety and Health Administration/Act
OSWER	Office of Solid Waste and Emergency Response
PA	preliminary assessment
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PEC	Probable Effects Concentration
PID	photoionization detector
ppb	parts per billion
ppm	parts per million
PPE	personal protective equipment
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control

RBC	risk-based concentration
RCRA	Resource Conservation and Recovery Act
RDX	hexahydro-1,3,5-trinitro-1,3,5-triazine
RI	remedial investigation
RPM	remedial project manager
SARA	Superfund Amendments and Reauthorization Act
SERA	Screening Level Ecological Risk Assessment
SOP	Standard operating procedure
SOW	Statement of Work
SSA	Site Screening Area
SSL	soil screening level
SSP	Site Screening Process
SVOC	semivolatile organic compound
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCL	Target Compound List
TtNUS	Tetra Tech NUS, Inc.
UCL	upper confidence limit
USDA	United Sates Department of Agriculture
USGS	United States Geological Survey
UTL	upper tolerance limit
VOC	volatile organic compound
WP	work plan
WQC	water quality criteria

EXECUTIVE SUMMARY

This Site Screening Process (SSP) report for seven sites at Indian Head Naval Surface Warfare Center (IHDIV-NSWC) Indian Head, Maryland was prepared by Tetra Tech NUS, Inc. (TtNUS) under the Comprehensive Long-Term Environmental Action Navy (CLEAN), Contract Number N62467-94-D-0888, Contract Task Order (CTO) 0803.

The objective of the SSP investigation was to collect sufficient data for the seven sites to determine for each site whether the site requires additional investigation (e.g., remedial investigation/feasibility study), or whether it can be closed with no further action. EPA Region 3 human health residential risk-based concentrations (RBCs) were used to evaluate human health risk. A screening level ecological risk assessment was used to evaluate ecological risk. The seven sites and the recommended dispositions are as follows:

Site 32 – Suspected Tool Burial

No samples were collected at this site based on the results at Site 34, a similar site. No action is recommended.

Site 33 – Scrap Metal Pit

Six subsurface soil samples and three groundwater samples were collected. Based on the laboratory results and a preliminary human health risk evaluation, a supplemental sampling investigation is recommended to verify the results of a single turbid groundwater sample before determining if an RI is justified.

Site 34 – Tool Burial

One subsurface soil sample and three groundwater samples were collected. Based on comparison of the laboratory results to screening levels, no action is recommended.

Site 36 – Closed Landfill

A geophysical investigation was performed, but no samples were collected. Because the geophysical investigation identified the presence of buried material, and because of the anticipated level of effort needed to evaluate this type of site, a remedial investigation/feasibility study is recommended.

Site 37 – Causeway

Five subsurface soil samples, three groundwater samples, three surface water samples, and three sediment samples were collected. Based on the laboratory results and a preliminary human health risk

evaluation, a remedial investigation/feasibility study is recommended. The RI should also include further evaluation of ecological COPCs.

Site 51 – Building 101 Dry Well

Two subsurface soil samples were collected and trace concentrations of benzene and toluene were detected. Only one dry well was found in an area where two dry wells were suspected (see Site 52, below). Based on the laboratory results and site conditions, no action is recommended.

Site 52 – Building 102 Dry Well

Only one dry well was found, and it was designated as Site 51. No second dry well was found, so Site 52 does not exist. No action is recommended.

1.0 INTRODUCTION

This Site Screening Process (SSP) report for seven sites at Indian Head Naval Surface Warfare Center (IHDIV-NSWC) Indian Head, Maryland was prepared by Tetra Tech NUS, Inc. (TtNUS) under the Comprehensive Long-Term Environmental Action Navy (CLEAN), Contract Number N62467-94-D-0888, Contract Task Order (CTO) 0803.

1.1 PURPOSE

The purpose of the SSP is to determine whether operations at seven sites have resulted in the release of hazardous substances, pollutants, contaminants, hazardous wastes, or hazardous constituents at concentrations of potential environmental concern. Five of the seven sites are among the 37 Site Screening Areas (SSAs) identified in Appendix B of the Federal Facilities Agreement (FFA). SSAs are those geographical areas with suspected contamination that will require some level of investigation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program. The other two sites of the seven sites were not among the list of SSAs and are being investigated to confirm previous evaluations.

1.2 OBJECTIVE AND SCOPE

The objective of the SSP investigation was to collect sufficient data to determine whether each of the sites requires additional investigation [i.e., supplemental SSP investigation or remedial investigation (RI)/feasibility study (FS)], designation as an accelerated operable unit, or if the site can be closed with no action (NA). The general scope of this SSP investigation was agreed upon by the Indian Head Installation Restoration Team (IHIRT) in the Site Screening Investigation Work Plan (TtNUS, 2001). The following sites were investigated under this SSP:

- Site 32 – Suspected Tool Burial (SSA)
- Site 33 – Scrap Metal Pit (SSA)
- Site 34 – Tool Burial (SSA)
- Site 36 – Closed Landfill (SSA)
- Site 37 – Causeway (SSA)
- Site 51 – Building 101 Dry Well (not an SSA)
- Site 52 – Building 102 Dry Well (not an SSA)

The investigative process consisted of research, limited geophysical investigations, media sampling, and analytical data evaluation. The research consisted of a review of historical facility documents as related

to the operations at the individual sites, and interviews with Base personnel. Geophysical surveys were conducted at Sites 33, 34, 36, 51, and 52 to more accurately identify sample locations, site boundaries, and buried utility lines. Environmental media sampling was conducted at six of the seven sites. Samples were collected from soil, groundwater, surface water, and/or sediment locations, as appropriate, based on site history and possible containment transport pathways. Analytical data were evaluated via a formal data validation process, background comparisons, and human health and ecological risk screening analyses.

1.3 REPORT ORGANIZATION

Section 1.0 of this report presents the purpose, scope, and objectives of this report. Section 2.0 provides background information for IHDIV-NSWC. Section 3.0 describes the investigative procedures that were used to implement the fieldwork at the SSP sites. A discussion of the general data evaluation methods used in this SSP report is provided in Section 4.0. Sections 5.0 through 11.0 provide the background, physical characteristics, summaries of field activities, analytical data, risk screening analyses, conclusions, and recommendations for each SSP site.

Support documentation for the SSP investigation is appended to this report. The field forms associated with the field investigation are contained in Appendices A through F. The entire analytical database (including nondetect and positive analytical results) for the SSP sites and a data validation report for the associated chemical analyses are provided in Appendices G and H. Appendix I contains support documentation for the human health risk screening analyses.

2.0 BACKGROUND INFORMATION

This section presents the facility location and history, a discussion of previous environmental investigations at IHDIV-NSWC, physical characteristics of the facility, demography and land use, and ecology.

2.1 FACILITY LOCATION

The IHDIV-NSWC is located in northwestern Charles County, Maryland, approximately 25 miles southwest of Washington, DC. The IHDIV-NSWC is a military facility consisting of the Main Area on the Cornwallis Neck Peninsula and the Annex on Stump Neck. The Main Area is bounded by the Potomac River to the northwest, west, and south, Mattawoman Creek to the south and east, and the town of Indian Head to the northeast (Figure 2-1). Stump Neck Annex is located across Mattawoman Creek. The Stump Neck Annex is not contiguous with the main area. It has a separate United States Environmental Protection Agency (EPA) identification number, and is operated by a tenant. Sites 32, 33, 34, 36, and 37 are located within the Stump Neck Annex. Sites 51 and 52 are located within the main base area. The locations of the seven sites are shown on Figures 2-2 and 2-3.

2.2 PREVIOUS INVESTIGATIONS

The following provides brief descriptions of past investigations at IHDIV-NSWC, which were conducted to address some or all of the Installation Restoration (IR) sites and that specifically relate to the seven sites included in this report.

In 1983, the Navy completed an initial assessment study (IAS) of IHDIV-NSWC. This study identified and examined 29 sites in the Main Area and 9 sites in the Stump Neck Annex. Sites 32, 33, 34, 36, and 37 were included in this study. In 1996, the Navy, EPA, and Maryland Department of the Environment (MDE) decided to perform RIs at eight sites in the Main Area and postpone further investigation of the balance of the sites to the Site Screening Process (EPA and DON, 2000).

In 1992, the Navy completed a supplemental preliminary assessment (PA). This PA was an addendum to the IAS and examined 17 additional sites in the Main Area. Sites 51 and 52 were included in this study. At that time, no action was recommended for Sites 51 and 52.

In 1988, the EPA completed a Resource Conservation and Recovery Act (RCRA) solid waste management unit (SWMU) Investigation of the Main Base Area. This document included 78 SWMUs and

12 areas of concern. In 1990, the EPA completed a RCRA SWMU Investigation of the Stump Neck Annex. This document included 24 SWMUs. Sites 32, 33, 34, 36, and 37 were identified as SWMUs.

Since 1983, additional site-specific investigations, studies, and removal actions have been performed at other sites throughout IHDIV-NSWC. Information on these studies can be found in other reports. In addition, Sites 51 and 52 are encompassed by the RI that is currently underway in the Lab Area (Sites 14, 15, 16, 49, 50, 53, 54, and 55).

A basewide Background Investigation (BI) was performed in 1997 (B&R Environmental, 1997). This study was expanded and revised in February 2002 (TtNUS, 2002). The purpose of the BI was to establish a basewide background database for IHDIV-NSWC that would be used as a tool to evaluate analytical results for soil and groundwater samples collected during future investigations. In particular, the data contained in the BI would be used to determine whether environmental samples collected at IHDIV-NSWC contain contaminants at concentrations that exceed naturally occurring background concentrations. Section 4.2 contains a more detailed discussion of the BI and its applicability to the SSP.

2.3 PHYSICAL SETTING

General descriptions of the physical setting at IHDIV-NSWC are provided below.

2.3.1 Topography, Surface Water, and Drainage

Indian Head consists of two areas: the Indian Head NSWC and the Stump Neck Annex. Indian Head lies within the Atlantic Coastal Plain Physiographic Province, approximately 8 to 10 miles east of the Fall Line that marks the western extent of the Atlantic Coastal Plain Physiographic Province. The two facilities have gently rolling to undulating topography with elevations ranging from sea level to 111 feet above mean sea level (msl). The higher elevations exist in the northern portion of Indian Head. Generally, the land surface slopes to the east and southeast, with slopes of 5-percent or less. The western side of the base along the Potomac River is characterized by 40- to 50-foot bluffs, and the eastern side along Mattawoman Creek is more gradational, except for a few areas with several 10- to 40-foot bluffs (Hart, 1983).

The three principal waterways in the vicinity of IHDIV-NSWC and Stump Neck Annex are the Potomac River, Mattawoman Creek, and Chicamuxen Creek. The Potomac River is a tidally influenced estuary that is slightly brackish. Mattawoman and Chicamuxen Creeks are tributaries to the Potomac River. Both are also tidally influenced. Tidal marshes exist along Mattawoman Creek and Chicamuxen Creek.

Wastewater from IHDIV-NSWC is discharged directly to the Potomac River or Mattawoman Creek and from outfalls to tributaries of the Potomac River or Mattawoman Creek. The wastewaters consist of industrial, sanitary, and storm effluents or combinations thereof (Hart, 1983).

2.3.2 Geology

The regional geology consists of a sedimentary wedge of Cretaceous to Quaternary, fluvial and marine deposits overlying crystalline Precambrian metamorphic and igneous bedrock. The sedimentary wedge dips and thickens eastward and ranges in thickness from 650 feet in the west to 900 feet in the eastern portion of the Charles County (Vroblesky, 1991). It lies unconformably on the crystalline basement rock surface, which dips to the east.

The geologic units underlying IHDIV-NSWC, in stratigraphically ascending order, are the Lower Cretaceous Potomac Group, the Tertiary age Aquia Formation and Park Hall Formation, and several Quaternary fluvial and estuarine deposits.

The Potomac Group (Lower Cretaceous) consists of three geologic units (in descending stratigraphic order): the Patapsco Formation, the Arundel Formation, and the Patuxent Formation. The lithology of the Potomac Group consists of interbedded clay, silt, sand, and gravel deposited in fluviodeltaic environments (Hiortdahl, 1990) and ranges in thickness from 650 to 750 feet (Vroblesky, 1991; Harsh, 1990). The Patapsco Formation generally consists of clays with interbedded sand units. The Arundel Formation generally consists of a variegated clay. The Patuxent Formation consists of clays with interbedded sand units.

The Aquia Formation (Upper Paleocene) consists of marine deposits of olive black to olive gray, micaceous, glauconitic quartz sand interbedded with sand, silt, and clay. The formation is approximately 0 to 80 feet thick in the IHDIV-NSWC peninsula area.

The Park Hall Formation (upper Pliocene) consists of non-marine, fluvial, and estuarine deposits of sand and clay interbedded with sand with gravel. It is overlain unconformably by Quaternary deposits. The thickness of this formation in the area ranges from 0 to approximately 60 feet.

The Tertiary geologic formations are missing in many locations in the IHDIV-NSWC peninsula area. Where this occurs, the overlying Quarternary deposits come in contact with the underlying Cretaceous formations. The Quarternary fluvial and estuarine deposits in the IHDIV-NSWC peninsula area consist of Pleistocene paleochannel deposits and Holocene alluvial deposits (Hiortdahl, 1990). These deposits consist of gravel, sand, silt, clay, and peat mixtures with irregular bedding. The aggregate thickness may range from 0 to approximately 40 feet.

2.3.3 Hydrogeology

The lower and middle sands of the Patasco Formation and the Patuxent Formation of the Potomac Group are the principal aquifers for domestic use at the IHDIV-NSWC. Potable water wells at IHDIV-NSWC are screened in one or more sand zones to an average depth of 200 to 300 feet. These potable water wells serve an approximate population of 3,350 people, including civilian and enlisted Navy employees and contractor employees. None of these wells supply reserves or residences beyond the facility boundaries. The Upper Sands of the Patasco Formation are poor producers of groundwater in the area and are not considered to be an important aquifer. The Upper Sands are considered to be a confining layer above the underlying Middle and Lower Sand Aquifers in the area and below the shallow, small-scale, surficial water-bearing zones. The Middle Sand aquifer is believed to be hydraulically connected to the Potomac River, where the river has eroded into the aquifer. Potomac River water may be partially recharging the aquifer in this area because of the heavy pumping of supply wells at Indian Head (Hiortdahl, 1990).

Shallow, unconfined to semiconfined groundwater at the IHDIV-NSWC occurs from near surface to approximately 45 feet below ground surface (bgs), with water-table elevations ranging from sea level to approximately 65 feet above msl. Typically, the shallow groundwater occurs in perched water-bearing zones and is recharged from infiltration (Hart, 1983; Slaughter and Otton, 1968). In some lowland areas, surface water intrusion may be an additional source of recharge of the shallow aquifer along the edge of water bodies and during periods of high tide. It is assumed that shallow groundwater flow follows topography and discharges into local water bodies.

2.3.4 Climate

IHDIV-NSWC is located in the Atlantic Coastal Plain on the eastern bank of the Potomac River, midway between the rigorous climate of the north and the mild climate of the south. Since IHDIV-NSWC is located in the middle latitudes where the general atmospheric flow is from west to east across North America, it has a continental-type climate with four well-defined seasons. However, the proximity of the Potomac River and its tributaries has a considerable modifying effect on the climate, especially in moderating extreme temperatures.

Indian Head experiences a modified moist, humid continental climate with warm and wet summers and cool winters. The Appalachian and Blue Ridge Mountain ranges to the west obstruct cold, continental air in the winter, and the Potomac River and Atlantic Ocean contribute to more moderate temperatures and higher humidity.

The annual normal temperature (1971 to 2000) is 56ºF (UMD, 2002). The warmest month is typically July, with a normal temperature of 76ºF, and January is the coldest month, with a normal temperature of 35ºF. The normal annual precipitation is approximately 44 inches, normal monthly precipitation varying from 2.25 (February) to 4.60 (August) inches.

Prevailing surface winds are from the west-northwest to northwest except during the warm months of the year, when they become more southerly. The periods with most wind occur in late winter and early spring. The growing season is approximately 187 days long.

More detailed data are presented in Tables 2-1, 2-2, and 2-3.

2.4 SOILS

The following discussion is a brief description of the soil types as classified by the United States Department of Agriculture (USDA) Soil Survey of Charles County, Maryland, 1974. The dominant soil series in the Indian Head area are the Beltsville, Keyport, and Elkton Silt Loams (Hart, 1983). Additional soil types commonly found on the Stump Neck Annex and surrounding area are Alluvial Land, Exum, Gravelly Land, Mattawan, and Westphalia.

The Beltsville Silt Loam is found primarily in the upland elevations of the northern portion of the Indian Head facility. The Beltsville series soils consist of silt and sand with moderate amounts of clay. They are nearly level to moderately sloping and slowly permeable but well drained.

Areas of cut-and-fill soils are found in the northern portion of IHDIV-NSWC. Cut-and-fill lands are areas where the native soils have been removed and graded or filled with other material or soil.

The Keyport and Elkton Silt Loams are found in the lower elevations of the southern portion of IHDIV-NSWC. They are both clayey silt loam soils. Both series are slowly permeable; however, the Elkton series is less permeable than the Keyport series.

The Gravelly Land soils consist of gravelly deposits with soil types unidentifiable due to erosion.

Alluvial Land is nearly level and consists of soils formed by material recently eroded from uplands and deposited on flood plains or other low-lying areas. The predominant soil is silt, which generally drain poorly. However, in areas where the soil is sandier, it drains well.

The Exum Series consists of gently sloping to moderately sloping, deep, moderately draining soils on uplands. These soils are silty loams, with moderate amounts of clay and minor amounts of sand.

The Mattawan Series consists of soils that are nearly level to gently sloping and moderately well drained to well drained. These soils formed on uplands in a sandy mantle over loamy sediment.

Westphalia series soils are gently sloping to strongly sloping, very deep, well-drained soils on uplands. They are sandy loams formed in old deposits containing well-sorted sands.

2.5 DEMOGRAPHY AND LAND USE

The main area of IHDIV-NSWC on Cornwallis Peninsula covers approximately 2,300 acres and is bounded by the Potomac River to the north and west, Mattawoman Creek to the south and east, and the town of Indian Head to the east. The Stump Neck Annex covers approximately 1,100 acres and is bounded by the Potomac River to the north, Chicamuxen Creek to the south, and private residential property to the east.

The population of IHDIV-NSWC is approximately 4,050. This includes approximately 2,200 civilian employees, 500 military personnel, 800 contractor personnel, and 550 military dependants. Based on the 2000 U.S. Census Bureau estimates, the population of the town of Indian Head is approximately 3,422, and the total population of Charles County is 120,546. The town of Indian Head is primarily residential, with a business corridor located along Maryland Route 210. Tourism comprises a significant portion of the local commerce, because Indian Head is located near some of the best fishing locations on Mattawoman Creek.

2.6 ECOLOGY

The information in this section was extracted from the IAS report (Hart, 1983), except where noted.

2.6.1 Flora

Approximately 35 percent of IHDIV-NSWC is wooded. The forests consist of hardwoods, including oak and hickory, and loblolly and Virginia pines. The upland areas are characterized by older growth of pine and oaks, and the lower elevations are composed of sycamore, ash, elm, and sweet gum.

About 53 percent of IHDIV-NSWC is open field and shrub vegetation. Loblolly pine, sweet gum, red cedar, and black locust are typical of these communities.

Along the shoreline and beaches of the Potomac River, black persimmon, false indigo, poison ivy, sea myrtle, grape, and Virginia creeper are present, along with phlox, gama grass, panic grass, Bermuda

grass, or finger grass. Marsh areas predominate along the shores of Mattawoman Creek. They are characterized by jewelweed, alger, marsh cattail, weedgrass, sedge, three square bulrush, wild rice, saltmarsh cordgrass, smartweek, and marsh mallow.

2.6.2 Wildlife

The ecosystem at IHDIV-NSWC supports a variety of animal life, including an abundant white-tailed deer population. Other common mammals include possum, bats, squirrels, mice, raccoon, woodchuck, rabbits, skunks, and other burrowing rodents, such as voles and shrews. The birds found within Charles County include grebes, herons, ducks, geese, hawks, kestrels, osprey, eagles, owls, gulls, and perching birds, such as robins, warblers, and jays. Common reptiles and amphibians of Charles County include lizards, snakes, turtles, salamanders, frogs, and toads.

2.6.3 Aquatic Life

The area of the Potomac River adjacent to IHDIV-NSWC is part of the spawning and nursery area for striped bass, white perch, herrings, and shad. Bay anchovies and three species of silversides also spawn and nurse within this area. The area is the upstream limit of the nursery area for estuarine-dependent species, including the Atlantic menhaden and Atlantic croaker. Mattawoman Creek is a spawning area for blueback herring, white and yellow perch, and gizzard shad.

2.6.4 Threatened and Endangered Species

Several rare, threatened, and endangered species of plants and animals occur on or near IHDIV-NSWC. A rare, threatened, and endangered species and natural protection area (sensitive or rare habitat) survey was performed at IHDIV-NSWC by the Maryland Natural Heritage Program in 1992. A comprehensive list of the species observed by Maryland Department of Natural Resources (MDNR) is provided in their survey report (MDNR, 1992).

TABLE 2-1

TEMPERATURE DATA FOR LAPLATA, CHARLES COUNTY, MARYLAND
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Month	Normal[1] Maximum Temperature	Normal[1] Minimum Temperature	Normal[1] Temperature	Normal[1] Monthly Precipitation	Extreme[2] Maximum Temperature	Most Recent Date of Extreme Maximum	Extreme[3] Minimum Temperature	Most Recent Date of Extreme Minimum
January	44	26	35	3.42	79	1/26/1950	-8	1/22/1984
February	48.5	28.4	38.5	2.85	81	2/24/1985	-2	2/18/1979
March	57.8	35.4	46.6	3.96	91	3/30/1998	1	3/11/1960
April	68.4	43.2	55.8	3.11	95	4/18/1976	20	4/7/1982
May	74.6	53.2	63.9	4.13	96	5/20/1996	29	5/9/1956
June	81.2	61.9	71.6	3.81	100	6/26/1952	39	6/2/1966
July	84.8	66.8	75.8	4.12	103	7/31/1954	46	7/1/1988
August	83.4	65.4	74.4	4.6	102	8/31/1953	45	8/29/1986
September	77.9	58.7	68.3	4.31	103	9/10/1983	31	9/21/1956
October	68	47.1	57.6	3.36	96	10/4/1954	19	10/24/1969
November	58.6	38.1	48.4	3.21	86	11/2/1971	9	11/29/1955
December	48.2	30.1	39.2	3.16	77	12/16/1971	1	12/26/1980
Annual	66.3	46.2	56.3	44.04				

1 Normals are calculated using data collected from 1971-2000.
2 Extreme Maximum Temperatures from 1948 through 1998.
3 Extreme Minimum Temperatures from 1948 through 1998.

Source: Maryland State Climatologist Office, University of Maryland Collage Park, Department of Meteorology, November 2002.
http://www.atmos.umd.edu/~climate/

TABLE 2-2

PRECIPITATION DATA FOR LAPLATA, CHARLES COUNTY, MARYLAND
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Month	Normal[1] Monthly Precipitation	Maximum[2] Daily Precipitation	Most Recent Date of Maximum Daily Precipication
January	3.42	2.37	1/27/1976
February	2.85	2.2	2/23/1994
March	3.96	2.38	3/26/1978
April	3.11	2.16	4/14/1970
May	4.13	2.23	5/16/1983
June	3.81	7.49	6/22/1972
July	4.12	4.2	7/13/1975
August	4.6	9.8	8/27/1971
September	4.31	5.21	9/13/1989
October	3.36	5.45	10/14/1955
November	3.21	2.64	11/28/1993
December	3.16	2.4	12/21/1951
Annual	44.04	9.8	8/27/1971

1 Normals are calculated using data collected from 1971-2000.
2 Maximum Daily Precipitation from 1948 through 1998.

Source: Maryland State Climatologist Office, University of Maryland Collage Park, Department of Meteorology, November 2002. http://www.atmos.umd.edu/~climate/

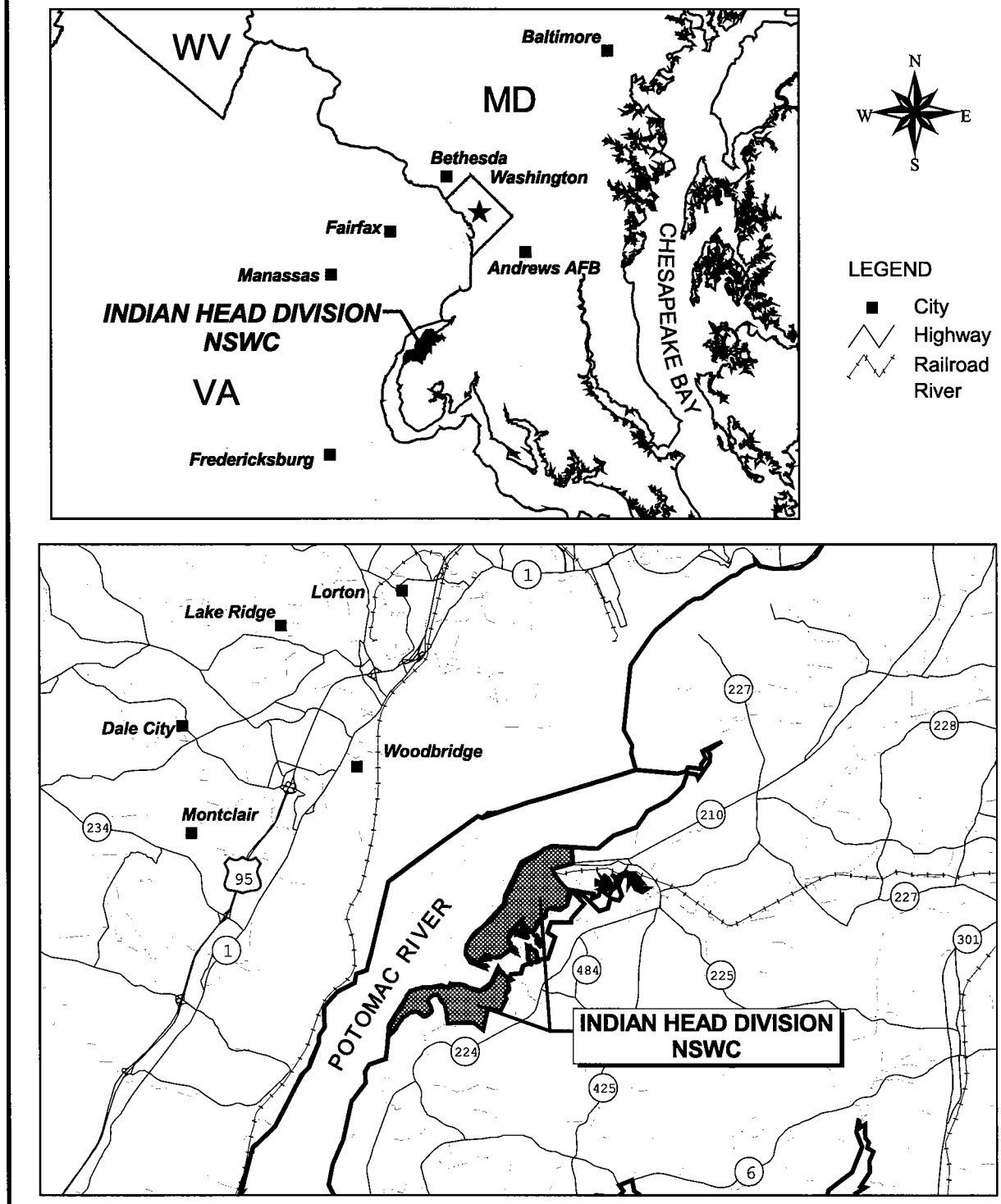
TABLE 2-3

MISCELLANEOUS WEATHER DATA FOR LAPLATA, CHARLES COUNTY, MARYLAND
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

	Average Number of Days	Average Date of First Occurrence	Average Date of Last Occurrence
Minimum Temperature Less Than or Equal to 32 Degrees	96	October 24	April 20
Maximum Temperature Less Than or Equal to 32 Degrees	8	December 21	February 11
Maximum Temperature Greater Than or Equal to 90 Degrees	24	May 25	September 3
Growing Season [1]	187	N/A	N/A

1 The growing season is defined as the number of days between the last 32-degree temperature in the spring and first in the fall.

Source: Maryland State Climatologist Office, University of Maryland Collage Park, Department of Meteorology, November 2002. http://www.atmos.umd.edu/~climate/



DRAWN BY: J. LAMEY — DATE: 8/2/01	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 0525	OWNER NO.: 0325
CHECKED BY: GJL — DATE: 8/3/01	FACILITY LOCATION MAP INDIAN HEAD DIVISION, NSWC INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/3/01	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE 2-1	REV: 0

P:\GIS\NSWC_INDIAN_HEAD\SITE_LOCATION.APR FACILITY LOCATION MAP 2/13/02 KMP

P:\GIS\INDIANHEAD_NSWC\APR\SITE 7 SCREENING REPORT.APR SITE 7 MAIN AREA 11/5/02 KMP

DRAWN BY: K. PEILA — DATE: 7/26/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NUMBER: —
CHECKED BY: GJL — DATE: 7/26/02	SITE LOCATION MAP MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE 2-2	REV: 0

DRAWN BY: K. PEILA — DATE: 7/26/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NUMBER: —
CHECKED BY: GJL — DATE: 7/26/02	SITE LOCATION MAP STUMP NECK ANNEX IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE 2-3	REV: 0

P:\GIS\INDIANHEAD_NSWC\APR\SITE 7 SCREENING REPORT.APR SITE 7 STUMP NECK ANNEX 11/19/02 KMP

3.0 GENERAL INVESTIGATIVE PROCEDURES

Investigation of the sites was conducted in accordance with the Site Screening Investigation Work Plan (TtNUS, 2001). This plan was developed to identify the presence or absence of contaminants at each site.

3.1 GEOPHYSICAL SURVEYS

Earth Resources Technology, Inc. (ERT) performed electromagnetic (EM), magnetic, and ground penetrating radar (GPR) surveys on January 22, 2002 through January 24, 2002. An EM survey was conducted at Site 34 to determine the location of buried beryllium-copper alloy tools and at Site 36 to determine the extent of a closed landfill. A magnetic survey was conducted at Site 33 to determine the location of buried scrap metal. A GPR survey was conducted at Sites 51 and 52 to determine the locations and depths of steam lines entering dry wells. The ERT geophysical report is provided in Appendix D.

3.2 FIELD SAMPLING

3.2.1 Temporary Well Point Construction

Temporary well points were installed by advancing the borehole using hollow-stem auger (HSA) drilling methods. An all-terrain vehicle (ATV) HSA drill rig with minimum 4-1/4-inch inside diameter (ID) augers was used to perform the drilling. The on-site TtNUS geologist determined the total drilling depth.

After the boring was completed, the 1-inch- or 2-inch-diameter, flush-joint, threaded Schedule 40 polyvinyl chloride (PVC) well screen and riser pipe were positioned in the borehole by inserting the PVC casing through the center of the HSA. Well screens were factory slotted with 0.010-inch screen slot size. A sand filter pack was installed between the outside of the well screen and the borehole wall. In most cases, filter sand was added to approximately 2 to 3 feet above the top of the 10-foot well screen. A minimum 2-foot-thick bentonite pellet seal was then added above the top of the sand pack and allowed to hydrate to seal the well from surface infiltration of water. TtNUS well completion forms are provided in Appendix A.

The temporary well points were developed just prior to purging for sample collection. The groundwater from the well was pumped until it was reasonably clear. Stabilization parameters were then measured as part of the purging process. After groundwater sampling was completed, the temporary wells were abandoned by pulling out the PVC riser and screen material and backfilling the borehole with bentonite chips. State of Maryland well abandonment reports and completion reports are provided in Appendix A.

3.2.2 Soil Borings and Subsurface Soil Sampling

Subsurface soil borings were drilled using an ATV HSA rig and utilizing 2- and 3-inch split spoons. Subsurface soil samples were generally collected along continuous 2-foot intervals to the maximum boring depth. A geologist visually classified and logged all split-spoon samples. At the time of extraction, each split-spoon sample was also scanned for volatile organic compounds (VOCs) using the photo-ionization detector (PID). Soil boring logs are provided in Appendix B.

Some subsurface soil samples were collected using a hand auger. At test pits, subsurface soil samples were collected directly from the backhoe bucket.

To minimize possible cross contamination between the drilling and sampling of each boring, the augers and all downhole sampling tools were cleaned with a high-pressure steam cleaner. In addition, the split-spoon samplers were cleaned between sample intervals at a particular boring using non-phosphate detergent and a clean water wash and rinse. Sample log sheets that were generated for each sample are provided in Appendix C.

3.2.3 Groundwater Sampling

Groundwater samples were collected from the wells in accordance with the low-flow sampling procedures detailed in the station standard operating procedures (SOPs) (NSWC, 1996). Stabilization parameters, pH, temperature, dissolved oxygen, and specific conductivity were measured at 5-minute intervals using a flow-through cell in combination with the U-22 water-quality meter. Groundwater sample collection was not initiated until at least one saturated screen length well volume was removed and stabilization of the groundwater parameters was observed. Stabilization was defined as ±0.1 pH units, ±10% for specific conductance, ±0.1°C for temperature, and less than 10 nephelometric turbidity units (NTU) for turbidity. The depth from the top of the well casing to the water level was measured to the nearest 0.01 foot and recorded between each purge volume. Sample log sheets generated for each sample are provided in Appendix C.

A submersible bladder pump was used at Site 33 (2-inch ID wells). The pump and its associated cables were lowered slowly into the well to at least 2 feet above the bottom of the well to minimize agitation. All other wells were sampled using a peristaltic pump. The peristaltic pump purging and sampling apparatus used to collect groundwater samples consisted of a length of ¼ inch Teflon tubing connected to the pump. Silicon tubing was threaded through the pump to connect with the Teflon tubing.

3.2.4 Surface Water Sampling

Surface water samples were collected by slowly immersing the glass collection vial into the water body and allowing the water to gently drain along the inner wall of the vial. The container for VOC analysis was filled so there was no air space; this was accomplished by filling the vial cap with sample water and slowly pouring the water into the vial until the vial was completely full. Sample log sheets generated for each sample are provided in Appendix C.

3.2.5 Sediment Sampling

Sediment samples were collected from the top 0 to 6 inches of the streambed using disposable and dedicated plastic pre-cleaned hand trowels. However, the volatile organics analysis aliquot was obtained using an Encore sampler. The remaining material was homogenized and distributed into the remaining sample containers. Sample log sheets generated for each sample are provided in Appendix C.

3.2.6 Quality Control Samples

Quality assurance/quality control (QA/QC) samples were collected in accordance with the work plan (TtNUS, 2001) and included field duplicates, trip blanks, and equipment (rinsate) blanks. Five field duplicates, three trip blanks, and two rinsate blanks were collected. One field duplicate was collected per ten samples per medium. One field blank was collected for the entire sampling event. One trip blank was analyzed per cooler containing VOC samples. For rinsate blanks, rinsate was batched and sampled each day; blanks were submitted for analysis every other day. Matrix spike and matrix spike duplicate samples were collected once for every 20 samples. Since QA/QC samples were only collected once for every 10 or 20 samples, some of the sites may not have any site-dedicated QA/QC samples.

3.2.7 Water-Level Measurements

One complete round of water level measurements was collected from nine temporary monitoring wells on February 12, 2002. The synoptic groundwater level measurement was performed to determine the groundwater flow pattern at each site. Measurements were taken with an electronic water-level indicator (M-scope) using the top of the well riser pipe as the reference point for determining depths to water. Groundwater-level measurements were recorded on a groundwater-level measurement form to the nearest 0.01 foot. The groundwater level data are provided in Appendix E.

3.3 LABORATORY ANALYSES

Samples were analyzed by some or all of the following methods:

- Target Compound List (TCL) VOCs [Contract Laboratory Program (CLP) Statement of Work (SOW) OLM04.2 or CLP SOW OLC02.1)]
- TCL Semivolatile Organic Compounds (SVOCs) (CLP SOW OLM04.2 or CLP SOW OLC02.1)
- TCL Pesticides/polychlorinated biphenyls (PCBs) (CLP SOW OLM04.2 or CLP SOW OLC02.1)
- Target Analyte List (TAL) Metals (CLP ILM04.1)
- Explosives (SW-846 8330)

3.4 INVESTIGATION DERIVED WASTE HANDLING

Purge water, decontamination water, and development water generated during field operations were collected and containerized in a 1000-gallon plastic tank in an area across the street from Building D-21C. Drill cuttings were placed in a lined and covered roll-off box in the same area.

A plastic-lined decontamination pad constructed near Building D-21C was used to collect the water when the drilling rig and equipment were steam cleaned. The water was pumped out of the lined pad into 55-gallon drums. The water was subsequently transferred from the drums to the 1000-gallon plastic tank.

Bay Associates, Inc. was contracted to profile and dispose of the investigation-derived waste (IDW). The IDW was removed from the site on March 19, 2002 and transported to an off-site disposal facility.

3.5 SURVEYING

A licensed Maryland land surveyor determined the horizontal and vertical coordinates of all sample locations. Existing base control points within IHDIV-NSWC were used as reference points. The horizontal locations of all points were surveyed to the $\pm$ 0.1 foot. The tops of PVC riser pipe and ground surface elevations were surveyed to the $\pm$ 0.01 foot for the monitoring well locations. Horizontal positioning was referenced to 1983 North America Datum (NAD), and vertical elevations were referenced to the North American Geodetic Vertical Datum (NGVD) 1929. In addition to sampling locations, two benchmark monuments (brass cap) were installed at each site. Survey data are included in Appendix F.

4.0 GENERAL DATA EVALUATION METHODS

4.1 DATA EVALUATION

All samples were subjected to data validation. Data validation is an objective, systematic process in which analytical data are reviewed to ascertain the validity of the reported results and to identify for the data user the possible limitation of these results. This section summarizes the various aspects of the data validation process. Appendix G contains the data validation memoranda for all samples, and Appendix H includes the entire database.

4.1.1 General Data Validation Procedures

Validation of data generated for samples collected during the field effort was completed in accordance with the Navy Installation Restoration Laboratory Quality Assurance Guide [Naval Facilities Engineering Service Center (NFESC), 1996] and the EPA Region 3 Modifications to the Contract Laboratory Program (CLP) National Functional Guidelines for Organic and Inorganic Data Review (EPA, 1993 and 1994c).

During data validation activities, the SSP sample results were evaluated for data completeness; holding time compliance; calibration compliance; laboratory and field blank contamination; surrogate spike recovery; matrix spike recovery; laboratory control sample recovery; matrix spike, laboratory, and field duplicate precision; internal standard response; inductively coupled plasma (ICP) interferences; serial dilution; sample quantitation; and detection limits. Hard-copy data deliverables and electronic data files received from the analytical laboratory(s) were reviewed for completeness and accuracy.

Calibration standards were evaluated to assess compliance with the analytical method. An evaluation of the calibration standards aided in the elimination of false negatives. An assessment of calibration non-compliance also was used to qualify all analytical results (positive and nondetect results).

Evaluation of laboratory and field blank analyses aided in the elimination of false positive results. Laboratory artifacts and contaminants present in method blanks were used to establish action levels and were correlated to associated environmental samples. Positive results in environmental samples less than the established blank action level for an associated group of environmental samples were considered to be false positives.

Laboratory control sample recoveries were evaluated to assess the accuracy of laboratory operations. Surrogate and matrix spike recoveries were evaluated to assess the accuracy of laboratory operations as affected by sample matrix. Matrix spike duplicate, laboratory duplicate, and field duplicate results were

used to evaluate the precision of the data. Internal standard responses were evaluated for gas chromatography/mass spectrometry (GC/MS) methods to ensure that instrument sensitivity and response were stable during the analysis of samples. ICP interference check standards were used to verify the laboratory's interelement and background correction factors for spectral interference. Serial dilution results were evaluated to determine whether significant physical or chemical interferences existed for the sample matrix.

The overall determination of data utility or reliability was based upon laboratory compliance with specified methods and adherence to quality control requirements. Noncompliances observed during the validation process typically resulted in qualification of the associated analytical data. The qualifiers alert the data user to imprecise or estimated results and, in the worst case, unreliable and unusable data.

The net results of the validation process were summarized in sample-delivery-group-specific technical reports consisting of a memorandum, a section of qualified analytical results, results as reported by the laboratory, and a supporting documentation section that provided the rationale for changes and/or qualification of the data. These memoranda provide detailed explanations of the results of the data validation review and are kept on file at the TtNUS Pittsburgh, Pennsylvania office.

4.1.2 Data/Validation Qualifiers

Various qualifiers are attached to analytical data by the laboratory and as a result of the data validation process. As mentioned previously, qualification of analytical data during the validation process (i.e., application of B, J, K, L, R, UJ, UL, and UR qualifiers) was conducted as required by EPA Region 3 guidance (EPA, 1993 and 1994c). The attachment of the data qualifiers to analytical results signifies the occurrence of quality control noncompliances that were noted during the course of data validation. The various data qualifiers are defined as follows:

- B - This qualifier is added to a positive result (reported by the laboratory) during the data validation process if the detected concentration reported by the laboratory is determined to be attributable to contamination introduced during field sampling or laboratory analysis. The result is considered to be a false positive.

- J - Indicates that the chemical was detected. However, based on laboratory noncompliances noted during the data validation process, the associated numerical result is not a precise representation of the amount that is actually present in the sample. The laboratory-reported concentration is considered to be an estimated value. The bias (high or low) of this result cannot be determined.

- K - Indicates that the chemical was detected. However, the associated numerical result is not a precise representation of the amount that is actually present in the sample. The laboratory-reported concentration is considered to be biased high based on laboratory noncompliances noted during the data validation process.

- L - Indicates that the chemical was detected. However, the associated numerical result is not a precise representation of the amount that is actually present in the sample. The laboratory-reported concentration is considered to be biased low based on laboratory noncompliances noted during the data validation process.

- R - Indicates that the chemical may or may not be present. The positive analytical result reported by the laboratory is considered to be unreliable and unusable. This qualifier is applied during the data validation process when gross laboratory technical deficiencies are observed.

- U - Indicates that the chemical was not detected at the numerical detection limit (sample-specific quantitation limit) noted. Nondetect results are reported in this manner by the laboratory.

- UJ - Indicates that the chemical was not detected. However, the detection limit (sample-specific quantitation limit) is considered to be estimated based on problems encountered during laboratory analysis, as noted during the data validation process. The associated numerical detection limit is regarded as inaccurate or imprecise. The bias (high or low) of this result cannot be determined.

- UL - Indicates that the chemical was not detected. However, the detection limit (sample-specific quantitation limit) is considered to be biased low based on problems encountered during laboratory analysis, as noted during the data validation process. The associated numerical detection limit is regarded as inaccurate or imprecise.

- UR - Indicates that the chemical may or may not be present. The nondetect analytical result reported by the laboratory is considered to be unreliable and unusable. During the data validation process, this qualifier is applied in cases of gross laboratory technical deficiencies (i.e., holding times missed by a factor of two times the specified time limit, severe calibration noncompliances, and extremely low quality control recoveries).

The preceding data qualifiers added during the data validation process may be categorized as indicative of major or minor problems. Major problems are defined as issues that result in the rejection of data, qualified with R and UR data validation qualifiers. These data are considered invalid and are not used for the risk screening analysis and decision-making purposes. Minor problems are defined as issues

resulting in the estimation of data, qualified with B, J, K, L, UJ, and UL data validation qualifiers. Analytical results qualified as estimated or biased are suitable for the risk screening analysis and decision-making purposes.

4.2 BACKGROUND DATABASE

A basewide background investigation (BI) was conducted at IHDIV-NSWC between June 18, 1997 and September 17, 1997 (B&R Environmental, 1997). Additional background samples were collected, and the BI was revised in 2002 (TtNUS, 2002). The purpose of the BI was to establish a basewide background database that would be used as a tool to evaluate analytical results for soil, groundwater, and sediment samples collected during future IHDIV-NSWC investigations. In particular, the data contained in the BI would be used to determine whether environmental samples collected at IHDIV-NSWC contain contaminants at concentrations that exceed naturally occurring background concentrations.

The following conclusions were developed from the analysis of the data generated during the BI:

With few exceptions, the inorganic concentrations reported in the surface and subsurface soils are within the range of background concentrations reported for surface soils in the eastern United States (Shacklette and Boerngen, 1984). With few exceptions, the concentrations reported are also within the range of values reported for surface soils of the state of Maryland (Dragun, 1991).

The inorganic profile for background surface and subsurface soils is not the same. Generally, metals concentrations are greater in subsurface soil samples than surface soil samples collected from the same locations. The inorganic concentrations for the "clayey" (low-grain size) subsurface soil samples are generally greater than inorganic concentrations detected in the "non-clayey" (high grain size) subsurface soil samples. This relationship between grain size and metal concentrations was not evident in the background surface soil samples.

The background soils dataset was subdivided into three soil datasets based on the visual inspection of the data, the results of four different statistical analyses, and the soil type descriptions provided by the field geologist for the BI:

- Surface soil samples
- Clayey subsurface soil samples
- Non-clay subsurface soil samples

Table 4-1 summarizes the background values. Because of the limited number of sample locations (three or fewer per medium) collected at each site, the 95 percent upper tolerance limit (UTL) was used as a

threshold background level. This approach is somewhat conservative since it may lead to false positives; that is, a chemical may be identified as a chemical of potential concern (COPC) when it is actually a background chemical. As additional samples are collected in subsequent sampling rounds, more rigorous statistical evaluations can be performed that may show that a chemical is at background concentrations. Any site sample concentrations that were less than the background values were not considered as COPCs. The background values are also included in the data evaluation tables in the subsequent sections.

For the site screening process, background threshold values (95 percent UTLs) were used for soils and groundwater samples.

4.3 HUMAN HEALTH RISK SCREENING METHODOLOGY

The purpose of the human health risk screening in this document is to conservatively estimate the potential risk to human health so that management decisions can be made for a site (for example, should the site be recommended for an RI/FS or removed from further study). Note that, if the human health risk is determined to be unacceptable, and therefore, requires further investigation, then an abbreviated ecological risk screening evaluation will be performed in the SSP since a more thorough ecological risk valuation will be performed during the later investigation.

The risk screening analysis conducted for the SSP sites consists of steps similar to those used in a baseline human health risk assessment. The steps include

- Data evaluation (i.e., selection of COPCs)
- Exposure assessment
- Toxicity assessment
- Risk characterization

The risk screening analysis is based on the methodologies used to calculate EPA Region 3 risk-based concentrations (RBCs) (which are updated semi-annually) to conservatively assess potential exposure and toxicity to human receptors. The RBCs for soil are based on a lifetime resident for carcinogens and a child resident for noncarcinogens. The RBCs for tap water are based on a lifetime resident for carcinogens and an adult resident for noncarcinogens. The steps for performing the risk screening analysis are described below.

Note that the activities at the sites that were sampled were all subsurface (burial pits and dry wells). If contamination was present, it would most likely to be found in the subsurface rather than in the surface soil. Therefore, no surface soil samples were proposed or collected..

4.3.1 Selection of Chemicals of Potential Concern

The following factors were considered in the selection of COPCs for human receptors:

- Occurrence and distribution of chemicals in the environmental media
- Chemical toxicity
- Comparisons of site-specific concentrations with representative Basewide background concentrations

4.3.1.1 Occurrence and Distribution

The initial list of COPCs for the SSP sites included any chemical detected at least once in environmental samples collected for a site. Essential human nutrients, not otherwise known to be associated with the sites (magnesium, potassium, calcium, and sodium) and present at low concentrations and toxic only at high doses, were not included in the initial list of COPCs.

4.3.1.2 Chemical Toxicity

After the initial list of COPCs was completed, the data were further screened on the basis of chemical toxicity. The maximum concentration of a chemical detected in an environmental medium was compared to the most recent EPA Region 3 RBC (EPA, 2002) and other applicable criteria identified in this section. For the purposes of this report, the values used to select COPCs based on chemical toxicity were referred to as "risk screening levels." In general, if the maximum detected concentration at a site was greater than a risk screening level, the chemical was identified as a COPC. Because of the additive noncarcinogenic effects of some chemicals (i.e., some noncarcinogenic chemicals impact the same target organs or exhibit similar mechanisms of action), one-tenth of the RBC for noncarcinogenic effects was used as the risk screening level to select COPCs.

For soil and sediment, the following risk screening levels were used to select COPCs:

- EPA Region 3 RBCs for soil ingestion under residential land use (EPA, 2002).
- EPA Region 3 soil screening levels (SSLs) for the migration of chemicals from soil to groundwater (EPA, 2002).
- Federal (generic) SSLs for inhalation (transfers from soil to air) (EPA, 1996).

EPA Region 3 SSLs for migration to groundwater have not been developed for all constituents. For constituents lacking EPA Region 3 SSLs, federal SSLs for migration to groundwater were used, if available. For this report, the federal SSLs were used for mercury and nickel.

The following risk screening levels were used to select COPCs for groundwater:

- EPA Region 3 RBCs for tap water ingestion under residential land use (EPA, Region 3, 2002).
- Federal drinking water standards, including Primary and Secondary Maximum Contaminant Levels (MCLs) and Action Levels (EPA, 2000).

The surface water criteria presented in the remainder of this section were used to identify a conservative list of COPCs for groundwater. This criteria were used to address groundwater that is expected to impact nearby surface water bodies via groundwater discharge.

COPCs for surface water were selected using the following risk screening levels:

- EPA Region 3 RBCs for tap water ingestion under residential land use (EPA, 2002).
- Federal Recommended Water Quality Criteria (WQC) for the protection of human health (EPA, 1999).

Because federal and Maryland water quality criteria are only available for a limited number of chemicals, EPA Region 3 RBCs for tap water ingestion were also used to select COPCs for surface water. Tables 4-2 and 4-3 summarize the risk screening levels for soil and water, respectively.

4.3.1.3 Background

COPCs for inorganics in soil and groundwater were also selected based on a comparison of site concentrations to representative Basewide background concentrations, as described in the revised BI report (TtNUS, 2002). If the maximum detected concentration of a chemical at a site exceeded the risk screening levels and the representative background concentration, the chemical was retained as a COPC for further risk evaluation.

4.3.2 Exposure Assessment

The human health exposure assessment defines and evaluates, quantitatively or qualitatively, the type or magnitude of human exposure to COPCs identified in environmental media at the SSP sites. The general conceptual site model (CSM) for the SSP sites is presented as Figure 4-1. A general discussion of potential exposure and human receptors is contained in Section 4.3.2.1. The methodologies used to estimate exposure for the purposes of this risk screening analysis are provided in Appendix I.

4.3.2.1 Potential Exposure/Human Receptors

Potential exposure to environmental media at the SSP sites is expected to be limited. Given the current and anticipated future land use and the locations of the sites, military personnel, civilian employees, contractors, and trespassers are the most likely individuals exposed to COPCs at the SSP sites.

Three of the sites (Sites 33, 34, and 36) are relatively distant from buildings, limiting exposure to base personnel. Of the remaining sites, Site 32 is under a parking lot, Site 37 is a roadway, and Sites 51 and 52 are adjacent to buildings, so exposure to these sites is somewhat more likely. Access to the SSP sites is not physically restricted (i.e., chain-link fences are not present); therefore, civilians may trespass on the sites. However, civilian exposure is expected to be limited because the base is patrolled by security police.

In order to evaluate the sites on a conservative basis, risks at each site will be based on a residential scenario.

4.3.2.2 Estimation of Exposure

For purposes of this risk screening analysis, maximum detected site concentrations and exposure assumptions used to derive the EPA Region 3 RBCs (for soil and tap water ingestion under residential land use) were used to assess potential exposure to environmental media at the SSP sites. The RBCs consider the following exposure pathways under residential land use:

- Soil ingestion
- Tap water ingestion
- Inhalation of vapors from tap water exposure

4.3.3 Risk Characterization

The equations and exposure factors used by EPA Region 3 to calculate the RBCs are provided in Appendix I and are based on residential land use. For carcinogens, incremental lifetime cancer risks (ILCRs) were calculated and compared to the EPA target risk range of 10^{-6} to 10^{-4}. If the ILCR is within or less than this range, then no action is needed at the site based on the presence of a potential carcinogenic risk. For non-carcinogens, Hazard Quotients (HQs) and Hazard Indices (HIs) were calculated and compared to the EPA target level HI of 1.0. If the HI is less than this value, then no action is needed based on the presence of a potential non-carcinogenic risk.

4.4 ECOLOGICAL RISK ASSESSMENT METHODOLOGY

A Screening Level Ecological Risk Assessment (SERA) consists of the first two of eight steps required under EPA guidance (EPA, 1997 and 1998a) and Navy Policy for Conducting Ecological Risk Assessments (DON, 1999). Steps 1 and 2 of the Navy's tiered approach consist of a site visit, pathway identification/problem formulation, toxicity evaluation, exposure estimation, and risk calculation. Step 3a of the process consists of the refinement of COPCs. Refining the initially selected list of COPCs consists of reexamining the list on a less conservative, more site-specific basis which frequently results in a reduced list of COPCs. Step 3b through Step 8 are conducted as part of the Baseline Ecological Risk Assessment (BERA) if there are COPCs remaining after Step 3a. Note that, if the human health risk was determined to be unacceptable, then an abbreviated ecological risk screening evaluation was be performed since a more thorough ecological risk evaluation will be performed during a later investigation.

The goal of this SERA was to conduct an initial screening of the analytical data using conservative screening values and assumptions to determine whether portions of Site 33, Site 34, and Site 37 need to be further evaluated as part of a BERA under the RI/FS process.

In the first phase in the ecological risk assessment process, conservative exposure estimates are made for grouped or individual ecological receptors, and these exposures are compared to screening levels. The following steps were completed for the ERA for Sites 33, 34, and 37:

- Problem Formulation
- Exposure Assessment
- Ecological Effects Assessment
- Risk Characterization

4.4.1 Problem Formulation

Problem formulation is the first phase of an ERA and discusses the goals, breadth, and focus of the assessment. It includes general descriptions of the site with emphasis on the habitats and ecological receptors present. This phase also involves characterization of site-related contaminants, contaminant sources, migration routes, and an evaluation of routes of contaminant exposure. Assessment and measurement endpoints that are evaluated are also selected. Finally, a preliminary conceptual model is developed that describes how contaminants associated with the sites in question may come into contact with ecological receptors. The following sections provide more detailed descriptions of the steps completed as part of problem formulation.

4.4.1.1 Site Characterization

The site characterization describes likely contaminant sources, release mechanisms, migration pathways, and the fate of chemicals resulting from site-related activities, as well as ecological resources that could be adversely affected by contaminants. Descriptions of the general base habitat and potential ecological receptors within the seven sites are presented in Section 2.6 of this Screening Report. The site characterization involves the identification of chemicals potentially present and the identification of exposure pathways and potential receptors for analysis. The chemicals that are potentially present at the sites are present as a result of site history and activity and are presented in the work plan. The ecological conceptual site model for the sites is presented in Figure 4-2. The manner in which a receptor contacts contaminants is generally the result of interactions between a receptor's behavior or lifestyle and an exposure medium. Since the focus of this study is on the evaluation of chemical concentrations in groundwater, surface water and sediment, these are the only media that were evaluated in this SERA. Note that the activities at the sites that were sampled were all subsurface (burial pits and dry wells). If contamination was present, it would most likely to be found in the subsurface rather than in the surface soil. Therefore, no surface soil samples were proposed or collected. The rationale for the sampling of these media only was presented in the work plan.

Ecological receptors may be exposed to chemicals in sediment and surface water through various pathways. Benthic invertebrates and fish may be exposed to chemicals in surface water at the sites and to groundwater when discharged to the surface. Also, wildlife that consume invertebrates and/or fish can be exposed to chemicals that have accumulated in prey species.

4.4.1.2 Identification of Assessment and Measurement Endpoints

Assessment endpoints are an explicit expression of the environmental value that is to be protected (EPA, 1997). The selection of these endpoints is based on the habitats present, the migration pathways of probable contaminants, and the routes that contaminants may take to enter receptors. Measurement endpoints are estimates of biological impacts (i.e., mortality, reproduction) that are used to evaluate the assessment endpoints. The selection of measurement endpoints for this report was based on the data that were available to evaluate the assessment endpoints (i.e., chemical data only).

Based on the habitat at the site, the assessment endpoints include protection of the following groups of receptors from adverse effects of contaminants on growth, survival, and reproduction:

- Benthic invertebrates
- Fish
- Amphibians and reptiles

Measurement endpoints are estimates of biological impacts that are used to evaluate the assessment endpoints. The following measures of effects were used to evaluate the assessment endpoints in this SERA:

- Mortality and other adverse effects (i.e., growth, feeding rates, behavioral changes) of benthic macroinvertebrates was evaluated by comparing the measured concentrations of chemicals in the sediment to screening values designed to be protective of ecological receptors.

- Mortality and other adverse effects (i.e., growth, feeding rates, behavioral changes) of aquatic organisms were evaluated by comparing the measured concentrations of chemicals in the surface water to screening values designed to be protective of ecological receptors.

4.4.2 Exposure Assessment

This portion of the SERA includes identification of contaminant concentration data used to represent ecological exposure in various media, and the selection of Exposure Point Concentrations (EPCs) from the data. For each exposure pathway selected for quantitative evaluation, maximum concentrations at the exposure point were estimated and the receptor-specific exposure was quantified. EPCs were estimated using environmental sampling data.

4.4.3 Ecological Effects Assessment

In the ecological effects assessment, screening levels for toxicity of the chemicals to terrestrial and aquatic organisms were compiled. The Region III Biological Technical Assistance Group (BTAG) screening levels (EPA, 1995) were used to screen the parameters for COPCs. The BTAG values were supplemented with other values including Lowest Effects Levels (LELs) (OMOE, 1993), Probable Effects Concentrations (PECs) (EPA, 1996), and Adverse Effects Thresholds (AETs) (Cubbage et al., 1997) for sediment and Tier II values (Suter and Tsao, 1996) and the NAWQC (EPA, 1999) for surface water and groundwater, when necessary. Tables 4-4 and 4-5 present a summary of the screening values used in the ecological COPC selection for sediment and water data, respectively.

4.4.4 Risk Characterization

The risk characterization compares measured or calculated EPCs to ecological effect levels. An ecological effects quotient (EEQ) approach was used to characterize the risk to potential ecological receptors. When EEQ values are less than 1.0, it is an indication that ecological receptors are not at risk. However, when EEQ values are greater than 1.0, additional evaluation or data are necessary to confirm

with greater certainty whether ecological receptors are actually at risk, especially since most benchmarks are developed using conservative exposure assumptions and/or studies. The EEQ value should not be construed as being probabilistic; rather, it is a numerical indicator of the extent to which an EPC exceeds or is less than a benchmark.

EEQs for aquatic receptors were calculated as follows:

$$EEQ = \frac{C_{sw}}{SwSL} \text{ or } \frac{C_{sd}}{SSL}$$

where:

EEQ = Ecological effects quotient (unitless)
C_{sw} = Contaminant concentration in surface water (µg/L)
C_{sd} = Contaminant concentration in sediment (µg/kg or mg/kg)
SwSL = Surface water (or groundwater) screening level (µg/L)
SSL = Sediment screening level (µg/kg or mg/kg)

Ecological COPCs were selected using comparisons to risk screening levels. Chemicals with EEQs greater than 1.0 were retained as COPCs for further evaluation because they have a potential to cause risk. Calcium, magnesium, potassium, and sodium will be excluded as COPCs in all media because they are essential nutrients that can be tolerated by living systems even at high concentrations. Therefore, these chemicals will not be discussed in the ERA. Finally, contaminants without screening levels will be retained as COPCs but only evaluated qualitatively.

TABLE 4-1

BACKGROUND THRESHOLD CONCENTRATIONS
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Chemical	Surface Soil (mg/kg)	Subsurface Soil (clayey) (mg/kg)	Subsurface Soil (nonclayey) (mg/kg)	Groundwater (ug/L)
Aluminum	19700	35400	21400	286545198
Arsenic	14.9	18.9	28.7	NA
Barium	80.4	134	66.5	254
Beryllium	1.1	3.3	1.5	NA
Cadmium	2.5	0.61	0.61	2.8
Calcium	2060	2590	1270	599450
Chromium	33.4	60.1	59.1	20.9
Cobalt	22.3	133	14.7	39.6
Copper	20.3	48.6	47.6	22.4
Iron	38500	83100	35200	57199
Lead	62.5	40.5	38.6	NA
Magnesium	1620	2640	2940	31254
Manganese	1390	4130	155	28160
Mercury	0.16	0.18	0.14	0.13
Nickel	15.4	18.2	15.9	39
Potassium	1470	2610	3440	83058
Selenium	1.2	13.3	3.8	NA
Silver	0.84	11.4	1.1	NA
Sodium	120	258	461	79585
Thallium	2.3	21.8	4.1	NA
Vanadium	53.3	194	102	24.1
Zinc	37.5	70.4	49.7	45.2

Notes:
1 - Values are 95 percent UTL values from BI report.
2 - Groundwater is for non-turbid unfiltered data set.
NA - Data were insufficient to calculate a background value.

Source: Background Soil Investigation Report for Indian Head Stump Neck Annex, Indian Head and Stump Neck Annex, TtNUS, February 2002 (Draft).

TABLE 4-2

HUMAN HEALTH SCREENING CRITERIA - SOIL AND SEDIMENT
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

CAS Number	Chemical	EPA Region 3 RBC[1]		EPA SSL[2]
		Residential	Soil to Groundwater	Soil to Air
Volatile Organic Compounds (ug/kg)				
67-64-1	Acetone	7800000 N	2500	100000000
108-88-3	Toluene	16000000 N	8800	650000
71-43-2	Benzene	12000 C	1.8	800
Semivolatile Organic Compounds (ug/kg)				
91-57-6	2-Methylnaphthalene	1600000 N	22000	NA
208-96-8	Acenaphthylene	4700000 (8) N	NA	NA
100-52-7	Benzaldehyde	7800000 N	NA	NA
56-55-3	Benzo(a)anthracene	870 C	1500	NA
50-32-8	Benzo(a)pyrene	87 C	370	NA
205-99-2	Benzo(b)fluoranthene	870 C	4500	NA
207-08-9	Benzo(k)fluoranthene	8700 C	45000	NA
191-24-2	Benzo(g,h,i)perylene	2300000 (3) N	NA	NA
218-01-9	Chrysene	87000 C	150000	NA
53-70-3	Dibenzo(a,h)anthracene	87 C	1400	NA
206-44-0	Fluoranthene	3100000 N	6300000	NA
193-39-5	Indeno(1,2,3-cd)pyrene	870 C	13000	NA
91-20-3	Naphthalene	1600000 N	150	NA
85-01-8	Phenanthrene	2300000 (3) N	NA	NA
129-00-0	Pyrene	2300000 N	680000	NA
Pesticides/PCBs (ug/kg)				
72-54-8	4,4'-DDD	2700 C	11000	NA
72-55-9	4,4'-DDE	1900 C	35000	NA
50-29-3	4,4'-DDT	1900 C	1200	NA
Explosives (mg/kg)				
9004-70-0	Nitrocellulose	NA	NA	NA
Inorganics (mg/kg)				
7429-90-5	Aluminum	78000 N	NA	NA
7440-38-2	Arsenic	0.43 C	0.026	750
7440-39-3	Barium	5500 N	2100	690000
7440-41-7	Beryllium	160 N	1200	1300
7440-43-9	Cadmium	39 N	27	1800
7440-70-2	Calcium	NA	NA	NA
7440-47-3	Chromium	230 (4) N	42	270
7440-48-4	Cobalt	1600 N	NA	NA
7440-50-8	Copper	3100 N	11000	NA
7439-89-6	Iron	23000 N	NA	NA
7439-92-1	Lead	400 (5)	NA	NA
7439-95-4	Magnesium	NA	NA	NA
7439-96-5	Manganese	1600 N	950	NA
7439-97-6	Mercury	23 (6) N	2 (7)	10
7440-02-0	Nickel	1600 N	130 (7)	13000
7440-09-7	Potassium	NA	NA	NA
7782-49-2	Selenium	390 N	19	NA
7440-23-5	Sodium	NA	NA	NA
7440-28-0	Thallium	5.5 N	3.6	NA
7440-62-2	Vanadium	550 N	5100	NA
7440-66-6	Zinc	23000 N	14000	NA

Notes:
1 - EPA Region 3 Risk-Based Concentration Table, April 2, 2002.
2 - Soil Screening Levels for Inhalation EPA, May 1996. Soil Screening Guidance.
3- Value is for pyrene.
4 - Value is for hexavalent chromium.
5 - OSWER screening level. EPA,1994a:Guidance on Residential Lead-Based Paint, Lead-Contaminated Dust and Lead-Contaminated Soil.
6 - Value is for mercuric chloride.
7 - Soil screening levels for migration to groundwater. EPA, May 1996. Soil Screening Guidance.
8 - Value is for acenaphthene.
C - Carcinogenic
N - Noncarcinogenic
NA - No criteria available.

TABLE 4-3

HUMAN HEALTH SCREENING CRITERIA - WATER
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

CAS Number	Chemical	EPA Region 3 RBC[1] Tap Water	EPA MCL[2]	EPA NRWQC[3]
Volatile Organic Compounds (ug/L)				
1330-20-7	Total Xylenes	12000 N	10000	NA
Semivolatile Organic Compounds (ug/L)				
91-57-6	2-Methylnaphthalene	120 N	NA	NA
106-44-5	4-Methylphenol	180 N	NA	NA
83-32-9	Acenaphthene	370 N	NA	1200
117-81-7	Bis(2-Ethylhexyl)phthalate	4.8 C	6	1.8
86-73-7	Fluorene	240 N	NA	1300
91-20-3	Naphthalene	6.5 N	NA	NA
98-95-3	Nitrobenzene	3.5 N	NA	17
85-01-8	Phenanthrene	180 (4) N	NA	NA
108-95-2	Phenol	22000 N	NA	21000
Pesticides/PCBs (ug/L)				
72-54-8	4,4'-DDD	0.28 C	NA	0.00083
Inorganics, Total (ug/L)				
7429-90-5	Aluminum	37000 N	50 to 200(5)	NA
7440-38-2	Arsenic	0.045 C	10	0.018
7440-39-3	Barium	2600 N	2000	1000
7440-41-7	Beryllium	73 N	4	NA
7440-43-9	Cadmium	18 N	5	NA
7440-70-2	Calcium	NA	NA	NA
7440-47-3	Chromium	110 (6) N	100	NA
7440-48-4	Cobalt	730 N	NA	NA
7440-50-8	Copper	1500 N	1300 (7)	1300
7439-89-6	Iron	11000 N	300 (5)	300
7439-92-1	Lead	NA	15 (7)	NA
7439-95-4	Magnesium	NA	NA	NA
7439-96-5	Manganese	730 N	50 (5)	50
7440-02-0	Nickel	730 N	NA	610
7440-09-7	Potassium	NA	NA	NA
7782-49-2	Selenium	180 N	50	170
7440-22-4	Silver	180 N	100 (5)	NA
7440-23-5	Sodium	NA	NA	NA
7440-28-0	Thallium	2.6 N	2	1.7
7440-62-2	Vanadium	260 N	NA	NA
7440-66-6	Zinc	11000 N	5000 (5)	9100
Explosives (ug/L)				
606-20-2	2,6-Dinitrotoluene	37 N	NA	0.11 (8)
121-82-4	RDX	0.61 C	NA	NA

Notes:
1 - EPA Region 3 Risk-Based Concentration Table, April 2, 2002.
2 - EPA Drinking Water Regulations and Health Advisories, Summer 2000.
3 - EPA National Recommend Water Quality Criteria (NRWQC), April 1999.
4 - Value is for pyrene.
5 - Secondary MCL.
6 - Value is for hexavalent chromium.
7 - Action level.
8 - Value is for 2,4-dinitrotoluene.
C - Carcinogenic.
N - Noncarcinogenic.
NA - No criteria available.

TABLE 4-4

ECOLOGICAL SCREENING CRITERIA - SEDIMENT
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

PARAMETER	Screening Value	SOURCE
Volatile Organics (ug/kg)		
Acetone	NA	
Semi-Volatile Organics (ug/kg)		
2-Methylnaphthalene	70	BTAG
Acenaphthylene	44	BTAG
Benzaldehyde	NA	
Benzo(a)anthracene	261	BTAG
Benzo(a)pyrene	430	BTAG
Benzo(b)fluoranthene	3200	BTAG
Benzo(g,h,i)perylene	670	BTAG
Benzo(k)fluoranthene	240	LEL
Chrysene	384	BTAG
Dibenzo(a,h)anthracene	63.4	BTAG
Fluoranthene	600	BTAG
Indeno(1,2,3-cd)pyrene	600	BTAG
Naphthalene	160	BTAG
Phenanthrene	240	BTAG
Pyrene	665	BTAG
Pesticides/PCBs (ug/kg)		
4,4'-DDD	16	BTAG
4,4'-DDE	2.2	BTAG
Inorganics (mg/kg)		
Aluminum	58030	PEC
Arsenic	8.2	BTAG
Barium	48	AET
Beryllium	NA	
Cadmium	1.2	BTAG
Calcium	NA	
Chromium	81	BTAG
Cobalt	50	LEL
Copper	34	BTAG
Iron	20000	LEL
Lead	46.7	BTAG
Magnesium	NA	
Manganese	460	LEL
Nickel	20.9	BTAG
Potassium	NA	
Silver	1	BTAG
Sodium	NA	
Vanadium	57	AET
Zinc	150	BTAG
Explosives (mg/kg)		
Nitrocellulose	NA	

Notes:
NA = Not Available
AET = Apparent Effects Threshold (Buchman, 1999)
BTAG = EPA Region 3 BTAG Screening Levels (EPA, August 1995)
LEL = Lowest Effects Level (CCME, 1993)
PEC = Probable Effects Concentration (EPA, 1996)

TABLE 4-5

ECOLOGICAL SCREENING CRITERIA - SURFACE WATER / GROUNDWATER
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

PARAMETER	Surface Water / Groundwater Screening Value	Source
Volatile Organics (ug/L)		
Total Xylenes	6000	BTAG
Semivolatile Organics (ug/L)		
2-Mehtylnaphthalene	12	ORNL*
4,Methylphenol	NA	
Acenaphthene	520	BTAG
Bis(2-Ethylhexyl)phthalate	30	BTAG
Fluorene	430	BTAG
Naphthalene	100	BTAG
Nitrobenzene	27000	BTAG
Phenanthrene	6.3	BTAG
Phenol	79	BTAG
Pesticides/PCBs (ug/L)		
4,4'-DDD	0.6	BTAG
Explosives (ug/L)		
RDX	NA	
Inorganics (ug/L)		
Aluminum	25	BTAG
Arsenic	48	BTAG
Barium	10000	BTAG
Beryllium	5.3	BTAG
Cadmium	0.53	BTAG
Calcium	NA	
Chromium (VI)	2	BTAG
Cobalt	35000	BTAG
Copper	6.5	BTAG
Iron	320	BTAG
Lead	3.2	BTAG
Magnesium	NA	
Manganese	14500	BTAG
Nickel	160	BTAG
Potassium	NA	
Selenium	5	BTAG
Silver	0.0001	BTAG
Sodium	NA	
Thallium	40	AWQC
Vanadium	10000	BTAG
Zinc	30	BTAG

Notes:
NA = Not Available

AWQC = Ambient Water Quality Criteria (EPA, 1999)
BTAG = EPA Region 3 BTAG Screening Levels (EPA, August 1995)
ORNL = Oak Ridge National Laboratory (EPA, 1996)
*Naphthalene value was used as surrogate

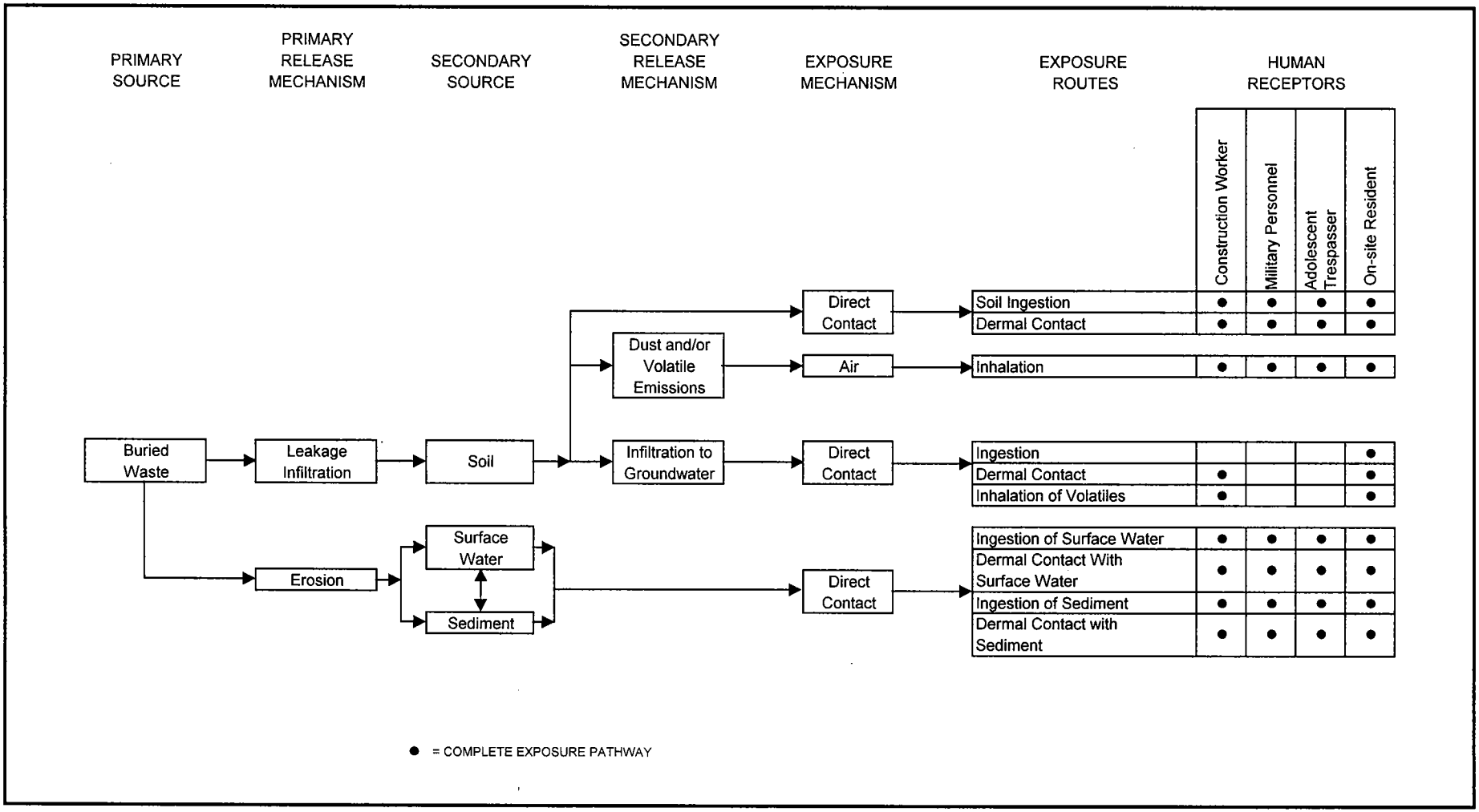


FIGURE 4-1

GENERAL CONCEPTUAL SITE MODEL
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

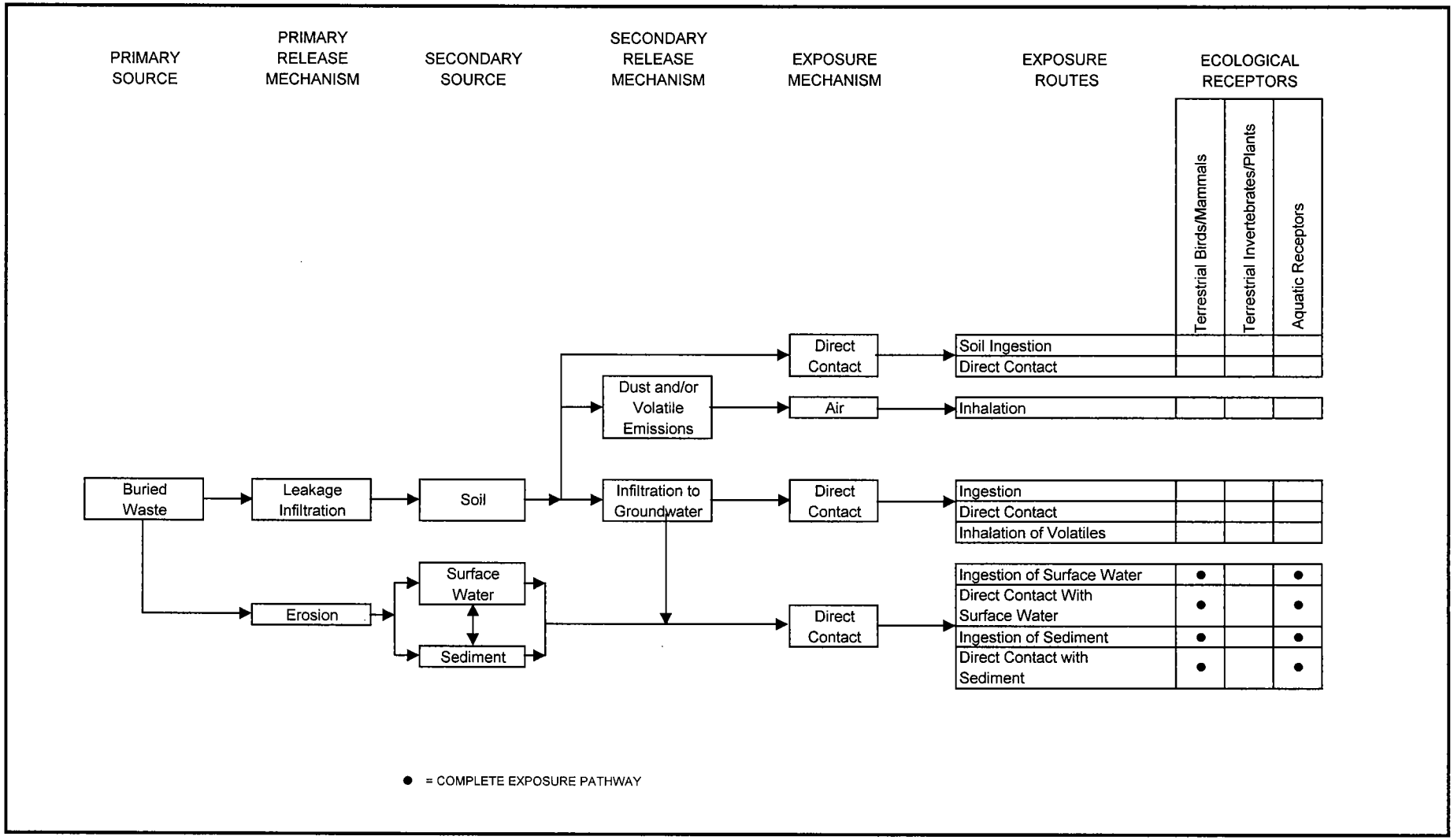


FIGURE 4-2

ECOLOGICAL GENERAL CONCEPTUAL SITE MODEL
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

5.0 SITE 32 – SUSPECTED TOOL BURIAL

5.1 BACKGROUND

During the IAS (Hart, 1983), one person who was interviewed believed that special beryllium-copper alloy hand tools used in explosive ordnance disposal work had been buried in the vicinity of Building 31SN (as shown on Figure 5-1). The area around the building was paved with asphalt. In addition, based on aerial photographs, the suspected burial area may include an area currently occupied by Building 2127. No other information was available to confirm this suspicion; however, another beryllium-copper alloy tool burial site (Site 34) is reported near Building D-21C (see Section 7.0).

5.2 SITE CHARACTERISTICS

5.2.1 Topography

As illustrated on Figure 5-1, the land surface at Site 32 gently slopes to the south.

5.2.2 Surface Water

During a rain event, precipitation either infiltrates the soil or runs off into the surrounding drainage swales, which direct the runoff to the south into Chicamuxen Creek.

5.2.3 Geology/Soils

No subsurface investigation was carried out at Site 32. Because of the findings of the site screening investigation at Site 34, it was determined that further investigation at Site 32 was not necessary.

5.2.4 Hydrogeology

No groundwater monitoring wells were installed at Site 32.

5.3 FIELD INVESTIGATION

No samples were collected at Site 32. Site 32 is similar to Site 34 with respect to the potential source of contamination, and based on the results of the investigation at Site 34 (Section 7.0), no sampling was determined to be necessary at Site 32.

5.4 ANALYTICAL RESULTS

Site 32 and Site 34 are similar with respect to the potential source of contamination, so the investigation of Site 32 was to be based on the results of sampling at Site 34. Because no contamination was detected at Site 34, described in Section 7.0, no samples were collected at Site 32.

5.5 HUMAN HEALTH RISK SCREENING EVALUATION

Because no COPCs were identified at Site 34, there is no reason to expect COPCs at Site 32. The human health risk evaluation of the results from Site 34 are included in Section 7.0, and no unacceptable risk to human health was identified.

5.6 ECOLOGICAL RISK SCREENING EVALUATION

Because no COPCs were identified at Site 34, there is no reason to expect COPCs at Site 32. The ecological risk evaluation of the results for Site 34 is included in Section 7.0, and that evaluation determined that there is no risk to ecological receptors.

5.7 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

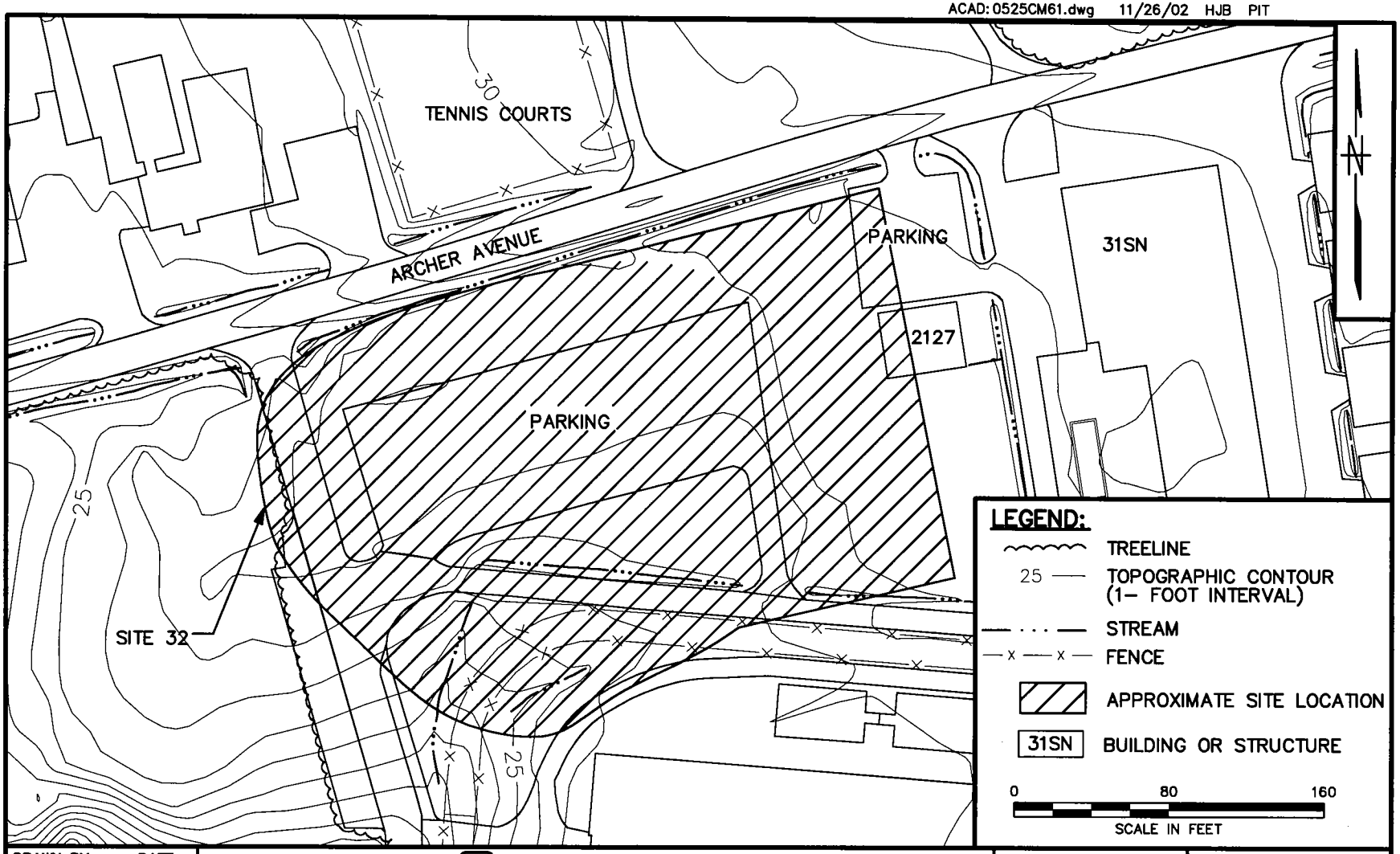
5.7.1 Summary and Conclusions

The evaluation of Site 34 in Section 7.0 shows that there are no risks to human health and ecological receptors from Site 34. Because Site 32 is similar to Site 34, no unacceptable risks to human health and ecological receptors are expected from Site 32. Therefore, no action needs to be taken at Site 32.

5.7.2 Recommendations

No action is required for Site 32, so the site should be removed from additional study under the FFA, and a no action decision document should be prepared for this site in accordance with the FFA.

ACAD: 0525CM61.dwg 11/26/02 HJB PIT



DRAWN BY HJB DATE 5/15/02	Tetra Tech NUS, Inc.	CONTRACT NO. 0525	OWNER NO. 0325
CHECKED BY DATE 11/25/02 COST/SCHED-AREA	SITE LAYOUT SITE 32 – SUSPECTED TOOL BURIAL INDIV–NSWC, INDIAN HEAD, MARYLAND	APPROVED BY	DATE
SCALE AS NOTED		APPROVED BY DATE 11/25/02	
		DRAWING NO. FIGURE 5–1	REV. 0

FORM CADD NO. TtNUS_AH.DWG - REV 0 - 1/22/98

6.0 SITE 33 – SCRAP METAL PIT

6.1 BACKGROUND

Site 33 is located within the Stump Neck Annex, about 100 feet southeast of Buildings 2116 and 2136. An excavation, 10 feet by 10 feet by 30 feet long, reportedly contained scrap metal The location of the site is shown on Figure 6-1. The metal was said to consist of parts of mines, torpedoes, and other explosive-inert items. The location was approximate and no other details were available (Hart, 1983).

6.2 SITE CHARACTERISTICS

6.2.1 Topography

As illustrated on Figure 6-1, the land surface at Site 33 moderately slopes to the northwest. The land surface elevation across the site ranges from approximately 82 feet above msl in the southwestern corner to approximately 95 feet above msl in the northeastern corner.

6.2.2 Surface Water

Precipitation either infiltrates the soil or runs off the ground surface into the intermittent stream that is southwest of Building 2136 and flows to the west.

6.2.3 Geology/Soils

Logs from soil borings and test pits installed at the site indicate that shallow geologic conditions consist primarily of gravelly clay overlying sand and silt mixtures. The gravels are composed of quartz and are well rounded to subrounded. Soil boring and test pit logs are provided in Appendix B.

6.2.4 Hydrogeology

The shallow aquifer beneath the site displays the characteristics of a semi-confined to confined system. Groundwater at the site was encountered at approximately 20 to 22 feet bgs and, after the wells were installed, the water in the well rose and stabilized to approximately 10 feet bgs. The potentiometric surface, shown on Figure 6-4, shows that the groundwater flow direction is to the southwest. The groundwater levels used to generate potentiometric contours were measured on February 12, 2002. The groundwater-level data are provided in Appendix E.

6.3 FIELD INVESTIGATION

A geophysical survey and test pit excavations were completed at the site to locate the scrap metal burial pit and to evaluate the potential presence of contaminants. In addition, groundwater and subsurface soil samples were collected and submitted to a fixed-base laboratory for chemical analysis. The samples and analyses are summarized on Table 6-1.

6.3.1 Geophysical Investigation

A geophysical survey using a magnetometer was performed at the site to locate the scrap metal burial pit. The magnetometer measures the earth's total geomagnetic field at a particular location in units of nano-teslas. The total magnetic field consists of three components: main field, external field, and local variations. The main field and the external field remain fixed over the duration of the survey, and the local variations are attributed to metallic objects at the ground surface or buried in the ground. The effective penetration depth of the instrument is approximately 50 feet, and the horizontal range varies with the size and density of the targets.

As shown on Figure 6-2, the survey was conducted on a reference grid that was 100 feet by 200 feet. The resulting magnetic contour map is presented on Figure 6-2, the anomalies are indicated by the high density of the contour lines in circular patterns. The most significant anomaly is located in the southwestern corner of the grid. Based on the size and intensity of this anomaly, it was believed to be the metal waste burial pit area. The other anomalies noted by the survey were generally small or explained by surface articles such as unused concrete culvert pipe sections reinforced with steel rebar. A detailed report of the geophysical survey results is provided in Appendix D.

6.3.2 Temporary Well Installation and Groundwater Sampling

Three temporary monitoring wells were installed at the site to determine if wastes from the scrap metal burial pit had contaminated shallow groundwater. One well (S33TW003) was installed immediately adjacent to and downgradient of the suspected burial area. Two wells (S33TW001 and S33TW002) were installed upgradient. Well locations are shown on Figure 6-2. The wells were constructed with 2-inch-ID PVC riser and screen material and installed and abandoned as described in Section 3.0. State of Maryland abandonment reports and TtNUS temporary well construction diagrams are presented in Appendix A.

Groundwater samples were collected from the temporary wells as described in Section 3.2.3, and analyzed for TAL metals (total and dissolved) and explosives including nitroguanidine and nitroglycerine (excluding nitrocellulose). Groundwater sample log sheets are provided in Appendix C.

6.3.3 Subsurface Soil Sampling

Six subsurface soil samples were collected; two from each upgradient well boring (S33TW001/SB001 and S33TW002/SB002) and two from S33TP003 (sample location designation as S33SB003). The soil samples were collected using HSA drilling and split-spoon sampling techniques and using a backhoe at the test pit location. Sample locations are shown on Figure 6-2.

Two subsurface soil samples were selected from each location based upon field observations and the depths proposed in the work plan. No elevated PID readings or wastes were encountered during the subsurface investigation. The samples were submitted to a fixed-base laboratory for analysis for TAL metals and explosives including nitroguanidine and nitroglycerine (excluding nitrocellulose). The samples and analyses are summarized on Table 6-1. Soil sample log sheets are provided in Appendix C.

One field duplicate S33SBDUP0101 was collected at the same location as S33SB0030201 and analyzed for TAL metals and explosives excluding nitrocellulose.

6.3.4 Test Pit Activities

Test pit excavations were conducted in suspected areas, as described in Section 6.3.1. The test pit locations are shown on Figure 6-2. The excavation at S33TP001 uncovered a 40-foot section of steel rebar that was 2 inches in diameter. The S33TP001 test pit consisted of two excavations installed at right angles. Both excavations had approximate widths of 3 feet, lengths of 10 feet and depths of 10 feet bgs. Test pits S33TP002 and S33TP003 were excavated at two magnetic anomaly locations, and scrap metal was not found at either test pit. Test pit logs are provided in Appendix B.

6.4 ANALYTICAL RESULTS AND COPC SELECTION

This section provides the data, evaluation, and selection of human health COPCs for subsurface soil and groundwater contamination at Site 33. The selection of ecological COPCs is discussed in Section 6.6. The human health screening evaluation is based on the following samples:

- Six subsurface soil samples
- Three groundwater samples collected from temporary monitoring wells

The results were evaluated as described in Section 4.3. Complete chemical analytical results are presented in Appendix H.

6.4.1 Data and Risk-Based Evaluation of Subsurface Soil Contamination

Positive analytical results and summary statistics for subsurface soil samples are provided in Tables 6-2 and 6-3, respectively.

Based on the analytical results, seven metals (aluminum, arsenic, chromium, iron, manganese, thallium, and vanadium) were detected at concentrations exceeding human health screening levels.

- All of the samples had at least one the seven metals detected at concentrations greater than the screening concentrations.

- Of the metals that exceeded the screening levels, only arsenic was detected at a maximum concentration greater than the clayey soil background threshold concentration. The remaining metals were detected at maximum concentrations less than the clayey soil background threshold concentrations.

- Maximum concentrations for aluminum, arsenic, chromium, iron, manganese, and vanadium were reported in sample S33SB0030201 or its duplicate, S33SBDUP0101.

The COPC concentrations greater than risk screening levels and background are shown on Figure 6-3.

None of the other detected metals exceeded any screening levels. No explosives were detected in the subsurface soil.

Based on the laboratory results, arsenic is to be retained as a soil COPC for further risk evaluation.

6.4.2 Data and Risk-Based Evaluation of Groundwater Contamination

Positive analytical results for unfiltered and filtered groundwater samples are provided in Table 6-4. The summary statistics for unfiltered and filtered groundwater samples are provided in Table 6-5.

Based on the analytical results, six metals (aluminum, arsenic, chromium, iron, manganese, and vanadium) were detected at concentrations exceeding human health screening concentrations.

- All samples had at least one of the six metals detected at a concentration greater than screening concentrations.

- Of the six metals, three (aluminum, iron, and manganese) were detected at maximum concentrations less than the background threshold concentrations.

- Arsenic, chromium, and vanadium were detected at maximum concentrations greater than the background threshold concentrations in a single sample (S33TW0030001, the most downgradient well).

- The maximum concentrations for aluminum, arsenic, chromium, iron, manganese, and vanadium were reported in sample S33TW0030001.

- With the exception of manganese, the metals concentrations in the filtered samples were less than screening levels and background threshold concentrations. Manganese concentrations in all of the filtered samples were greater than the background threshold concentration.

The COPC concentrations greater than risk screening levels and background for unfiltered groundwater samples are shown on Figure 6-4.

The sample with the maximum concentrations, S33TW0030001, also had a very high turbidity, more than 999 NTUs, as measured by a field turbidity meter during sample collection. This high turbidity is probably responsible for the very high metals concentrations in the sample. The metals concentrations in the filtered sample from the same location were very low and were comparable to the filtered metals concentrations from the other two wells..

None of the other detected metals exceeded any screening levels. Only one explosive, 2,6-dinitrotoluene, was detected in the groundwater, but it did not exceed the screening level.

Based on the laboratory results, arsenic, chromium, and vanadium are to be retained as groundwater COPCs for further risk evaluation.

6.5 HUMAN HEALTH RISK SCREENING EVALUATION

This section contains a summary of the human health risk estimates for Site 33. The methodology used to calculate the risks presented in this section is provided in Appendix I. Chemical-specific risk estimates and risks to affected target organs for COPCs in subsurface soil and groundwater are presented in Tables 6-6 and 6-7, respectively. A discussion of the estimated noncarcinogenic and carcinogenic risks is provided in the balance of this section.

6.5.1 Subsurface Soil

Estimated incremental lifetime cancer risks (ILCRs) for exposure to subsurface soil at Site 33 are presented in Table 6-6. The cumulative cancer risk is 5.8×10^{-5}, which is within EPA's target cancer risk range of 1.0×10^{-6} to 1.0×10^{-4}.

The cumulative HI (the sum of HQs for each COPC) is 1.1, which is approximately equal to the target level of 1 for noncarcinogenic health effects. Given the marginal exceedance of the benchmark, adverse health effects are not anticipated for receptors exposed to subsurface soil under the defined conditions.

6.5.2 Groundwater

ILCRs for exposure to groundwater at Site 33 are presented in Table 6-7. The cumulative cancer risk is 2.6×10^{-4}, which exceeds EPA's target cancer risk range of 1×10^{-6} to 1×10^{-4}. Arsenic (ILCR = 2.6×10^{-4}) was the only contributor to the cumulative ILCR. The arsenic concentration also exceeded the MCL.

The cumulative HI is 1.9. When the HI exceeds 1, target organ effects for individual COPCs contributing to the risk are considered. Arsenic, chromium, and vanadium were the contributors to the HI and they affect different target organs. The target organs for arsenic (HQ = 1.1) are the skin and cardiovascular system. The toxicity criterion for chromium (HQ = 0.5) is based on the No Observed Adverse Effect Level (NOAEL) and the toxicity criterion for vanadium (HQ = 0.3) is based on the No Observed Effect Level (NOEL). Since the HQs for the affected target organs are less than or approximately equal to the acceptable level of 1.0, adverse health effects are not anticipated for exposures to groundwater at Site 33.

Because of the high turbidity in the sample with the highest metals concentrations, the risk was also calculated for filtered water, as shown on Table 6-8. For this calculation, the cumulative cancer risk is below the EPA's target risk range, and the HQ is much less than 1.0.

Note that there is currently no risk to current users of the site because there is no exposure to the groundwater. Similarly, the risk from the subsurface soil to current site users under an industrial scenario is substantially lower than the residential exposure. Risk calculations for industrial exposure to subsurface soil are included in Appendix I.

6.6 ECOLOGICAL RISK SCREENING EVALUATION

Although subsurface samples were collected at Site 33, subsurface sample results were not included in the ecological COPC screening because invertebrates and plants are not exposed to subsurface soils. Therefore, only the groundwater data was used in the ecological COPC screening. Groundwater data was

evaluated due to the possibility of discharge to Mattawoman Creek and potential risk to aquatic receptors. Unfiltered and filtered samples were evaluated in the screening (see Table 6-9).

6.6.1 Data and Risk-Based Evaluation of Groundwater Contamination

Six metals in the unfiltered samples had maximum concentrations in sample S33TW0030001 exceeding the COPC screening values, including aluminum, chromium, copper, iron, lead, and zinc. However, all maximum metals concentrations were below the screening values in the filtered samples. Filtered sample results are believed to better represent any indications of toxicity when evaluating risks to aquatic receptors because dissolved metals are potentially more bioavailable (EPA, 1992). For these reasons, metals are not considered to pose potential risks to aquatic receptors.

One explosive, 2,6-dinitrotoluene was retained as a COPC because a screening value is unavailable for comparison. However, the maximum detected concentration (0.13 ug/L) is well below the BTAG screening level for 2,4-dinitrotoluene (230 ug/L). Even though the chemicals are slightly different it is unlikely that the low detection of 2,6-dinitrotoluene will cause a risk to aquatic receptors. Therefore, 2,6-dinitrotoluene is not considered to pose a potential risk to aquatic receptors.

6.7 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

6.7.1 Summary and Conclusions

Arsenic was detected in the subsurface soil and arsenic, chromium, and vanadium were detected in groundwater at concentrations greater than human health screening levels. The metals were considered to be COPCs and a preliminary risk evaluation was performed.

The preliminary human health risk evaluation showed that the subsurface soil concentrations were within risk range acceptable to the EPA, but that the arsenic concentration in groundwater exceeded the acceptable risk range. The arsenic concentration in groundwater also exceeded the MCL. However, the groundwater sample with the highest metals concentrations had a very high turbidity, and the unfiltered metals concentrations from this sample may not be representative of the groundwater. Using the filtered groundwater analytical results for the purposes of comparison, the risk is less than the EPA's target range, and the HQ is much less than 1.0.

The preliminary ecological risk evaluation showed that the groundwater concentrations did not pose unacceptable risks to ecological receptors. Because the site was a disposal pit, contamination, if present, was not anticipated to be at the surface. No surface soil samples were collected, so terrestrial ecological receptors could not be quantitatively evaluated.

6.7.2 Recommendations

Because the high turbidity in the groundwater sample, an additional supplemental investigation is recommended. This supplemental investigation would consist of installing a temporary monitoring well near S33TW003 so that a low turbidity sample can be obtained and analyzed. If the results show that metals are at concentrations acceptable to human health, then no action is recommended. If the results show that metals are at concentrations unacceptable to human health, then an RI and FS are recommended for this site.

TABLE 6-1

ENVIRONMENTAL SAMPLING AND ANALYSIS SUMMARY - SITE 33
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location	Sample Designation	Sample Depth (feet below ground surface) [1]	Sample Analysis					
			TCL VOCs	TCL SVOCs	TAL Metals[2]	Beryllium and Copper[2]	TCL Pesticides/ PCBs	Explosives (with nitrocellulose, nitroguanidine, and nitroglycerine)
SUBSURFACE SOIL								
S33SB001 / S33TW001	S33SB0010101	6-8			●			● (3)
S33SB001 / S33TW001	S33SB0010201	14-16			●			● (3)
S33SB002 / S33TW002	S33SB0020101	6-8			●			● (3)
S33SB002 / S33TW002	S33SB0020201	14-16			●			● (3)
S33SB003	S33SB0030101	3 – 5			●			● (3)
S33SB003	S33SB0030201	8 – 10			●			● (3)
S33SB0030201	S33SBDUP0101	8 – 10			●			● (3)
TEMPORARY WELLS								
S33TW001	S33TW0010001	--			●			● (3)
S33TW002	S33TW0020001	--			●			● (3)
S33TW003	S33TW0030001	--			●			● (3)

Notes:

1 Sample depths are as collected in the field.
2 Groundwater samples were analyzed for total and filtered metals.
3 Excluding nitrocellulose.

TABLE 6-2

SUMMARY OF POSITIVE DETECTIONS - SUBSURFACE SOIL - SITE 33
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location	S33SB001/TW001	S33SB001/TW001	S33SB002/TW002	S33SB002/TW002	S33SB003/TW003	S33SB003/TW003	S33SB003/TW003
Sample Number	S33SB0010101	S33SB0010201	S33SB0020101	S33SB0020201	S33SB0030101	S33SB0030201	S33SBDUP0101
Duplicate of:							S33SB0030201
Collection Date	02/07/02	02/07/02	02/08/02	02/08/02	02/12/02	02/12/02	02/12/02
Interval, feet bgs	6 - 8	14 - 16	6 - 8	14 - 16	3 - 5	8 - 10	8 - 10
Inorganics (mg/kg)							
ALUMINUM	6520	5870	2760	4880	7660	12500	13000
ARSENIC	6.1	5.3 K	1.6 K	5.6 K	3.2 K	25 K	17.9 K
BARIUM	29.5	40.3	17.3	29.4	15.9	22.4	20.4
BERYLLIUM	0.34 K	1.3 K	0.16 K	1.5 K	0.22 K	1.9 K	1.5 K
CALCIUM	551	1170	165	640	8.9 U	14.1 U	30.6 U
CHROMIUM	15.1	18	11.6	21.2	16.6	44.1	47.5
COBALT	0.97 U	3 J	0.22 U	2 J	1.5 J	2.5 J	1.5 J
COPPER	3.6 K	7 K	3.3 K	13.2	7.6 K	4.7 J	3.9 J
IRON	12700	17700	7770	32300	15400	50200	40300
LEAD	8.4 J	9.3 J	4.4 J	7.9 J	8 J	10.1 J	7.2 J
MAGNESIUM	625	897	177	641	554	1930	1980
MANGANESE	2.4 J	16.8 J	1.4 J	21.8 J	20.9 J	228 J	107 J
MERCURY	0.047 U	0.055	0.055 U	0.046 U	0.055 U	0.057 U	0.059 U
NICKEL	2.9 K	9.6 K	0.94 U	13 K	3.1 K	9.5 K	7.3 K
POTASSIUM	546 J	981 J	292 J	853 J	543 J	3990 J	4100 J
SELENIUM	0.38 U	0.35 UL	0.32 U	0.43 UL	0.42 U	0.61 J	0.46 UL
THALLIUM	0.38 U	0.35 UL	0.33 K	0.63 J	0.42 U	1.1 K	0.93 J
VANADIUM	36.2	29.9	14.4 K	36.8	25.1	55.6	49.5
ZINC	12.1 U	37	5.9 K	36.3	14.6	49.3	38.8

Notes:
U - Not detected at detection limit value shown.
J - Estimated value.
K - Estimated value, biased high.
= Sample concentration exceeds screening concentration. See Table 6-3.

TABLE 6-3

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH SUBSURFACE SOIL - SITE 33
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Site 33

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Nondetects(2)	Average Concentration	Concentration Used for Screening(3)	Background Value(4)	U.S. EPA Region 3 RBC-Residential (5)	EPA SSLs Soil to Air(6)	U.S. EPA Region 3 SSLs Soil to Groundwater(7)	COPC Flag	Rationale for Contaminant Deletion or Selection(8)
Inorganics																	
7429-90-5	Aluminum	2760		13000		mg/kg	S33SB0030201-D	6/6	NA	6740	13000	35400	7800 N	NA	NA	No	BKG
7440-38-2	Arsenic	1.6	K	25	K	mg/kg	S33SB0030201	6/6	NA	7.21	25	18.9	0.43 C	750	0.026	Yes	ASL
7440-39-3	Barium	15.9		40.3		mg/kg	S33SB0010201	6/6	NA	25.6	40.3	134	550 N	690000	2100	No	BSL, BKG
7440-41-7	Beryllium	0.16	K	1.9	K	mg/kg	S33SB0030201	6/6	NA	0.870	1.9	3.3	16 N	1300	1200	No	BSL, BKG
7440-70-2	Calcium	165		1170		mg/kg	S33SB0010201	4/6	8.9 - 30.6	424	1170	2590	NA	NA	NA	No	NUT, BKG
7440-47-3	Chromium	11.6		47.5		mg/kg	S33SB0030201-D	6/6	NA	21.4	47.5	60.1	23 (9) N	270	42	No	BKG
7440-48-4	Cobalt	1.5	J	3	J	mg/kg	S33SB0010201	4/6	0.22 - 0.97	1.52	3	133	160 N	NA	NA	No	BSL, BKG
7440-50-8	Copper	3.3	K	13.2		mg/kg	S33SB0020201	6/6	NA	6.50	13.2	48.6	310 N	NA	11000	No	BSL, BKG
7439-89-6	Iron	7770		50200		mg/kg	S33SB0030201	6/6	NA	21853	50200	83100	2300 N	NA	NA	No	BKG
7439-92-1	Lead	4.4	J	10.1	J	mg/kg	S33SB0030201	6/6	NA	7.78	10.1	40.5	400 (10)	NA	NA	No	BSL, BKG
7439-95-4	Magnesium	177		1980		mg/kg	S33SB0030201-D	6/6	NA	808	1980	2640	NA	NA	NA	No	NUT, BKG
7439-96-5	Manganese	1.4	J	228	J	mg/kg	S33SB0030201	6/6	NA	38.5	228	4130	160 N	NA	950	No	BKG
7439-97-6	Mercury	0.055		0.055		mg/kg	S33SB0010201	1/6	0.046 - 0.059	0.031	0.055	0.18	2.3 (11) N	10	2	No	BSL, BKG
7440-02-0	Nickel	2.9	K	13	K	mg/kg	S33SB0020201	5/6	0.94	6.25	13	18.2	160 N	13000	130 (12)	No	BSL, BKG
7440-09-7	Potassium	292	J	4100	J	mg/kg	S33SB0030201-D	6/6	NA	1210	4100	2610	NA	NA	NA	No	NUT
7782-49-2	Selenium	0.61	J	0.61	J	mg/kg	S33SB0030201	1/6	0.32 - 0.46	0.228	0.61	13.3	39 N	NA	19	No	BSL, BKG
7440-28-0	Thallium	0.33	K	1.1	K	mg/kg	S33SB0030201	3/6	0.35 - 0.42	0.425	1.1	21.8	0.55 N	NA	3.6	No	BKG
7440-62-2	Vanadium	14.4	K	55.6		mg/kg	S33SB0030201	6/6	NA	32.5	55.6	194	55 N	NA	5100	No	BKG
7440-66-6	Zinc	5.9	K	49.3		mg/kg	S33SB0030201	5/6	12.1	24.0	49.3	70.4	2300 N	NA	14000	No	BSL, BKG

Notes:

1 - Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.

2 - Values presented are sample-specific quantitation limits.

3 - The maximum detected concentration is used for screening purposes.

4 - 95% UTL for clayey soils from Background Soil Investigation Report for Indian Head Stump Neck Annex, Indian Head and Stump Neck Annex, TINUS, February 2002 (Draft).

5 - EPA Region 3 Risk-Based Concentration Table, April 2, 2002. (RBCs for noncarcinogenic compounds are divided by 10).

6 - Soil Screening Levels for Inhalation EPA, May 1996. Soil Screening Guidance.

7 - EPA Region 3 Risk-Based Concentration Table, April 2, 2002. DAF (Dilution attenuation factor) of 20.

8 - Rationale Codes
Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Level (BSL)
Below Background Value (BKG)

9 - Value is for hexavalent chromium.

10 - OSWER screening level. EPA,1994:Guidance on Residential Lead-Based Paint, Lead-Contaminated Dust, and Lead-Contaminated Soil.

11 - Value is for mercuric chloride.

12 - Soil Screening Levels for migration to groundwater. EPA, May 1996. Soil Screening Guidance.

Shaded cells indicate that the specified criterion has been exceeded or that the chemical has been selected as a COPC.

Definitions:

NA = Not Applicable.
SQL = Sample Quantitation Limit.
COPC = Chemical of Potential Concern.
J = Estimated Value.
K = Estimated value, biased high.
C = Carcinogenic.
N = Noncarcinogenic.

Associated Samples:
S33SB0010101 S33SB0030101
S33SB0010201 S33SB0030201
S33SB0020101 S33SB0030201-D
S33SB0020201

TABLE 6-4

SUMMARY OF POSITIVE DETECTIONS - GROUNDWATER - SITE 33
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location	S33SB001/TW001	S33SB001/TW001	S33SB002/TW002	S33SB002/TW002	S33SB003/TW003	S33SB003/TW003
Sample Number	S33TW0010001	S33TW0010001-F	S33TW0020001	S33TW0020001-F	S33TW0030001	S33TW0030001-F
Unfiltered/filtered?	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered	Filtered
Collection Date	02/08/02	02/09/02	02/12/02	02/13/02	02/12/02	02/08/02
Explosives (ug/L)						
2,6-DINITROTOLUENE	0.2 U		0.11 J		0.13 J	
Inorganics (ug/L)						
ALUMINUM	**286**	**53.5 U**	**435**	17.2 U	**15400**	18.6 U
ARSENIC	**2 U**	**2 U**	**2 U**	**2 U**	**11.8 K**	2 U
BARIUM	25.8 J	25.3	21.8 J	21.8	117 J	22.9
BERYLLIUM	0.2 U	0.2 U	0.2 U	0.2 U	2.8 K	0.2 U
CALCIUM	3780	3800	2570	2790	5400	2760
CHROMIUM	1.7 K	0.75 K	1.8 K	0.4 U	**56**	0.64 K
COBALT	3.9 U	3.8 U	3.1 U	4 U	**42.8 K**	3.3 U
COPPER	1.4 U	1 U	1.7 U	1 U	26.8	2.6 U
IRON	**700**	223	**1060**	23 U	**30600**	23 U
LEAD	0.4 U	0.4 U	0.77 U	0.4 U	9.8	0.4 U
MAGNESIUM	**1130**	**1130**	**905**	**969**	**4210**	**897**
MANGANESE	**59.3**	**62.7**	**62.8**	**61.2**	**191**	**61.5**
NICKEL	4.6 U	4.4 U	2.8 U	2.6 U	31 K	3.4 U
POTASSIUM	1380	1380	1470	1280	7290	1200
SODIUM	3110 U	3090 U	6070	2350 U	6320	3070 U
VANADIUM	1.1 K	0.3 U	2 K	0.37 K	**76.4 K**	0.3 U
ZINC	16.9 U	15 U	18.3 U	10.5 U	**129**	14.2 U

Notes:
Blank means no analysis was performed.
U - Not detected at detection limit value shown.
J - Estimated value.
K - Estimated value, biased high.
= Sample concentration exceeds screening concentration. See Table 6-5.

TABLE 6-5

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH GROUNDWATER - SITE 33
SITE SCREENING STUDY
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Site 33

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Average Concentration	Concentration Used for Screening(3)	Background Value(4)	U.S. EPA Region 3 RBC-Tap Water (5)	Potential ARAR/TBC Value(6)	Potential ARAR/TBC Source(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Inorganics, Total																	
7429-90-5	Aluminum	286		15400		ug/L	S33TW0030001	3/3	NA	5374	15400	286545198	3700 N	50 to 200	SMCL	No	BKG
7440-38-2	Arsenic	11.8	K	11.8	K	ug/L	S33TW0030001	1/3	2	4.60	11.8	NA	0.045 C	10	MCL	Yes	ASL
7440-39-3	Barium	21.8	J	117	J	ug/L	S33TW0030001	3/3	NA	54.9	117	254	260 N	2000	MCL	No	BSL, BKG
7440-41-7	Beryllium	2.8	K	2.8	K	ug/L	S33TW0030001	1/3	0.2	1.00	2.8	NA	7.3 N	4	MCL	No	BSL
7440-70-2	Calcium	2570		5400		ug/L	S33TW0030001	3/3	NA	3917	5400	599450	NA	NA	NA	No	NUT, BKG
7440-47-3	Chromium	1.7	K	56		ug/L	S33TW0030001	3/3	NA	19.8	56	20.9	11 (8) N	100	MCL	Yes	ASL
7440-48-4	Cobalt	42.8	K	42.8	K	ug/L	S33TW0030001	1/3	3.1 - 3.9	15.4	42.8	39.6	73 N	NA	NA	No	BSL
7440-50-8	Copper	26.8		26.8		ug/L	S33TW0030001	1/3	1.4 - 1.7	9.45	26.8	22.4	150 N	1300 (9)	MCL	No	BSL
7439-89-6	Iron	700		30600		ug/L	S33TW0030001	3/3	NA	10787	30600	57199	1100 N	300	SMCL	No	BKG
7439-92-1	Lead	9.8		9.8		ug/L	S33TW0030001	1/3	0.4 - 0.77	3.46	9.8	NA	NA	15 (9)	MCL	No	BSL
7439-95-4	Magnesium	905		4210		ug/L	S33TW0030001	3/3	NA	2082	4210	31254	NA	NA	NA	No	NUT, BKG
7439-96-5	Manganese	59.3		191		ug/L	S33TW0030001	3/3	NA	104	191	28160	73 N	50	SMCL	No	BKG
7440-02-0	Nickel	31	K	31	K	ug/L	S33TW0030001	1/3	2.8 - 4.6	11.6	31	39	73 N	NA	NA	No	BSL, BKG
7440-09-7	Potassium	1380		7290		ug/L	S33TW0030001	3/3	NA	3380	7290	83058	NA	NA	NA	No	NUT, BKG
7440-23-5	Sodium	6070		6320		ug/L	S33TW0030001	2/3	3110	4648	6320	79585	NA	NA	NA	No	NUT, BKG
7440-62-2	Vanadium	1.1	K	76.4	K	ug/L	S33TW0030001	3/3	NA	26.5	76.4	24.1	26 N	NA	NA	Yes	ASL
7440-66-6	Zinc	129		129		ug/L	S33TW0030001	1/3	16.9 - 18.3	48.9	129	45.2	1100 N	5000	SMCL	No	BSL
Explosives																	
606-20-2	2,6-Dinitrotoluene	0.11	J	0.13	J	ug/L	S33TW0030001	2/3	0.2	0.113	0.13	NA	3.7 N	NA	NA	No	BSL
Inorganics, Filtered																	
7440-39-3	Barium	21.8		25.3		ug/L	S33TW0010001-F	3/3	NA	23.3	25.3	254	260 N	2000	MCL	No	BSL, BKG
7440-70-2	Calcium	2760		3800		ug/L	S33TW0010001-F	3/3	NA	3117	3800	599450	NA	NA	NA	No	NUT, BKG
7440-47-3	Chromium	0.64	K	0.75	K	ug/L	S33TW0010001-F	2/3	0.4	0.530	0.75	20.9	11 N	100	MCL	No	BSL, BKG
7439-89-6	Iron	223		223		ug/L	S33TW0010001-F	1/3	23	82.0	223	57199	1100 N	300	SMCL	No	BSL, BKG
7439-95-4	Magnesium	897		1130		ug/L	S33TW0010001-F	3/3	NA	999	1130	31254	NA	NA	NA	No	NUT, BKG
7439-96-5	Manganese	61.2		62.7		ug/L	S33TW0010001-F	3/3	NA	61.8	62.7	28160	73 N	50	SMCL	No	BKG
7440-09-7	Potassium	1200		1380		ug/L	S33TW0010001-F	3/3	NA	1287	1380	83058	NA	NA	NA	No	NUT, BKG
7440-62-2	Vanadium	0.37	K	0.37	K	ug/L	S33TW0020001-F	1/3	0.3	0.223	0.37	24.1	26 N	NA	NA	No	BSL, BKG

Notes:
1 - Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - 95% UTL from Background Soil Investigation Report for Indian Head Stump Neck Annex, Indian Head and Stump Neck Annex, TtNUS, February 2002 (Draft).
5 - EPA Region 3 Risk-Based Concentration Table, April 2, 2002. (RBCs for noncarcinogenic compounds are divided by 10).
6 - Drinking Water Standards and Health Advisories, EPA 2000.
7 - Rationale Codes:
Selection Reason: Above Screening Levels (ASL)
No Toxicity Information (NTX)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Level (BSL)
Below Background Value (BKG)
8 - Value is for hexavalent chromium.
9 - Action Level.

Definitions:
NA = Not Applicable.
SQL = Sample Quantitation Limit.
COPC = Chemical of Potential Concern.
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
J = Estimated Value.
K = Estimated value, biased high.
MCL - Maximum Contaminant Level.
SMCL - Secondary Maximum Contaminant Level.
C = Carcinogenic
N = Noncarcinogenic

Shading indicates that the maximum detected concentration exceeded the screening criteria; therefore, the chemical was retained as a COPC.

Associated Samples:

S33TW0010001	S33TW0010001-F
S33TW0020001	S33TW0020001-F
S33TW0030001	S33TW0030001-F

TABLE 6-6

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - SUBSURFACE SOIL - SITE 33
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Chemical	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)		
	Concentration (mg/kg)	RBC[1] (mg/kg)	Estimated ILCR	Primary	RBC[1] (mg/kg)	Estimated HQ
Arsenic	25	0.43	5.8E-05	Skin, Vascular	23	1.1
	Total Carcinogenic Risk		**5.8E-05**		**Total HI**	**1.1**

Target Organ HIs

Total Vascular HI =	1.1
Total Skin HI =	1.1

Notes:

1 Risk-Based Concentration (RBC) Table (EPA Region 3, 2002). Some noncarcinogenic RBCs not presented in the EPA Region 3 RBC Table were calculated per the methodology detailed in Appendix I.

TABLE 6-7

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - GROUNDWATER - SITE 33
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Chemical	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)		
	Concentration µg/L	RBC[1] µg/L	Estimated ILCR	Primary	RBC[1] µg/L	Estimated HQ
Arsenic	11.8	0.045	2.6E-04	Skin, Vascular	11	1.1
Chromium	56	NA	NA	NOAEL	110	0.5
Vanadium	76.4	NA	NA	NOEL	260	0.3
	Total Carcinogenic Risk		**2.6E-04**		**Total HI**	**1.9**

Target Organ HIs

Total Skin HI =	1.1
Total Vascular HI =	1.1

Notes:
1 Risk-Based Concentration (RBC) Table (EPA Region 3, 2002). Some noncarcinogenic RBCs not presented in the EPA Region 3 RBC Table were calculated per the methodology detailed in Appendix I.
2 NA - Not applicable. The EPA has not established a cancer slope factor (CSF) or noncarcinogenic reference dose (RfD).

Definition:
NOAEL = No Observed Adverse Effect Level
NOEL = No Observed Effect Level

TABLE 6-8

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - FILTERED GROUNDWATER - SITE 33
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Chemical	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)		
	Concentration µg/L	RBC[1] µg/L	Estimated ILCR	Primary	RBC[1] µg/L	Estimated HQ
Arsenic	ND	NA	NA	Skin, Vascular	11	NA
Chromium	0.75	NA	NA	NOAEL	110	0.007
Vanadium	0.37	NA	NA	NOEL	260	0.001
	Total Carcinogenic Risk		**NA**		**Total HI**	**0.008**

1 Risk-Based Concentration (RBC) Table (EPA Region III, 2002). Some noncarcinogenic RBCs not presented in the EPA Region III Risk Based Concentration Table were calculated as per the methodology detail in Appendix I.
2 NA - Not applicable. The EPA has not established a cancer slope factor (CSF) or noncarcinogenic reference dose (R

Definition:
NOAEL = No Observed Adverse Effect Level
NOEL = No Observed Effect Level

TABLE 6-9

SELECTION OF ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN - GROUNDWATER - SITE 33
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Parameter	Frequency of Detection	Minimum Concentration	Maximum Concentration[1]	Location of Maximum Concentration	Average of Positive Results	Average of All Results	Grounwater COPC Screening Level[2]	Ecological Effects Quotient[3]	Retain as a COPC?	Rationale for Contaminant Deletion or Selection [4]
Inorganics, Total (ug/L)										
Aluminum	3/3	286	15400	S33TW0030001	5374	5374	25	616	YES	ASL
Arsenic	1/3	11.8 K	11.8 K	S33TW0030001	11.8	4.6	48	0.2	NO	BSL
Barium	3/3	21.8 J	117 J	S33TW0030001	54.9	54.9	10000	0.01	NO	BSL
Beryllium	1/3	2.8 K	2.8 K	S33TW0030001	2.8	1	5.3	0.5	NO	BSL
Calcium	3/3	2570	5400	S33TW0030001	3917	3917	NA	NA	NO	NT
Chromium	3/3	1.7 K	56	S33TW0030001	19.8	19.8	2	28	YES	ASL
Cobalt	1/3	42.8 K	42.8 K	S33TW0030001	42.8	15.4	35000	0.001	NO	BSL
Copper	1/3	26.8	26.8	S33TW0030001	26.8	9.5	6.5	4.1	YES	ASL
Iron	3/3	700	30600	S33TW0030001	10787	10787	320	96	YES	ASL
Lead	1/3	9.8	9.8	S33TW0030001	9.8	3.5	3.2	3.1	YES	ASL
Magnesium	3/3	905	4210	S33TW0030001	2082	2082	NA	NA	NO	NT
Manganese	3/3	59.3	191	S33TW0030001	104	104	14500	0.01	NO	BSL
Nickel	1/3	31 K	31 K	S33TW0030001	31	11.6	160	0.2	NO	BSL
Potassium	3/3	1380	7290	S33TW0030001	3380	3380	NA	NA	NO	NT
Sodium	2/3	6070	6320	S33TW0030001	6195	4648	NA	NA	NO	NT
Vanadium	3/3	1.1 K	76.4 K	S33TW0030001	26.5	26.5	10000	0.01	NO	BSL
Zinc	1/3	129	129	S33TW0030001	129	48.9	30	4.3	YES	ASL
Inorganics, Filtered (ug/L)										
Barium	3/3	21.8	25.3	S33TW0010001-F	23.3	23.3	10000	0.003	NO	BSL
Calcium	3/3	2760	3800	S33TW0010001-F	3117	3117	NA	NA	NO	NT
Chromium	2/3	0.64 K	0.75 K	S33TW0010001-F	0.7	0.53	2	3.8E-01	NO	BSL
Iron	1/3	223	223	S33TW0010001-F	223	82	320	0.7	NO	BSL
Magnesium	3/3	897	1130	S33TW0010001-F	999	999	NA	NA	NO	NT
Manganese	3/3	61.2	62.7	S33TW0010001-F	61.8	61.8	14500	0.004	NO	BSL
Potassium	3/3	1200	1380	S33TW0010001-F	1287	1287	NA	NA	NO	NT
Vanadium	1/3	0.37 K	0.37 K	S33TW0020001-F	0.37	0.22	10000	0.00004	NO	BSL
Explosives (ug/L)										
2,6-Dinitrotoluene	2/3	0.11 J	0.13 J	S33TW0030001	0.12	0.11	NA	NA	YES	NTX

Shaded cells indicate that the chemical was selected as a COPC.
COPC = Chemical of Potential Concern
NA = Not Available
J = Estimated value
K = Estimated value, biased high
The sample and duplicate were counted as two separate samples when determining the minimum and maximum detected concentrtions and location of maximum concentration, but were only counted as one sample when determining the frequency of detection. One-half of the detection limit was used when averaging non-detected data.

Footnotes:
1 The maximum detected concentration was used to calculate the ecological effects quotient.
2 Refer to Table 4-5 for sources of groundwater screening criteria
3 Refer to Section 4.4.4 for ecological effects quotient calculation.
4 Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level
BIO = Bioaccumulative Chemical
NTX = No Toxicity Information Available

For Elimination as a COPC:
BSL = Below COPC Screening Level
NT = Nontoxic

Associated Samples:

S33TW0010001
S33TW0020001
S33TW0030001

S33TW0010001-F
S33TW0020001-F
S33TW0030001-F

ACAD: 0525CM62.dwg 05/20/02 HJB PIT

2136

2116

SITE 33

90

100

110

80

N

LEGEND:

- TREELINE
- 25 — TOPOGRAPHIC CONTOUR (1-FOOT INTERVAL)
- STREAM
- X FENCE
- APPROXIMATE SITE LOCATION
- 31SN BUILDING OR STRUCTURE

0 30 60
SCALE IN FEET

DRAWN BY / DATE	HJB 5/20/02
CHECKED BY / DATE	
REVISED BY / DATE	
SCALE	AS NOTED

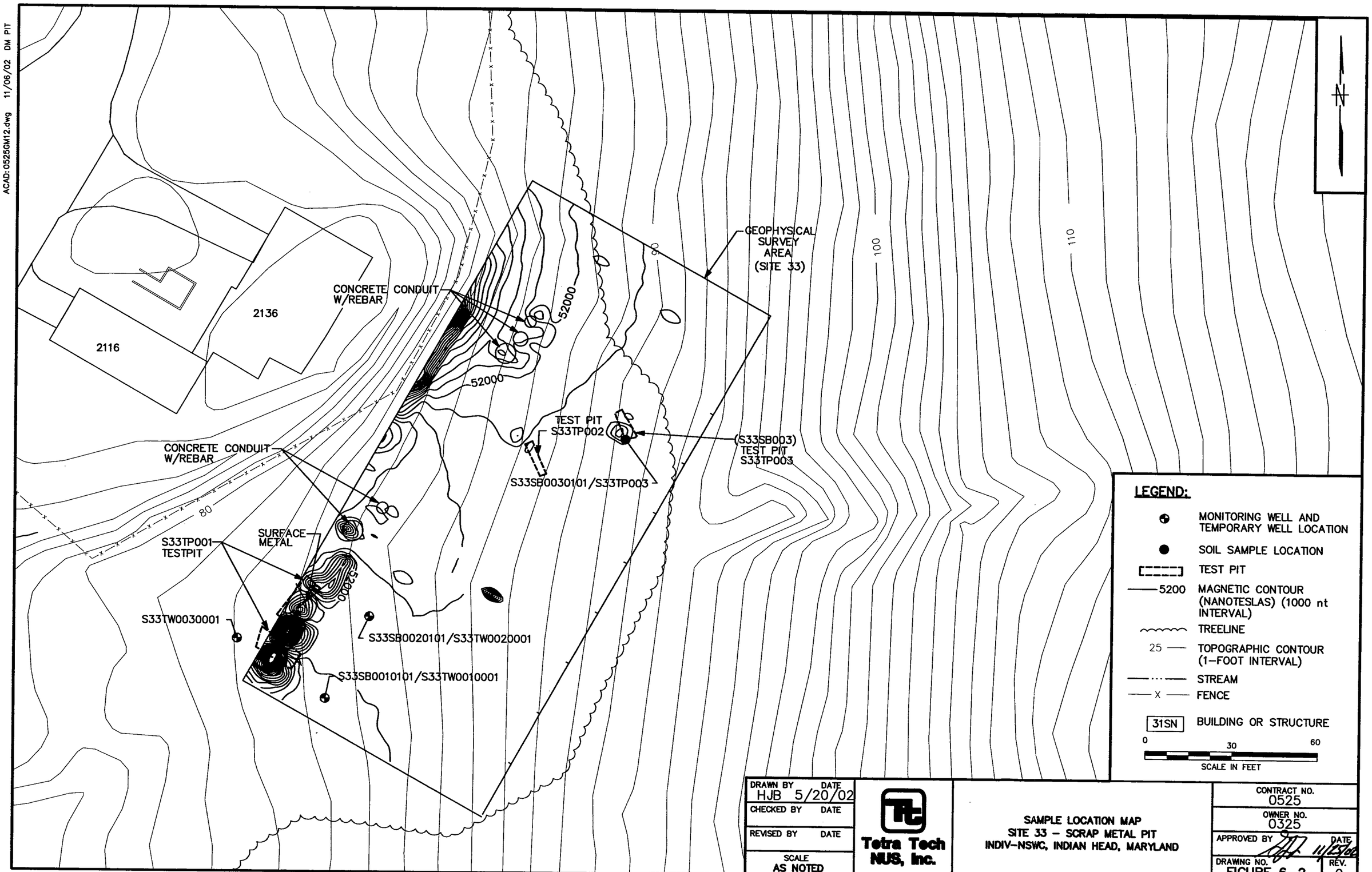
Tetra Tech NUS, Inc.

SITE LAYOUT
SITE 33 – SCRAP METAL PIT
INDIV–NSWC, INDIAN HEAD, MARYLAND

CONTRACT NO.	0525
OWNER NO.	0325
APPROVED BY / DATE	11/25/02
DRAWING NO.	FIGURE 6-1
REV.	0

FORM CADD NO. TTNUS-BH.DWG – REV 1 – 9/10/98

ACAD:0525GM12.dwg 11/06/02 DM PIT



DRAWN BY / DATE	HJB 5/20/02
CHECKED BY / DATE	
REVISED BY / DATE	
SCALE	AS NOTED

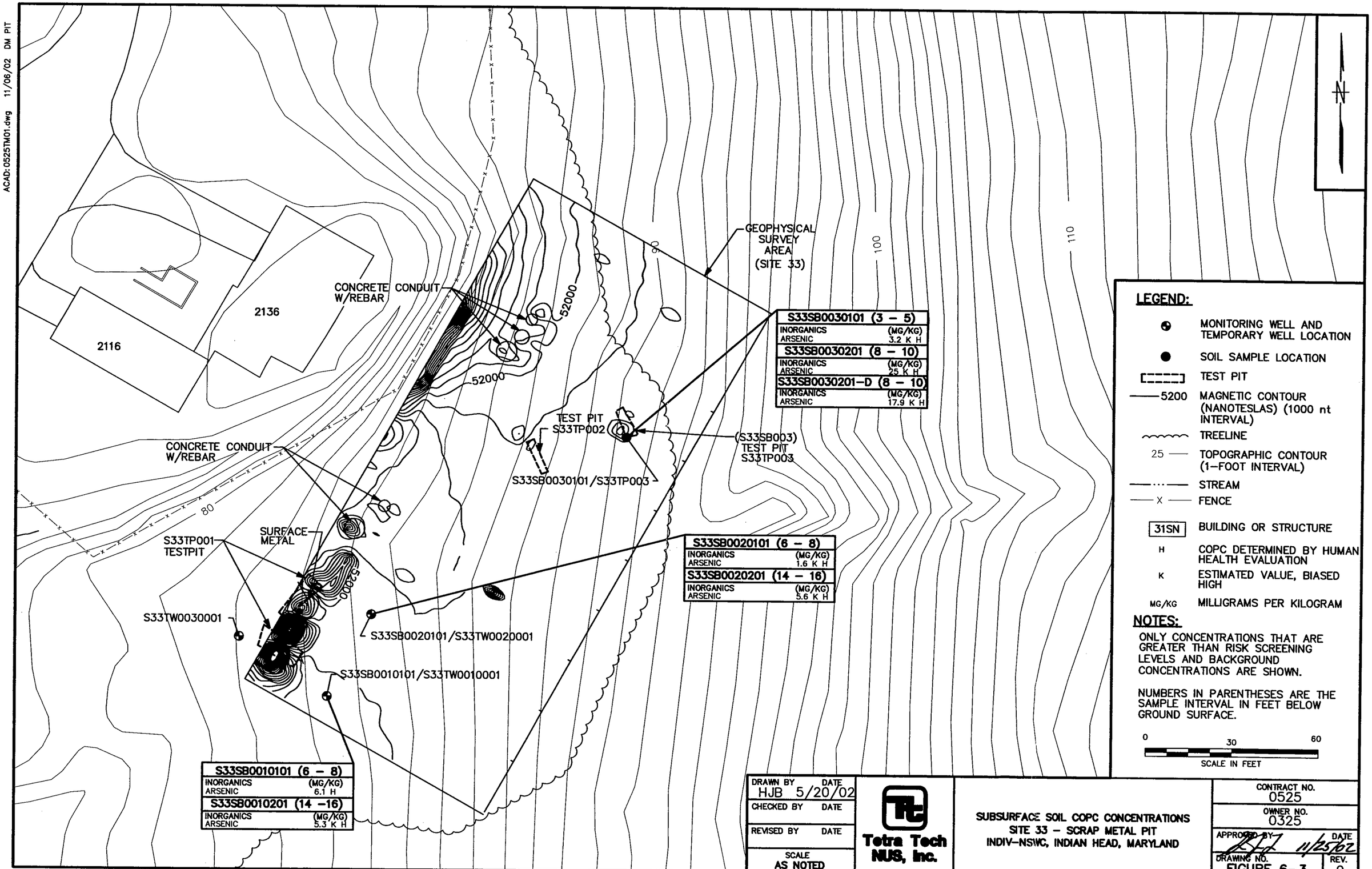
Tetra Tech NUS, Inc.

SAMPLE LOCATION MAP
SITE 33 – SCRAP METAL PIT
INDIV–NSWC, INDIAN HEAD, MARYLAND

CONTRACT NO.	0525
OWNER NO.	0325
APPROVED BY / DATE	11/25/02
DRAWING NO.	FIGURE 6-2
REV.	0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

ACAD:0525TM01.dwg 11/06/02 DM PIT



DRAWN BY / DATE	HJB 5/20/02
CHECKED BY / DATE	
REVISED BY / DATE	
SCALE	AS NOTED

Tetra Tech NUS, Inc.

SUBSURFACE SOIL COPC CONCENTRATIONS
SITE 33 – SCRAP METAL PIT
INDIV–NSWC, INDIAN HEAD, MARYLAND

CONTRACT NO.	0525
OWNER NO.	0325
APPROVED BY / DATE	11/25/02
DRAWING NO.	FIGURE 6-3
REV.	0

FORM CADD NO. TTNUS-BH.DWG – REV 1 – 9/10/98

ACAD:0525TM04.dwg 11/06/02 DM PIT

2136

2116

80

90

100

110

TEST PIT
S33TP002

(S33SB003)
TEST PIT
S33TP003

S33SB0030101/S33TP003

S33TP001
TESTPIT

S33TW0030001
(70.25)

S33SB0020101/S33TW0020001
(72.57)

S33SB0010101/S33TW0010001
(71.14)

71.0

72.0

S33TW0030001	
INORGANICS	(UG/L)
ARSENIC	11.8 K H
CHROMIUM	56 H
VANADIUM	76.4 K H

N

LEGEND:

- MONITORING WELL AND TEMPORARY WELL LOCATION
- SOIL SAMPLE LOCATION
- TEST PIT
- 71.0 — POTENTIOMETRIC SURFACE CONTOUR (1-FOOT INTERVAL) (DASHED WHERE INFERRED)
- (72.57) GROUNDWATER ELEVATION (FEET MSL)
- 25 — TOPOGRAPHIC CONTOUR (1-FOOT INTERVAL)
- GROUNDWATER FLOW DIRECTION
- TREELINE
- STREAM
- FENCE
- 31SN BUILDING OR STRUCTURE
- H COPC DETERMINED BY HUMAN HEALTH EVALUATION
- K ESTIMATED VALUE, BIASED HIGH
- UG/L MICROGRAMS PER KILOGRAM

NOTE:

ONLY CONCENTRATIONS THAT ARE GREATER THAN RISK SCREENING LEVELS AND BACKGROUND CONCENTRATIONS ARE SHOWN.

0 30 60
SCALE IN FEET

DRAWN BY / DATE	HJB 5/20/02
CHECKED BY / DATE	
REVISED BY / DATE	
SCALE	AS NOTED

Tetra Tech NUS, Inc.

GROUNDWATER COPC CONCENTRATIONS
SITE 33 – SCRAP METAL PIT
INDIV–NSWC, INDIAN HEAD, MARYLAND

CONTRACT NO.	0525
OWNER NO.	0325
APPROVED / DATE	11/25/02
DRAWING NO.	FIGURE 6-4
REV.	0

FORM CADD NO. TTNUS-BH.DWG – REV 1 – 9/10/98

7.0 SITE 34 – TOOL BURIAL

7.1 BACKGROUND

Site 34 is located within the Stump Neck Annex. Beryllium-copper alloy hand tools reportedly buried near Building D-21CSN, in the area shown on Figure 7-1. Two burial holes, each about 5 feet by 15 feet by 12 feet deep were reported. The volume of tools in each pit was said to be about 5 feet by 8 feet by 2 feet. The tools were hand tools such as hammers, wrenches, screwdrivers, pliers, scrapers, and knives that were used in explosive ordnance disposal (EOD) work because they are nonmagnetic and nonsparking. According to interviewees, the tools in the pits had failed a magnetometer test and were considered unserviceable. The burial was said to have taken place in 1972 or 1973. It was noted that the magnetometer test took place in Building D-21CSN, which was added in 1973. A memorandum dated May 28, 1975 (Ser 113-45-75) contains a sketch showing the two test pits 60 feet and 70 feet southeast of the building. On-site investigations confirmed subsidence of soil at these locations (Hart, 1983).

7.2 SITE CHARACTERISTICS

7.2.1 Topography

As illustrated on Figure 7-1, the land surface at Site 34 gently slopes toward Chicamuxen Creek to the south. The land surface elevation across the site ranges from approximately 1 to 6 feet above msl.

7.2.2 Surface Water

Precipitation either infiltrates the soil or runs off the ground surface. Surface water runoff from Site 34 is likely to go to Chicamuxen Creek to the south directly or via a drainage swale to the west.

7.2.3 Geology/Soils

Logs from soil borings and test pits installed at the site indicate that shallow geologic conditions consist primarily of sand and gravelly sand overlying clay and silt. However, the clay and silt layer is absent at S34TW003. The gravels are composed of quartz and are well rounded to subrounded. Soil boring and test pit logs are provided in Appendix B.

7.2.4 Hydrogeology

The shallow aquifer beneath the site displays the characteristics of an unconfined system. After the wells were installed, the water level in the wells stabilized to the depth at which it was encountered during well

installation. Groundwater at the site was encountered at approximately 2 to 6 feet bgs. Based on the groundwater level elevations, the groundwater flow direction is to the northwest away from Chicamuxen Creek and toward the Mattawoman Creek to the northwest (Figure 7-2). The groundwater levels used to generate potentiometric contours were measured on February 12, 2002. The groundwater-level data are provided in Appendix E.

7.3 FIELD INVESTIGATION

A geophysical survey and test pit excavations were completed at the site to locate the tool burial pit and to evaluate the potential presence of contaminants. In addition, groundwater and subsurface soil samples were collected and submitted to a fixed-base laboratory for chemical analysis. The sample depths and analyses are summarized on Table 7-1.

7.3.1 Geophysical Investigation

An EM-31 electromagnetometer was used to perform a geophysical survey at Site 34 in order to locate the tool burial pit(s). The electromagnetometer measures the changes in the ground conductivity using a patented electromagnetic inductive technique that makes the measurements without electrodes or ground contact. This is a very useful instrument to locate buried non-ferrous metallic debris. The unit of conductivity that is used is millisiemens per meter (mS/m). The effective exploration depth of the instrument is approximately 20 feet.

As shown on Figure 7-2, the survey was conducted on a reference grid that was 80 feet by 190 feet. The resulting conductivity contour map is presented on Figure 7-2. The anomalies are indicated by the high-density contour lines. The major anomalies on Figure 7-2 are labeled as A, B, and C. Anomaly A actually results from Building D-21 immediately to the north of the anomalous area. Anomaly B is a reflection of a pile of scrap metal on the ground surface. However, anomaly C indicates the potential presence of buried metal and was considered the likely location of the tool burial area. A detailed report of the geophysical survey results is provided in Appendix D.

7.3.2 Test Pit Activities

One test pit was installed in the suspected area, as described in Section 7.3.1. The test pit location is shown on Figure 7-2. The excavation at S34TP001 uncovered abundant quantities of the beryllium-copper alloy tools. Other materials were also found such as canvas material, hardware, plastics, and paper. The S34TP001 test pit was approximately 2 feet wide, 10 feet in length and a depth of 10 feet bgs. Test pit log is provided in Appendix B.

7.3.3 Temporary Well Installation and Groundwater Sampling

Three temporary monitoring wells were installed at the site to determine if wastes from the tool burial pit had contaminated shallow groundwater. Based on field observation, the downgradient flow direction was believed to be toward Chicamuxen Creek. One well (S34TW002) was installed downgradient of the suspected burial area. Two wells (S34TW001 and S34TW003) were installed upgradient. Subsequent water-level data suggest that the groundwater flow is to the northwest, as described in Section 7.2.4, therefore, well S34TW003 is a downgradient well. Well locations are shown on Figure 7-2. The wells were constructed with 1-inch-ID PVC riser and screen material; they were installed and abandoned as described in Section 3.0. State of Maryland abandonment reports and TtNUS temporary well construction diagrams are presented in Appendix A.

Groundwater samples were collected from the temporary wells, as described in Section 3.2.3, and analyzed for beryllium and copper (total and dissolved). Groundwater sample log sheets are provided in Appendix C.

7.3.4 Subsurface Soil Sampling

One subsurface soil sample was collected from within the area of beryllium-copper alloy tools encountered at S34TP001 (the sample location designation is S34SB001) at a depth of 4 to 4.5 feet bgs. The soil sample was collected using a backhoe. The sample depth and analyses are summarized on Table 7-1. Sample locations are shown on Figure 7-2.

No elevated PID readings were recorded during the subsurface investigation. Ordnance hardware was found in the test pit; therefore, the soil sample was submitted to a fixed-base laboratory to be analyzed for explosives including nitrocellulose, nitroguanidine, and nitroglycerine, in addition to beryllium and copper. Soil sample log sheets are provided in Appendix C.

One field duplicate S34SBDUP0101 was collected at the same location as S34SB0010101 and analyzed for the same parameters.

7.4 ANALYTICAL RESULTS AND COPC SELECTION

This section provides the data, evaluation, and selection of human health COPCs for subsurface soil and groundwater contamination at Site 34. The selection of ecological COPCs is discussed in Section 7.6. This screening evaluation is based on the following samples:

- One subsurface soil sample
- Three groundwater samples collected from temporary monitoring wells

The results were evaluated as described in Section 4.3. Complete chemical analytical results are presented in Appendix H.

7.4.1 Data and Risk-Based Evaluation of Subsurface Soil Contamination

Positive analytical results and summary statistics for subsurface soil samples are provided in Tables 7-2 and 7-3, respectively.

Based on the analytical results, although copper concentrations exceeded background concentrations, neither beryllium nor copper concentrations exceeded the screening levels in the subsurface soil samples. Both metals were detected in sample S34SB0010101. No explosives were detected in the subsurface soil. Therefore, there are no soil COPCs.

7.4.2 Data and Risk-Based Evaluation of Groundwater Contamination

Positive analytical results for unfiltered and filtered groundwater samples are provided in Table 7-4. The summary statistics for unfiltered and filtered groundwater samples are provided in Table 7-5.

Based on the analytical results, neither beryllium nor copper concentrations exceeded the screening levels in the groundwater samples. Therefore, there are no groundwater COPCs. Beryllium was detected only in sample S34TW0010001.

7.5 HUMAN HEALTH RISK SCREENING EVALUATION

COPCs were not selected from the environmental media sampled at Site 34. No further human health risk screening is necessary.

7.6 ECOLOGICAL RISK SCREENING EVALUATION

Surface water, surface soil, and sediment samples were not collected at Site 34 were not collected, so the ecological COPC screening was performed with groundwater results only. Groundwater data was evaluated due to the possibility of discharge to Mattawoman Creek and potential risks to aquatic receptors. Unfiltered and filtered samples were evaluated in the screening (see Table 7-6).

7.6.1 Data and Risk-Based Evaluation of Groundwater Contamination

Beryllium and copper were detected in unfiltered samples and beryllium was detected in filtered samples. Maximum concentrations were below the screening values, so beryllium and copper were not retained as COPCs.

7.7 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

7.7.1 Summary and Conclusions

Tools that were buried at the sites were found during the test pit investigation. Concentrations of beryllium and copper in the subsurface soil and groundwater samples were less than human health and ecological screening levels. In addition, no explosives were detected in the subsurface soil. Thus, there are no COPCs, and no unacceptable risks to human health or ecological receptors were identified.

The preliminary ecological risk evaluation showed that the groundwater concentrations did not pose unacceptable risks to ecological receptors. Because the site was a burial pit, contamination, if present, was not anticipated to be at the surface. No surface soil samples were collected, so terrestrial ecological receptors could not be quantitatively evaluated.

7.7.2 Recommendations

No action is required for Site 34, so the site should be removed from additional study under the FFA, and a No Action Decision Document should be prepared for this site in accordance with the FFA.

TABLE 7-1

ENVIRONMENTAL SAMPLING AND ANALYSIS SUMMARY – SITE 34
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location	Sample Designation	Sample Depth (feet below ground surface) [1]	Sample Analysis					
			TCL VOCs	TCL SVOCs	TAL Metals[2]	Beryllium and Copper[2]	TCL Pesticides/ PCBs	Explosives (with nitrocellulose, nitroguanidine, and nitroglycerine)
SUBSURFACE SOIL								
S34SB001 48 hr TAT	S34SB0010101	From bottom of excavation 4-4.5'				●		●
Duplicate at S34SB0010101	S34SBDUP0101	From bottom of excavation				●		●
TEMPORARY WELLS								
S34TW001	S34TW0010001	--				●		
S34TW002	S34TW0020001	--				●		
S34TW003	S34TW0030001	--				●		

Notes:

1 Sample depths are as collected in the field.
2 Groundwater samples were analyzed for total and filtered metals.

TABLE 7-2

SUMMARY OF POSITIVE DETECTIONS - SUBSURFACE SOIL - SITE 34
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location	S34SB001	S34SB001
Sample Number	S34SB0010101	S34SBDUP0101
Duplicate of:		S34SB0010101
Collection Date	1/30/2002	1/30/2002
Interval, feet bgs	4 - 4.5	4 - 4.5
Inorganics (mg/kg)		
BERYLLIUM	0.65	0.565
COPPER	110	85.55

TABLE 7-3

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH SUBSURFACE SOIL - SITE 34
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Site 34

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Nondetects(2)	Average Concentration	Concentration Used for Screening(3)	Background Value(4)	U.S. EPA Region 3 RBC-Residential (5)	EPA SSLs Soil to Air(6)	U.S. EPA Region 3 SSLs Soil to Groundwater(7)	COPC Flag	Rationale for Contaminant Deletion or Selection(8)
Inorganics																	
7440-41-7	Beryllium	0.48		0.65		mg/kg	S34SB0010101	1/1	NA	0.565	0.65	1.5	16 N	1300	1200	No	BSL, BKG
7440-50-8	Copper	61.1		110		mg/kg	S34SB0010101	1/1	NA	85.6	110	47.6	310 N	NA	11000	No	BSL

Notes:

1 - Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.

2 - Values presented are sample-specific quantitation limits.

3 - The maximum detected concentration is used for screening purposes.

4 - 95% UTL for non-clayey soils from Background Soil Investigation Report for Indian Head Stump Neck Annex, Indian Head and Stump Neck Annex, TtNUS, February 2002 (Draft).

5 - EPA Region 3 Risk-Based Concentration Table, April 2, 2002. (RBCs for noncarcinogenic compounds are divided by 10).

6 - Soil Screening Levels for Inhalation EPA, May 1996. Soil Screening Guidance.

7 - EPA Region 3 Risk-Based Concentration Table, April 2, 2002. DAF (Dilution attenuation factor) of 20.

8 - Rationale Codes
Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Level (BSL)
Below Background Value (BKG)

Shaded cells indicate that the specified criterion has been exceeded or that the chemical has been selected as a COPC.

Definitions:

NA = Not Applicable.
SQL = Sample Quantitation Limit.
COPC = Chemical of Potential Concern.
J = Estimated Value.
C = Carcinogenic.
N = Noncarcinogenic.

Associated Samples:
S34SB0010101
S34SB0010101-D

TABLE 7-4

SUMMARY OF POSITIVE DETECTIONS - GROUNDWATER - SITE 34
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location	S34TW001	S34TW001	S34TW002	S34TW002	S34TW003	S34TW003
Sample Number	S34TW0010001	S34TW0010001-F	S34TW0020001	S34TW0020001-F	S34TW0030001	S34TW0030001-F
Unfiltered/filtered?	Unfiltered	Filtered	Unfiltered	Filtered	Unfiltered	Filtered
Collection Date	02/08/02	02/08/02	02/04/02	02/04/02	02/04/02	02/04/02
Inorganics (ug/L)						
BERYLLIUM	1.6 K	1.7 K	0.2 U	0.2 U	1.2 K	1.1 K
COPPER	1 U	1 U	1 U	1 U	3 K	1 U

Notes:
U - Not detected at detection limit value shown.
K - Estimated value, biased high.

TABLE 7-5

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH GROUNDWATER - SITE 34
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Site 34

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Average Concentration	Concentration Used for Screening(3)	Background Value(4)	U.S. EPA Region 3 RBC-Tap Water (5)	Potential ARAR/TBC Value(6)	Potential ARAR/TBC Source(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Inorganics, Total																	
7440-41-7	Beryllium	1.2	K	1.6	K	ug/L	S34TW0010001	2/3	0.2	0.967	1.6	NA	7.3 N	4	MCL	No	BSL
7440-50-8	Copper	3	K	3	K	ug/L	S34TW0030001	1/3	1	1.33	3	22.4	150 N	1300 (8)	MCL	No	BSL, BKG
Inorganics, Filtered																	
7440-41-7	Beryllium	1.1	K	1.7	K	ug/L	S34TW0010001-F	2/3	0.2	0.967	1.7	NA	73 N	4	MCL	No	BSL

Notes:
1 - Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - 95% UTL from Background Soil Investigation Report for Indian Head Stump Neck Annex, Indian Head and Stump Neck Annex, TtNUS, February 2002 (Draft).
5 - EPA Region 3 Risk-Based Concentration Table, April 2, 2002. (RBCs for noncarcinogenic compounds are divided by 10).
6 - Drinking Water Standards and Health Advisories, EPA 2000.
7 - Rationale Codes
Selection Reason: Above Screening Levels (ASL)
No Toxicity Information (NTX)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Level (BSL)
Below Background Value (BKG)
8 - Action Level.

Definitions:
NA = Not Applicable
SQL = Sample Quantitation Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Estimated value
K = Estimated value, biased high
N - Noncarcinogenic
MCL - Maximum Contaminant Level.
SMCL - Secondary Maximum Contaminant Level.

Shading indicates that the maximum detected concentration exceeded the screening criteria therefore the chemical was retained as a COPC.

Associated Samples:

S34TW0010001	S34TW0010001-F
S34TW0020001	S34TW0020001-F
S34TW0030001	S34TW0030001-F

TABLE 7-6

SELECTION OF ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN - GROUNDWATER - SITE 34
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIANHEAD, MARYLAND

Parameter	Frequency of Detection	Minimum Concentration	Maximum Concentration[1]	Location of Maximum Concentration	Average of Positive Results	Average of All Results	Groundwater COPC Screening Level[2]	Ecological Effects Quotient[3]	Retain as a COPC?	Rationale for Contaminant Deletion or Selection[4]
Inorganics, Total (ug/L)										
Beryllium	2/3	1.2 K	1.6 K	S34TW0010001	1.4	0.97	5.3	0.30	NO	BSL
Copper	1/3	3 K	3 K	S34TW0030001	3	1.33	6.5	0.46	NO	BSL
Inorganics, Filtered (ug/L)										
Beryllium	2/3	1.1 K	1.7 K	S34TW0010001-F	1.4	0.97	5.3	0.32	NO	BSL

Shaded cells indicate that the chemical was selected as a COPC.
COPC = Chemical of Potential Concern
K = Estimated value, biased high
The sample and duplicate were counted as two separate samples when determining the minimum and maximum detected concentrations and location of maximum concentration, but were only counted as one sample when determining the frequency of detection. One-half of the detection limit was used when averaging non-detected data.

Footnotes:
1 The maximum detected concentration was used to calculate the ecological effects quotient.
2 Refer to Table 4-5 for sources of groundwater screening criteria
3 Refer to Section 4.4.4 for ecological effects quotient calculation.
4 Rationale Code:
For Elimination as a COPC:
BSL = Below COPC Screening Level

Associated Samples:

S34TW0010001
S34TW0020001
S34TW0030001
S34TW0010001-F
S34TW0020001-F
S34TW0030001-F

ACAD: 0525CM63.dwg 03/07/03 DM PIT

D-21CSN

SITE 34

6

5

4

CHICAMUXEN CREEK
(MARSH)

N

LEGEND:

- TREELINE
- 25 — TOPOGRAPHIC CONTOUR (1-FOOT INTERVAL)
- STREAM
- WETLAND
- APPROXIMATE SITE LOCATION
- D-21 BUILDING OR STRUCTURE

0 20 40
SCALE IN FEET

DRAWN BY / DATE	HJB 5/20/02
CHECKED BY / DATE	
REVISED BY / DATE	
SCALE	AS NOTED

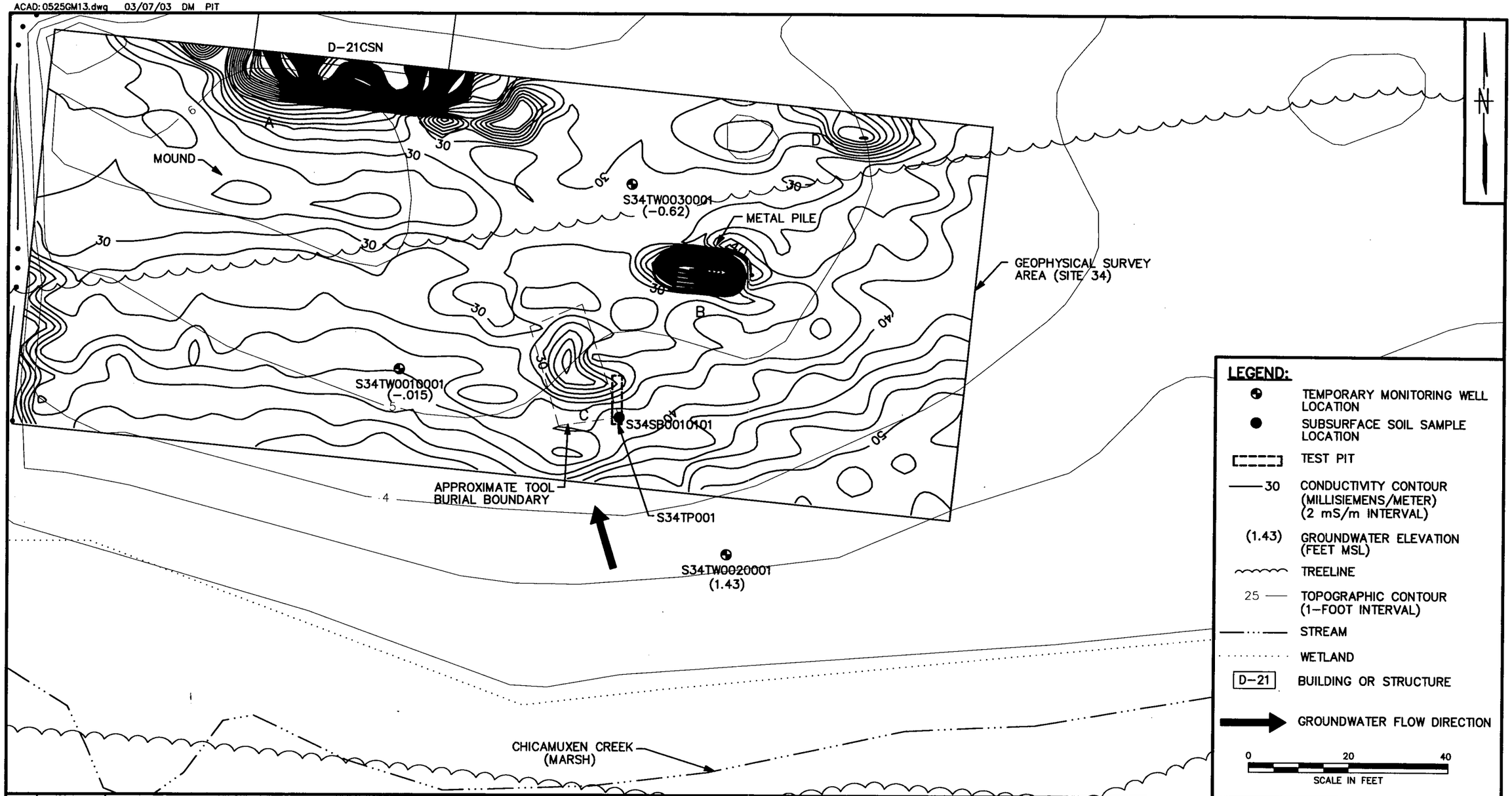
Tetra Tech NUS, Inc.

SITE LAYOUT
SITE 34 – TOOL BURIAL
INDIV-HSWC, INDIAN HEAD, MARYLAND

CONTRACT NO.	0525
OWNER NO.	0325
APPROVED BY / DATE	3/7/03
DRAWING NO.	FIGURE 7-1
REV.	0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

ACAD: 0525GM13.dwg 03/07/03 DM PIT



LEGEND:

- TEMPORARY MONITORING WELL LOCATION
- SUBSURFACE SOIL SAMPLE LOCATION
- TEST PIT
- 30 — CONDUCTIVITY CONTOUR (MILLISIEMENS/METER) (2 mS/m INTERVAL)
- (1.43) — GROUNDWATER ELEVATION (FEET MSL)
- TREELINE
- 25 — TOPOGRAPHIC CONTOUR (1-FOOT INTERVAL)
- STREAM
- WETLAND
- D-21 — BUILDING OR STRUCTURE
- GROUNDWATER FLOW DIRECTION

0 20 40
SCALE IN FEET

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJB DATE 5/15/02
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

Tetra Tech NUS, Inc.

SAMPLE LOCATION MAP
SITE 34 – TOOL BURIAL
INDIV-NSWC, INDIAN HEAD, MARYLAND

CONTRACT NO. 0525
OWNER NO. 0325
APPROVED BY DATE 3/7/03
APPROVED BY DATE
DRAWING NO. FIGURE 7-2
REV. 0

FORM CADD NO. T:tNUS_BH.DGN - REV 0 - 1/20/98

8.0 SITE 36 – CLOSED LANDFILL

8.1 BACKGROUND

The IAS (Hart, 1983) reported that there was a landfill in the area shown on Figure 8-1. The filled area was a wetland or marsh. The filled, leveled ground occupied an area of approximately 1 to 2 acres. Grass and other low vegetation covered most of the site. The fill was believed to contain metal casings such as mines, bombs, and torpedoes. The contents were reportedly certified inert and did not contain any explosives or chemicals when buried. The landfill was used from 1972 to 1974. A site inspection revealed evidence of small metal parts in the surface soil, which was a gravelly-clay fill material.

8.2 SITE CHARACTERISTICS

8.2.1 Topography

As illustrated on Figure 8-1, the land surface at Site 36 gently slopes toward Chicamuxen Creek to the west. The land surface elevation across the site ranges from approximately 1 to 10 feet above msl.

8.2.2 Surface Water

Precipitation most likely infiltrates the soil and possibly runs off the ground surface into the surrounding Chicamuxen Creek. The site is bounded by Chicamuxen Creek to the north, west, and south.

8.3 FIELD INVESTIGATION

A geophysical survey was completed at the site to better define the size and location of the landfill. Environmental samples were not collected during this investigation.

8.3.1 Geophysical Investigation

An EM-31 electromagnetometer was used to perform a geophysical survey at Site 36. The electromagnetometer measures the changes in the ground conductivity using a patented electromagnetic inductive technique that makes the measurements without electrodes or ground contact. This is a very useful instrument to locate buried non-ferrous metallic debris. The unit of conductivity used is mS/m. The results are showed on Figure 8-2.

As shown on the figure, the survey was conducted along 15 transects that were spaced 30 feet apart; measurements were taken at intervals of 10 feet along each transect. The effective exploration depth of the instrument is approximately 20 feet. The high densities (anomalies) of the contour lines on Figure 8-2

indicate where metal debris may be found in the subsurface. Anomalies are seen throughout the suspected landfill area. Based on field observations, surface debris is scattered along much of the shoreline, which is marked by the approximated boundary (Figure 8-2) except along Roach Road. The very dense contours located adjacent to and along Roach Road are attributed to the underground utilities. A detailed report of the geophysical survey results is provided in Appendix D.

8.4 ANALYTICAL RESULTS

In accordance with the work plan, no environmental samples were collected at Site 36.

8.5 HUMAN HEALTH RISK SCREENING EVALUATION

Because no samples were collected at Site 36, a human health screening evaluation cannot be performed.

8.6 ECOLOGICAL RISK SCREENING EVALUATION

Because no samples were collected at Site 36, an ecological risk screening evaluation cannot be performed.

8.7 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

8.7.1 Summary and Conclusions

Based on the results of the geophysical investigation and site history, there is evidence that a relatively large quantity of waste has been disposed at the site. However, since no samples were collected, the nature and potential extent of contamination cannot be evaluated. The extent of waste burial has been estimated by the geophysical investigation.

Because of the extent of the site and the potential for contamination, additional investigation of this site is required to determine the nature and extent of contamination.

8.7.2 Recommendations

An RI and FS are recommended for this site. The results of the geophysical survey support the view that the site is a former landfill. The RI will establish the type of contaminants, if any, that are present, and the FS will determine the remedial measures appropriate to address contamination identified during the RI, as well as addressing State of Maryland regulations for closing landfills.

ACAD: 4019CP01.dwg 11/26/02 DM PIT

CHICAMUXEN CREEK

SWAMP

SITE 36

ASPHALT ROAD

2010

5

20

50

40

N

LEGEND:

- TREELINE
- 25 — TOPOGRAPHIC CONTOUR (1-FOOT INTERVAL)
- STREAM
- FENCE
- WETLAND
- APPROXIMATE SITE LOCATION
- 2010 BUILDING OR STRUCTURE

0 60 120

SCALE IN FEET

DRAWN BY / DATE	HJB 5/20/02
CHECKED BY / DATE	
REVISED BY / DATE	
SCALE	AS NOTED

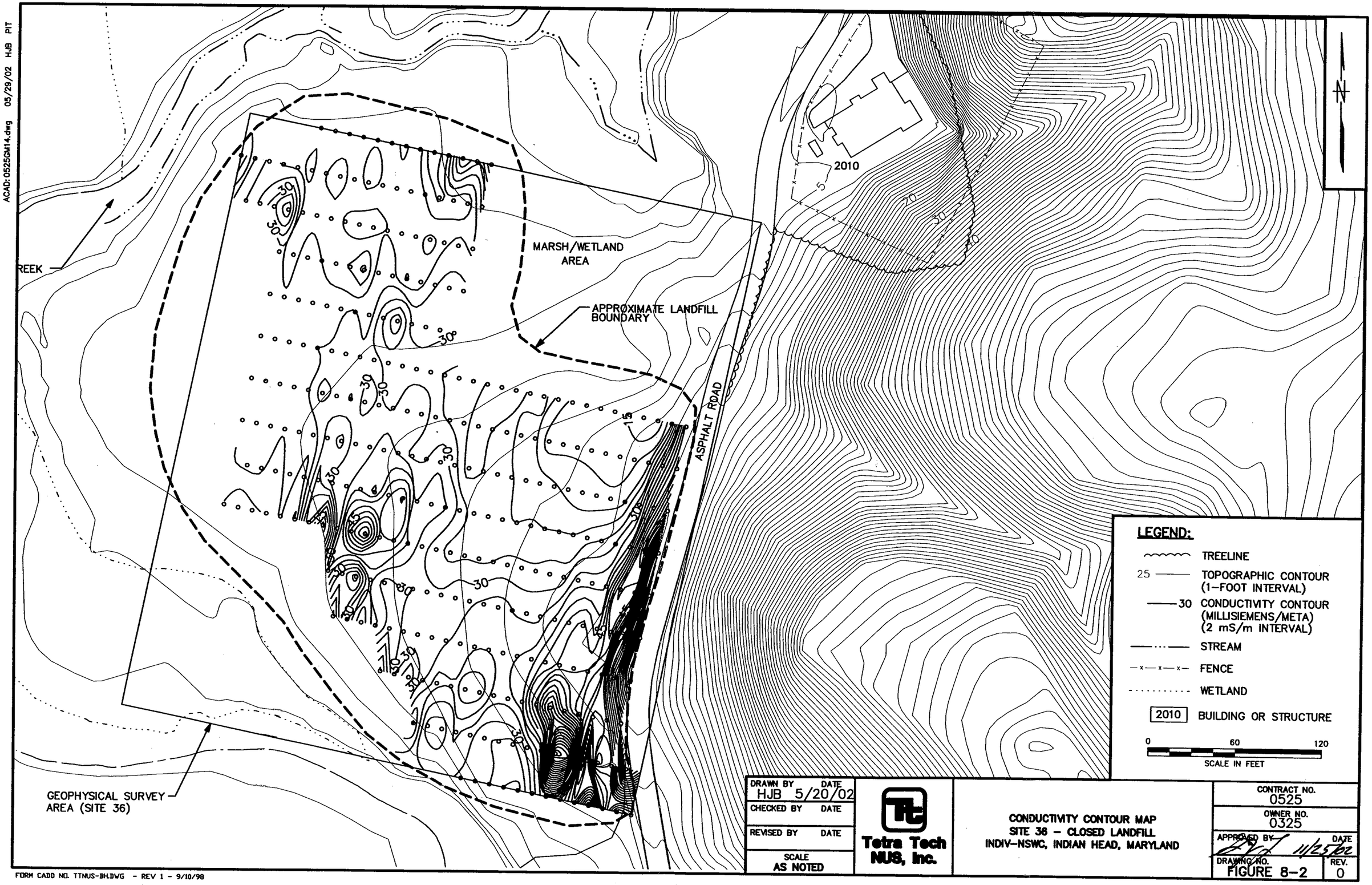
Tetra Tech NUS, Inc.

SITE LAYOUT
SITE 36 – CLOSED LANDFILL
INDIV–NSWC, INDIAN HEAD, MARYLAND

CONTRACT NO.	0525
OWNER NO.	0325
APPROVED BY / DATE	11/25/02
DRAWING NO.	FIGURE 8-1
REV.	0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

ACAD: 0525GM14.dwg 05/29/02 HJB PIT



DRAWN BY HJB DATE 5/20/02	Tetra Tech NUS, Inc.	CONDUCTIVITY CONTOUR MAP SITE 36 – CLOSED LANDFILL INDIV–NSWC, INDIAN HEAD, MARYLAND	CONTRACT NO. 0525
CHECKED BY DATE			OWNER NO. 0325
REVISED BY DATE			APPROVED BY DATE 11/25/02
SCALE AS NOTED			DRAWING NO. FIGURE 8-2 REV. 0

FORM CADD NO. TTNUS-BH.DWG – REV 1 – 9/10/98

9.0 SITE 37 – CAUSEWAY

9.1 BACKGROUND

Site 37 is a causeway on the northern side of Stump Neck Annex, adjacent to Mattawoman Creek and about 150 feet northeast of Building 2075. Archer Avenue runs along the top of the causeway. The road crosses a narrow neck of land that has been built up with fill materials. The location is shown on Figure 9-1. Reportedly, the causeway fill may contain hazardous materials in addition to rubble. An on-site inspection showed generous use of large concrete slabs to protect the Mattawoman Creek side of the roadway from erosion for a distance of 300 to 400 feet along the roadway. There was no visual evidence of hazardous material on site (Hart, 1983).

9.2 SITE CHARACTERISTICS

9.2.1 Topography

As illustrated on Figure 9-1, the top of the causeway is relatively flat. Steep banks mark the southern boundary, giving way to the marshy headwaters of Chicamuxen Creek. The site is bounded to the north by riprap baskets that separate the graded road area from the sandy beach shoreline of Mattawoman Creek. The land surface elevation across the site ranges from approximately 1 foot above msl along the southern and northern edges to approximately 5 to 7 feet above msl on the Archer Avenue road surface.

9.2.2 Surface Water

Precipitation and surface water runoff from the paved road are likely to flow to the adjacent grassy areas and either infiltrate the soil or run off to Chicamuxen Creek or Mattawoman Creek.

9.2.3 Geology/Soils

Logs from soil borings installed at the site indicate that shallow geologic conditions consist primarily of sand overlying silt and clay north of Archer Avenue and of sand and gravel at the well boring south of Archer Avenue. No waste material was encountered in the soil borings. Soil boring logs are provided in Appendix B.

9.2.4 Hydrogeology

The shallow aquifer present beneath the site displays the characteristics of an unconfined system. After the wells were installed, the water level in the wells stabilized to the depth at which it was encountered

during well installation. Groundwater at the site was encountered at approximately 5.5 feet bgs. The potentiometric surface (see Figure 9-3) shows that the groundwater flow direction is to the northwest toward Mattawoman Creek. The groundwater-levels used to generate potentiometric contours were measured on February 12, 2002. The groundwater level data are provided in Appendix E.

9.3 FIELD INVESTIGATION

Groundwater, subsurface soil, surface water, and sediment samples were collected and submitted to a fixed-base laboratory for chemical analysis to evaluate the potential presence or absence of contaminants. The samples and analyses are summarized on Table 9-1.

9.3.1 Temporary Well Installation and Groundwater Sampling

Three temporary monitoring wells were installed at the site to determine if material from the causeway had contaminated shallow groundwater. One well (S37TW002) was installed upgradient of the causeway south of Archer Avenue. Two wells (S37TW001 and S37TW003) were installed downgradient of the causeway north of Archer Avenue. Well locations are shown on Figure 9-2. The wells were constructed with 1-inch-ID PVC riser and screen material and installed and abandoned as described in Section 3.0. State of Maryland abandonment reports and TtNUS temporary well construction diagrams are presented in Appendix A.

Groundwater samples were collected from the temporary wells, as described in Section 3.2.3, and analyzed for TCL VOCs, TCL SVOCs, TAL metals (total and dissolved), TCL pesticides/PCBs, and explosives including nitroguanidine, nitroglycerine, and nitrocellulose. Groundwater sample log sheets are provided in Appendix C.

One field duplicate, S37TWDUP001, was collected at the same location as S37TW0010001 and analyzed for TCL VOCs, TCL SVOCs, TAL metals (total and dissolved), TCL pesticides/PCBs, and explosives including nitroguanidine, nitroglycerine, and nitrocellulose.

9.3.2 Subsurface Soil Sampling

Five subsurface soil samples were collected; two from each downgradient well boring (S37TW001/SB001 and S37TW003/SB003) and one from S37TW003/SB002. The second subsurface soil sample proposed at S37TW003/SB002 was not collected because of the abundant gravel encountered in the subsurface material. The soil samples were collected using HSA drilling and split-spoon sampling techniques. Sample locations are shown on Figure 9-2.

Two subsurface soil samples were selected from each boring location based upon field observations and the depths proposed in the work plan. Except at S37TW003/SB002, only one sample was collected, for the reasons discussed above. No elevated PID readings or waste were encountered during the subsurface investigation. The samples were submitted to a fixed-base laboratory to be analyzed for TCL VOCs, TCL SVOCs, TAL metals, TCL pesticides/PCBs, and explosives including nitroguanidine, nitroglycerine, and nitrocellulose. The samples and analyses are summarized on Table 9-1. Soil sample log sheets are provided in Appendix C.

9.3.3 Surface Water and Sediment Sampling

Three surface water and three sediment samples were collected in pairs, two from Mattawoman Creek and one from Chicamuxen Creek south of the causeway. Sample locations are shown on Figure 9-2. Surface water samples were collected as described in Section 3.2.4. Sediment samples were collected as described in Section 3.2.5. The surface water and sediment samples were submitted to a fixed-based laboratory and analyzed for TCL VOCs, TCL SVOCs, TAL metals, TCL pesticides/PCBs, and explosives. Sample log sheets are provided in Appendix C.

One field duplicate, FD1310202, was collected at the same location as S37SW0010001 and another field duplicate, FD1310201, was collected at the same location as S37SD0010001. Both duplicate samples were analyzed for TCL VOCs, TCL SVOCs, TAL metals, TCL pesticides/PCBs, and explosives.

9.4 ANALYTICAL RESULTS AND COPC SELECTION

This section provides the data, evaluation, and selection of human health COPCs for subsurface soil, groundwater, surface water, and sediment contamination at Site 37. The selection of ecological COPCs is discussed in Section 9.6. This screening evaluation is based on the following samples:

- Five subsurface soil samples
- Three groundwater samples collected from temporary monitoring wells
- Three surface water and sediment samples collected in pairs

The results were evaluated as described in Section 4.3. Complete chemical analytical results are presented in Appendix H.

9.4.1 Data and Risk-Based Evaluation of Subsurface Soil Contamination

Positive analytical results and summary statistics for subsurface soil samples are provided in Tables 9-2 and 9-3, respectively.

Based on the analytical results, arsenic and iron were detected at concentrations exceeding screening levels. Neither was detected at a maximum concentration greater than the respective non-clayey soil background threshold concentration. Metal concentrations were detected at concentrations greater than screening levels in all samples. Maximum concentrations for arsenic and iron were reported in sample S37SB0030101.

None of the detected VOCs, SVOCs, or pesticides exceeded any screening levels. No PCBs or explosives were detected in the subsurface soil.

9.4.2 Data and Risk-Based Evaluation of Groundwater Contamination

Positive analytical results for unfiltered and filtered groundwater samples are provided in Table 9-4. The summary statistics for unfiltered and filtered groundwater samples are provided in Table 9-5.

As shown on Table 9-4, the concentrations of several metals in the filtered samples from S37TW002 and S37TW003 are greater than the concentrations in the respective unfiltered samples. These samples were not filtered in the field, and this may have led to the unusual results. Therefore, when these groundwater samples were evaluated for COPCs, the filtered sample results were also considered, as the maximum detected concentrations were often reported for the filtered samples.

Based on the analytical results, one SVOC, one explosive, and four metals exceeded the screening levels in the groundwater samples.

- Four metals (arsenic, barium, iron, and manganese) were detected at concentrations exceeding screening level concentrations.

- Of the four metals, only arsenic and barium were detected at maximum concentrations greater than the background threshold concentrations.

- Iron and manganese were detected at maximum concentrations that wee less than the background threshold concentrations.

- All of the samples contained at least one of the four metals at a concentration greater than the corresponding screening level concentration.

- The maximum concentrations of barium, iron, and manganese were reported in sample S37TW0020001.

- The maximum concentration for arsenic was reported in sample S37W0010001.

Arsenic and barium were retained as COPCs for evaluation because they exceeded the screening values for unfiltered groundwater samples. The results for unfiltered groundwater are shown on Figure 9-3.

One SVOC (naphthalene) was detected at a concentration greater than screening level in one sample, S37TW0020001. Naphthalene is retained as a COPC. The COPC concentrations that are greater than the screening levels for groundwater are shown on Figure 9-3.

One explosive (RDX) was detected at a concentration greater than the screening level in one sample, S37TW0020001. RDX is retained as a COPC. The COPC concentrations greater than the screening levels for groundwater are shown on Figure 9-3.

None of the detected VOCs exceeded any screening levels. No pesticides/PCBs were detected in the groundwater.

9.4.3 Data and Risk-Based Evaluation of Surface Water Contamination

Positive analytical results and summary statistics for surface water samples are provided in Tables 9-6 and 9-7, respectively.

Based on the analytical results, three metals (iron, manganese, and thallium) were detected at concentrations exceeding screening levels in the surface water samples and are retained as COPCs. Each of the samples contained at least one of the three metals at a concentration exceeding the corresponding screening level concentration. Maximum concentrations for all three metals were reported in sample S37SW0030001. The COPC concentrations that are greater than screening levels are shown on Figure 9-4.

Naphthalene was the only SVOC and 4,4'-DDD was the only pesticide detected at concentrations greater than the screening levels and are retained as COPCs. No explosives, VOCs, or PCBs were detected in the surface water.

Sample S37SW0030001 had a relatively high turbidity, 14 NTUs, as measured by a field turbidity meter during sample collection. The high turbidity is probably responsible for the high metals concentrations in the sample.

The thallium concentrations may be false positives. The trace ICP method, which is part of CLP SOW ILM04.1 and used in the analysis, can lead to false positives for lead, arsenic, and thallium. These false positives can be eliminated by using other methods.

9.4.4 Data and Risk-Based Evaluation of Sediment Contamination

Positive analytical results and summary statistics for sediment samples are provided in Tables 9-8 and 9-9, respectively. The sediment data are presented in Appendix H.

Five metals were detected at concentrations exceeding screening levels (aluminum, arsenic, iron, lead, and manganese). The metals were detected at concentrations greater than screening levels in only one sample. Therefore, aluminum, arsenic, iron, lead, and manganese are retained as COPCs in sediment at Site 37. Maximum concentrations for all the metals were reported in sample S37SD0030001. The COPC concentrations that are greater than screening levels are shown on Figure 9-5.

Benzo(a)pyrene was the only SVOC detected at a concentration greater than the screening levels and is retained as a COPC. None of the detected VOCs or pesticides exceeded any screening levels. No PCBs or explosives were detected in the sediment.

9.5 HUMAN HEALTH RISK SCREENING EVALUATION

This section contains a summary of the human health risk estimates for Site 37. The methodology used to calculate the risks presented in this section is provided in Appendix I. Chemical-specific risk estimates and risks to affected target organs for COPCs in groundwater, surface water, and sediment are presented in Tables 9-10, 9-11, and 9-12, respectively. No risks were estimated for exposures to subsurface soil because no COPCs were identified in this medium. A discussion of the estimated noncarcinogenic and carcinogenic risks is provided in the remainder of this section.

9.5.1 Groundwater

ILCRs for exposure to groundwater at Site 37 are presented in Table 9-10. The cumulative cancer risk is 1.4×10^{-4}, which exceeds the EPA's target cancer risk range of 1×10^{-6} to 1×10^{-4}. Arsenic (1.4×10^{-4}) is the major contributor to the cancer risk.

The cumulative HI is 2.2, which exceeds the target level of 1.0. Naphthalene (HQ = 1.5) was the major contributor to the noncarcinogenic risks.

Note that there is currently no risk to present users of the site because there is no exposure to the groundwater.

9.5.2 Surface Water

ILCRs for exposure to surface water at Site 37 are presented in Table 9-11. The cumulative cancer risk is 1.1×10^{-7}, which is below EPA's target cancer risk range of 1×10^{-6} to 1×10^{-4}.

The cumulative HI is 7.9, which exceeds the target level of 1.0. Manganese (HQ = 3.3) and thallium (HQ = 3.0) were the major contributors to the noncarcinogenic risks.

Note that sample S37SW0030001 was somewhat turbid. The relatively high concentrations of metals in the sample may be attributable to the suspended solids. If the turbidity is contributing a large portion of the metals concentration, then the HQs may be lower.

9.5.3 Sediment

Estimated cancer risks (ILCRs) for exposure to sediment at Site 37 are presented in Table 9-12. The cumulative cancer risk is 3.4×10^{-5}, which is within EPA's target cancer risk range of 1×10^{-6} to 1×10^{-4}.

The cumulative HI is 2.0. When the HI exceeds 1, target organ effects for individual COPCs contributing to the risk are considered. Arsenic, iron, and manganese were the major contributors to the HI and they affect different target organs. The target organs for arsenic (HQ = 0.5) are the skin and cardiovascular system. The target organs for iron (HQ = 1.1) are blood and the gastrointestinal system. The target organ for manganese (HQ = 0.3) is the central nervous system. Because the HQs for the affected target organs are less than or approximately equal to the acceptable level of 1.0, no adverse health effects are anticipated for exposures to sediment at Site 37.

The risk from the sediment to current site users under an industrial scenario is substantially lower than the residential exposure. Risk calculations for industrial exposure to sediment are included in Appendix I.

9.5.4 Exposure to Lead

Lead was identified as a COPC for sediment at Site 37. The maximum detected concentration of lead in sediment (456 mg/kg) exceeded the Office of Solid Waste and Emergency Response (OSWER) soil screening level of 400 mg/kg for residential land use but was less than the EPA screening level of 750 mg/kg for industrial land use.

Hypothetical future residential exposures to lead in sediment were evaluated using EPA's integrated exposure uptake biokinetic (IEUBK) lead model (EPA, 2001). It should be noted that the IEUBK model is designed to evaluate residential exposures to soil and therefore the results of the evaluation are conservative since the exposure frequency used in the IEUBK model for exposure to soil is greater than the exposure frequency anticipated for exposure to sediment.

As recommended by the IEUBK model, the average concentration of lead in sediment (157 mg/kg) was used as the exposure point concentration. Default parameters were used for the rest of the model input parameters. IEUBK model outputs are included in Appendix I. The estimated geometric mean blood-lead level for children exposed to lead in sediment was 3.0 µg/dL, which is less than the level of concern of 10 µg/dL. The IEUBK model estimates that 0.5 percent of children are expected to have blood-lead levels greater than 10 µg/dL, which is less than the EPA acceptable level of 5 percent. Based on the results from the IEUBK model, blood-lead levels for children and the percent of children expected to have blood levels greater than 10 µg/dL are within acceptable levels as determined by EPA.

9.5.5 Uncertainty Analysis

A summary of the uncertainties specific to the human health risk screening for Site 37 is included in this section. The impact of a particular uncertainty on the results of the risk screening is also identified. General uncertainties associated with the risk estimates were provided in Appendix I.

9.5.5.1 Uncertainty Associated with Screening Criteria for Surface Water and Sediment

No EPA Region 3 RBCs are available for surface water and sediment; therefore, tap water RBCs were used to evaluate surface water and residential soil RBCs were used to evaluate sediment. The tap water RBCs are based on an individual drinking 2 liters of water a day for 350 days a year. The residential soil RBCs are based on an individual being exposed to soil 350 days a year. It is very unlikely that an individual would consume 2 liters of surface water a day or be exposed to surface water and sediment 350 days a year. Consequently, the use of RBCs for soil/groundwater to evaluate sediment/surface water will result in conservative estimates of risk. The use of the RBCs for soil/groundwater to estimate risks from exposures to sediment/surface water could overestimate risks by as much as an order of magnitude.

9.5.5.2 Uncertainty Associated with Background Data

No background data are available for surface water. In addition, background threshold concentrations for sediment were not used. Therefore, surface water and sediment were not screened against background for the selection of COPCs. Consequently, it is not known if inorganics retained as COPCs in surface water and sediment at Site 37 are site related or naturally occurring.

9.5.5.3 Uncertainty Associated with Nitrocellulose

Toxicity values are not currently available for nitrocellulose. Consequently, risk-based screening levels used for the selection of chemicals of potential concern are not currently published. However, a review of the conclusions and recommendations of the EPA Health Advisory for Nitrocellulose indicates that the chemical has a very low toxicity: "Based on available toxicity data and chemical and physical properties of the compound, nitrocellulose is apparently non-toxic to dogs, rats, and mice and is not digested or absorbed in these species. These data, along with the relative insolubility of nitrocellulose in water, suggest that Health Advisory values for nitrocellulose in drinking water are unnecessary. The physical characteristics of the drinking water as they relate to turbidity, clarity, taste and similar indicators of palatability appear to be the only guidelines necessary." Toxicity information suggests that the LD_{50} (lethal dose for 50 percent of the test animals) is greater than 5 grams per kilogram. It should be noted that published risk-based concentrations for other chemicals that are considered relatively non-toxic (e.g., aluminum) typically exceed 10,000 µg/L (tap-water) and 10,000 mg/kg (residential soil). Nitrocellulose concentrations detected in the environmental media at Mattawoman Creek do not exceed these concentrations.

9.6 ECOLOGICAL RISK SCREENING EVALUATION

This section contains a summary of the ecological COPC screening evaluation for Site 37. Surface water, groundwater, and sediment results were used in the evaluation. Subsurface sample results were not considered in the evaluation because invertebrates and plants are not exposed to subsurface soils. Groundwater data was evaluated due to the possibility of discharge to Mattawoman Creek and potential risks to aquatic receptors. The ecological COPC screening tables for groundwater, surface water, and sediment are presented in Tables 9-13, 9-14, and 9-15, respectively.

As noted in Section 9.5, there are COPCs that pose unacceptable human health risk, so additional investigation and evaluation of the site will be required. Further evaluation of ecological COPCs can be performed at that time.

9.6.1 Groundwater

VOCs, SVOCs, unfiltered and filtered metals, and one explosive were detected in groundwater samples at Site 37 (see Table 9-13). Of the VOCs and SVOCs detected, no maximum detected concentrations exceeded the screening values.

Three metals, including aluminum, iron, and silver, were detected at maximum concentrations exceeding the screening values and were retained as ecological COPCs in unfiltered samples. No other metals exceeded screening values in unfiltered samples. Only two metals, cadmium and iron, were detected at maximum concentrations exceeding the screening values and are retained as ecological COPCs in filtered samples. No other metals exceeded the screening values in filtered samples.

Only one explosive, RDX, was detected in groundwater at Site 37 at a maximum concentration of 1.2 µg/L, but it did not have a screening value. Therefore, RDX is retained as a COPC.

9.6.2 Surface water

SVOCs, one pesticide, and unfiltered metals were detected in surface water samples at Site 37 (see Table 9-14). Of the four SVOCs detected, 4-methylphenol is retained as a COPC because a screening value was not available for comparison.

Four metals, including aluminum, iron, lead, and zinc, had maximum concentrations exceeding the screening values and are retained as COPCs for further evaluation.

Thallium concentrations reported in the surface water samples may be false positives from the analytical method.

9.6.3 Sediment

One VOC, fifteen SVOCs, two pesticides, one explosive, and nineteen metals were detected in sediment samples at Site 37 (see Table 9-15). One VOC, acetone, is retained as a COPC because a screening value was unavailable for comparison.

Eight SVOCs, including 2-methylnaphthalene, acenaphthylene, benzo(a)anthracene, benzo(a)pyrene, chrysene, naphthalene, phenanthrene, and pyrene are retained as COPCs because maximum detected concentrations exceeded the screening values. Benzaldehyde is retained as a COPC because no screening value was available for comparison.

Two pesticides, 4,4'-DDD and 4,4'-DDE, are retained as COPCs because maximum detected concentrations exceeded screening values. Nitrocellulose is retained as a COPC because no screening value was available for comparison.

Seven metals, including arsenic, barium, cadmium, copper, iron, lead, and nickel, are retained as COPCs because maximum concentrations exceeded screening values. Beryllium is retained as a COPC because no screening value was available for comparison.

9.7 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

9.7.1 Summary and Conclusions

No human health COPCs were detected in subsurface soil samples. Arsenic, barium, naphthalene, and RDX were selected as human health COPCs in groundwater. Iron, manganese, thallium, naphthalene, and 4,4'-DDD were selected as COPCs in surface water. Aluminum, arsenic, iron, lead, nickel, and benzo(a)pyrene were selected as COPCs in sediment. A human health risk evaluation was performed based on these COPCs.

The human health risk evaluation showed that, in groundwater, the ILCR and HQ both exceeded the acceptable ranges. In surface water, the ILCR was in the acceptable range, but the HQ exceeded the acceptable benchmark. In sediments, the ILCR and HQ were both in the acceptable ranges.

The ecological risk evaluation showed that there are several ecological COPCs in groundwater, surface water, and sediment. Additional investigation is needed to further evaluate the ecological COPCs. Because the various materials were buried at the site, contamination, if present, was not anticipated to be at the surface. No surface soil samples were collected, so terrestrial ecological receptors could not be quantitatively evaluated.

Freshwater sediment background was not used, and the limited number of environmental samples restricted the use of statistical background analysis. Thus, the COPC selection is conservative, and some of the COPCs may be naturally occurring.

9.7.2 Recommendations

An RI and FS are recommended for this site. Both human health and ecological aspects should be considered. Thallium analyses should be performed by EPA Method SW-846 6020 ICP/MS to eliminate false positives. The investigation should include a statistical comparison of the sediment sample analytical results to the background data set.

TABLE 9-1

ENVIRONMENTAL SAMPLING AND ANALYSIS SUMMARY – SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND
PAGE 1 OF 2

Sample Location	Sample Designation	Sample Depth (feet below ground surface) [1]	Sample Analysis					
			TCL VOCs	TCL SVOCs	TAL Metals[2]	Beryllium and Copper[2]	TCL Pesticides/ PCBs	Explosives (with nitrocellulose, nitroguanidine, and nitroglycerine)
SUBSURFACE SOIL								
S37SB001 / S37TW001	S37SB0010101	2 – 4	●	●	●		●	●
S37SB001 / S37TW001	S37SB0010201	4 – 6	●	●	●		●	●
S37SB002 / S37TW002	S37SB0020101	2 – 4	●	●	●		●	●
S37SB003/S37TTW003	S37SB0030101	2 – 4	●	●	●		●	●
S37SB003/S37TTW003	S37SB0030201	4 – 6	●	●	●		●	●
TEMPORARY WELLS								
S37TW001	S37TW0010001	--	●	●	●		●	●
Duplicate of S37TW0010001	S37TWDUP001	--	●	●	●		●	●
S37TW002	S37TW0020001	--	●	●	●		●	●
S37TW003	S37TW0030001	--	●	●	●		●	●
SURFACE WATER								
S37SW001	S37SW0010001	--	●	●	●		●	●
Duplicate of S37SW0010001	FD01310202	--	●	●	●		●	●
S37SW002	S37SW0020001	--	●	●	●		●	●
S37SW003	S37SW0030001	--	●	●	●		●	●

TABLE 9-1

ENVIRONMENTAL SAMPLING AND ANALYSIS SUMMARY – SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location	Sample Designation	Sample Depth (feet below ground surface) [1]	Sample Analysis					
			TCL VOCs	TCL SVOCs	TAL Metals[2]	Beryllium and Copper[2]	TCL Pesticides/ PCBs	Explosives (with nitrocellulose, nitroguanidine, and nitroglycerine)
SEDIMENT								
S37SD001	S37SD0010001	--	●	●	●		●	●
Duplicate of S37SD0010001	FD01310201	--	●	●	●		●	●
S37SD002	S37SD0020001	--	●	●	●		●	●
S37SD003	S37SD0030001	--	●	●	●		●	●

Notes:

1 Sample depths are as collected in the field.
2 Groundwater samples were analyzed for total and filtered metals.

TABLE 9-2

SUMMARY OF POSITIVE DETECTIONS - SUBSURFACE SOIL - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location	S37SB001/TW001	S37SB001/TW001	S37SB002/TW002	S37SB003/TW003	S37SB003/TW003
Sample Number	S37SB0010101	S37SB0010201	S37SB0020101	S37SB0030101	S37SB0030201
Collection Date	02/05/02	02/05/02	02/05/02	02/05/02	02/05/02
Interval, feet bgs	2 - 4	4 - 6	2 - 4	2 - 4	4 - 6
Volatile Organics (ug/kg)					
ACETONE	4 J	18	10 U	2 J	10 U
Semivolatile Organics (ug/kg)					
2-METHYLNAPHTHALENE	78 J	380 U	350 UJ	350 U	97 J
BENZO(A)ANTHRACENE	340 U	380 U	41 J	350 U	370 U
BENZO(B)FLUORANTHENE	340 U	380 U	110 J	350 U	370 U
BENZO(K)FLUORANTHENE	340 U	380 U	44 J	350 U	370 U
CHRYSENE	340 U	380 U	70 J	350 U	370 U
FLUORANTHENE	340 U	380 U	87 J	350 U	86 J
PHENANTHRENE	340 U	380 U	41 J	350 U	370 U
PYRENE	340 U	380 U	99 J	350 U	86 J
Pesticides/PCBs (ug/kg)					
4,4'-DDT	3.4 U	3.9	4.7	3.6 U	3.7 U
Inorganics (mg/kg)					
ALUMINUM	382 J	554 J	3410 J	3900 J	1010 J
ARSENIC	0.8 K	0.87 K	2.6 K	4.3 K	1.1 K
BARIUM	5.5	5.9	8.6	13.4	6.1
BERYLLIUM	0.095 K	0.093 K	0.12 K	0.13 K	0.084 K
CADMIUM	0.1 K	0.031 U	0.038 U	0.039 U	0.031 U
CALCIUM	78.5	571	2040	25.7	148
CHROMIUM	2.8 K	4.1	15	9.2	3.4 K
COBALT	0.79 U	0.7 U	3.7 K	4.7 K	1.1 K
COPPER	1.8 K	2.4 K	14.7	5.6 K	3.6 K
IRON	2600 J	3030 J	8970 J	11200 J	3550 J
LEAD	15.5	8.2	22.9	13.5	7.2
MAGNESIUM	56.5 U	112	2530	133	95.3
MANGANESE	60.4	28.8	76.6	108	53.2
NICKEL	3.8 K	3.8 K	16.1	3.1 K	4 K
POTASSIUM	61.6 U	82.5 U	186	182	70.9 U
SODIUM	52.3 U	58.3 U	821	47.9 U	34.5 U
VANADIUM	4 K	4.1 K	17.5 K	15 K	4.9 K
ZINC	9.1	8.2	14.7	9.6	8.6

Notes:
U - Not detected at detection limit value shown.
J - Estimated value.
K - Estimated value, biased high.

TABLE 9-3

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH SUBSURFACE SOIL - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Site 37

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Nondetects(2)	Average Concentration	Concentration Used for Screening(3)	Background Value(4)	U.S. EPA Region 3 RBC-Residential (5)	EPA SSLs Soil to Air(6)	U.S. EPA Region 3 SSLs Soil to Groundwater(7)	COPC Flag	Rationale for Contaminant Deletion or Selection(8)
Volatile Organic Compounds																	
67-64-1	Acetone	2	J	18		ug/kg	S37SB0010201	3/5	10	6.80	18	NA	780000 N	100000000	2500	No	BSL
Semivolatile Organic Compounds																	
91-57-6	2-Methylnaphthalene	78	J	97	J	ug/kg	S37SB0030201	2/5	350 - 380	143	97	NA	160000 N	NA	22000	No	BSL
56-55-3	Benzo(a)anthracene	41	J	41	J	ug/kg	S37SB0020101	1/5	340 - 380	152	41	NA	870 C	NA	1500	No	BSL
205-99-2	Benzo(b)fluoranthene	110	J	110	J	ug/kg	S37SB0020101	1/5	340 - 380	166	110	NA	870 C	NA	4500	No	BSL
207-08-9	Benzo(k)fluoranthene	44	J	44	J	ug/kg	S37SB0020101	1/5	340 - 380	153	44	NA	8700 C	NA	45000	No	BSL
218-01-9	Chrysene	70	J	70	J	ug/kg	S37SB0020101	1/5	340 - 380	158	70	NA	87000 C	NA	150000	No	BSL
206-44-0	Fluoranthene	86	J	87	J	ug/kg	S37SB0020101	2/5	340 - 380	142	87	NA	310000 N	NA	6300000	No	BSL
85-01-8	Phenanthrene	41	J	41	J	ug/kg	S37SB0020101	1/5	340 - 380	152	41	NA	230000 (9) N	NA	NA	No	BSL
129-00-0	Pyrene	86	J	99	J	ug/kg	S37SB0020101	2/5	340 - 380	144	99	NA	230000 N	NA	680000	No	BSL
Pesticides/PCBs																	
50-29-3	4,4'-DDT	3.9		4.7		ug/kg	S37SB0020101	2/5	3.4 - 3.7	2.79	4.7	NA	1900 C	NA	1200	No	BSL
Inorganics																	
7429-90-5	Aluminum	382	J	3900	J	mg/kg	S37SB0030101	5/5	NA	1851	3900	21400	7800 N	NA	NA	No	BSL, BKG
7440-38-2	Arsenic	0.8	K	4.3	K	mg/kg	S37SB0030101	5/5	NA	1.93	4.3	28.7	0.43 C	750	0.026	No	BKG
7440-39-3	Barium	5.5		13.4		mg/kg	S37SB0030101	5/5	NA	7.90	13.4	66.5	550 N	690000	2100	No	BSL, BKG
7440-41-7	Beryllium	0.084	K	0.13	K	mg/kg	S37SB0030101	5/5	NA	0.104	0.13	1.5	16 N	1300	1200	No	BSL, BKG
7440-43-9	Cadmium	0.1	K	0.1	K	mg/kg	S37SB0010101	1/5	0.031 - 0.039	0.034	0.1	0.61	3.9 N	1800	27	No	BSL, BKG
7440-70-2	Calcium	25.7		2040		mg/kg	S37SB0020101	5/5	NA	573	2040	1270	NA	NA	NA	No	NUT
7440-47-3	Chromium	2.8	K	15		mg/kg	S37SB0020101	5/5	NA	6.90	15	59.1	23 (10) N	270	42	No	BSL, BKG
7440-48-4	Cobalt	1.1	K	4.7	K	mg/kg	S37SB0030101	3/5	0.7 - 0.79	2.05	4.7	14.7	160 N	NA	NA	No	BSL, BKG
7440-50-8	Copper	1.8	K	14.7		mg/kg	S37SB0020101	5/5	NA	5.62	14.7	47.6	310 N	NA	11000	No	BSL, BKG
7439-89-6	Iron	2600	J	11200	J	mg/kg	S37SB0030101	5/5	NA	5870	11200	35200	2300 N	NA	NA	No	BKG
7439-92-1	Lead	7.2		22.9		mg/kg	S37SB0020101	5/5	NA	13.5	22.9	38.6	400 (11)	NA	NA	No	BSL, BKG
7439-95-4	Magnesium	95.3		2530		mg/kg	S37SB0020101	4/5	56.5	580	2530	2940	NA	NA	NA	No	NUT, BKG
7439-96-5	Manganese	28.8		108		mg/kg	S37SB0030101	5/5	NA	65.4	108	155	160 N	NA	950	No	BSL, BKG
7440-02-0	Nickel	3.1	K	16.1		mg/kg	S37SB0020101	5/5	NA	6.16	16.1	15.9	160 N	13000	130 (12)	No	BSL
7440-09-7	Potassium	182		186		mg/kg	S37SB0020101	2/5	61.6 - 82.5	95.1	186	3440	NA	NA	NA	No	NUT, BKG
7440-23-5	Sodium	821		821		mg/kg	S37SB0020101	1/5	34.5 - 58.3	184	821	461	NA	NA	NA	No	NUT
7440-62-2	Vanadium	4	K	17.5	K	mg/kg	S37SB0020101	5/5	NA	9.10	17.5	102	55 N	NA	5100	No	BSL, BKG
7440-66-6	Zinc	8.2		14.7		mg/kg	S37SB0020101	5/5	NA	10.0	14.7	49.7	2300 N	NA	14000	No	BSL, BKG

Notes:

1 - Minimum and maximum detected concentrations.

2 - Values presented are sample-specific quantitation limits.

3 - The maximum detected concentration is used for screening purposes.

4 - 95% UTL for sandy soils from Background Soil Investigation Report for Indian Head Stump Neck Annex, Indian Head and Stump Neck Annex, TtNUS, February 2002 (Draft).

5 - EPA Region 3 Risk-Based Concentration Table, April 2, 2002. (RBCs for noncarcinogenic compounds are divided by 10).

6 - Soil Screening Levels for Inhalation EPA, May 1996. Soil Screening Guidance.

7 - EPA Region 3 Risk-Based Concentration Table, April 2, 2002. DAF (Dilution attenuation factor) of 20.

8 - Rationale Codes Selection Reason: Above Screening Levels (ASL)

Deletion Reason: Essential Nutrient (NUT)
Below Screening Level (BSL)
Below Background Value (BKG)

9 - Value is for pyrene.

10 - Value is for hexavalent chromium.

11 - OSWER screening level. EPA, 1994: Guidance on Residential Lead-Based Paint, Lead Contaminated Dust, and Lead Contaminated Soil.

12 - Soil screening levels for migration to groundwater. EPA, May 1996. Soil Screening Guidance.

Shaded cells indicate that the specified criterion has been exceeded or that the chemical has been selected as a COPC.

Definitions:

NA = Not Applicable.
SQL = Sample Quantitation Limit.
COPC = Chemical of Potential Concern.
J = Estimated Value.
K = Estimated value, biased high.
C = Carcinogenic.
N = Noncarcinogenic.

Associated Samples:
S37SB0010101
S37SB0010201
S37SB0020101
S37SB0030101
S37SB0030201

TABLE 9-4

SUMMARY OF POSITIVE DETECTIONS - GROUNDWATER - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001
Sample Number	S37TW0010001	S37TW0010001-F	S37TWDUP001	S37TWDUP001-F
Unfiltered/filtered?	Unfiltered	Filtered	Unfiltered	Filtered
Duplicate of:			S37TW0010001	S37TW0010001-F
Collection Date	02/05/02	02/05/02	02/05/02	02/05/02
Volatile Organics (ug/L)				
TOTAL XYLENES	1 U		1 U	
Semivolatile Organics (ug/L)				
2-METHYLNAPHTHALENE	5 U		5 U	
ACENAPHTHENE	5 U		5 U	
BIS(2-ETHYLHEXYL)PHTHALATE	5 U		2 J	
FLUORENE	5 U		5 U	
NAPHTHALENE	5 U		5 U	
NITROBENZENE				
PHENANTHRENE	5 U		5 U	
Explosives (ug/L)				
NITROBENZENE	0.2 U		0.2 U	
RDX	0.5 U		0.5 U	
Inorganics (ug/L)				
ALUMINUM	214	18.9	92.5	23.4
ARSENIC	6.1 K	2 U	5.8 K	2 U
BARIUM	149 J	127 J	157 J	131 J
CADMIUM	0.41 K	0.2 U	0.46 K	0.2 U
CALCIUM	94600	91700	99900	92600
CHROMIUM	1 U	0.86 U	0.77 U	0.77 U
COBALT	4.7 K	4.3 U	4.7 K	4.1 U
IRON	10500	3260	11000	2290
MAGNESIUM	24900 J	23800 J	26100 J	24300 J
MANGANESE	2840 J	2660 J	2980 J	2740 J
NICKEL	4.7 U	4.5 U	4.5 U	4 U
POTASSIUM	6660 J	6470 J	6780 J	6630 J
SELENIUM	2.5 K	2 U	3.4 K	2 U
SILVER	0.5 U	0.71 U	0.5 U	0.91 U
SODIUM	155000	153000	158000	153000
VANADIUM	0.3 U	0.3 U	0.3 U	0.3 U

Notes:
Blank means no analysis was performed.
U - Not detected at detection limit value shown.
J - Estimated value.
K - Estimated value, biased high.
L - Esti ·d value biased low.

TABLE 9-4

SUMMARY OF POSITIVE DETECTIONS - GROUNDWATER - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location	S37SB002/TW002	S37SB002/TW002	S37SB003/TW003	S37SB003/TW003
Sample Number	S37TW0020001	S37TW0020001-F	S37TW0030001	S37TW0030001-F
Unfiltered/filtered?	Unfiltered	Filtered	Unfiltered	Filtered
Duplicate of:				
Collection Date	02/06/02	02/08/02	02/06/02	02/08/02
Volatile Organics (ug/L)				
TOTAL XYLENES	2		1 U	
Semivolatile Organics (ug/L)				
2-METHYLNAPHTHALENE	6		5 U	
ACENAPHTHENE	2 J		5 U	
BIS(2-ETHYLHEXYL)PHTHALATE	5 U		5 U	
FLUORENE	3 J		5 U	
NAPHTHALENE	10		5 U	
NITROBENZENE	5 U		5 U	
PHENANTHRENE	4 J		5 U	
Explosives (ug/L)				
NITROBENZENE	0.2 U		0.087 J	
RDX	1.2		0.5 U	
Inorganics (ug/L)				
ALUMINUM	14.9 U	55.5 U	11.5 U	31.8 U
ARSENIC	2 U	2 U	2 U	3.2 K
BARIUM	299	134	92.1 J	229
CADMIUM	0.2 UL	0.98 J	0.2 UL	0.76 J
CALCIUM	231000	171000	131000	149000
CHROMIUM	0.4 U	0.66 K	0.4 U	0.4 U
COBALT	0.43 U	11.4 K	1.2 U	2.5 U
IRON	444	15100	194	12700
MAGNESIUM	13900	34900	47400	26500
MANGANESE	183	3310	56.7	2050
NICKEL	2.1 U	14.9 K	10.8 U	5.6 U
POTASSIUM	4400	4570	7640	6470
SELENIUM	3.1 J	2 UL	2 UL	2 UL
SILVER	0.5 UL	0.5 UL	0.86 J	0.5 UL
SODIUM	72900	321000	216000	717000
VANADIUM	0.3 U	0.3 U	0.3 K	0.3 U

Notes:
Blank means no analysis was performed.
U - Not detected at detection limit value shown.
J - Estimated value.
K - Estimated value, biased high.
L - Esti[illegible]d value biased low.

TABLE 9-5

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH GROUNDWATER - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Groundwater
Exposure Point: Site 37

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Average Concentration	Concentration Used for Screening(3)	Background Value(4)	U.S. EPA Region 3 RBC-Tap Water (5)	Potential ARAR/TBC Value(6)	Potential ARAR/TBC Source(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organic Compounds																	
1330-20-7	Total Xylenes	2		2		ug/L	S37TW0020001	1/3	1	1.00	2	NA	1200 N	10000	MCL	No	BSL
Semivolatile Organic Compounds																	
91-57-6	2-Methylnaphthalene	6		6		ug/L	S37TW0020001	1/3	5	3.67	6	NA	12 N	NA	NA	No	BSL
83-32-9	Acenaphthene	2	J	2	J	ug/L	S37TW0020001	1/3	5	2.33	2	NA	37 N	NA	NA	No	BSL
117-81-7	Bis(2-Ethylhexyl)phthalate	2	J	2	J	ug/L	S37TW0010001-D	1/3	5	2.33	2	NA	4.8 C	6	MCL	No	BSL
86-73-7	Fluorene	3	J	3	J	ug/L	S37TW0020001	1/3	5	2.67	3	NA	24 N	NA	NA	No	BSL
91-20-3	Naphthalene	10		10		ug/L	S37TW0020001	1/3	5	5.00	10	NA	0.65 N	NA	NA	Yes	ASL
98-95-3	Nitrobenzene	0.087	J	0.087	J	ug/L	S37TW0030001	1/5	0.2 - 5	1.06	0.087	NA	0.35 N	NA	NA	No	BSL
85-01-8	Phenanthrene	4	J	4	J	ug/L	S37TW0020001	1/3	5	3.00	4	NA	18 (8) N	NA	NA	No	BSL
Inorganics, Total																	
7429-90-5	Aluminum	92.5		214		ug/L	S37TW0010001	1/3	11.5 - 14.9	55.5	214	286545198	3700 N	50 to 200	SMCL	No	BKG
7440-38-2	Arsenic	5.8	K	6.1	K	ug/L	S37TW0010001	1/3	2	2.65	6.1	NA	0.045 C	10	MCL	Yes	ASL
7440-39-3	Barium	92.1	J	299	J	ug/L	S37TW0020001	3/3	NA	181	299	254	260 N	2000	MCL	Yes	ASL
7440-43-9	Cadmium	0.41	K	0.46	K	ug/L	S37TW0010001-D	1/3	0.2	0.212	0.46	2.8	1.8 N	5	MCL	No	BSL, BKG
7440-70-2	Calcium	94600		231000		ug/L	S37TW0020001	3/3	NA	153083	231000	599450	NA	NA	NA	No	NUT, BKG
7440-48-4	Cobalt	4.7	K	4.7	K	ug/L	S37TW0010001, S37TW0010001-D	1/3	0.43 - 1.2	1.84	4.7	39.6	73 N	NA	NA	No	BSL, BKG
7439-89-6	Iron	194		11000		ug/L	S37TW0010001-D	3/3	NA	3796	11000	57199	1100 N	300	SMCL	No	BKG
7439-95-4	Magnesium	13900		47400		ug/L	S37TW0030001	3/3	NA	28933	47400	31254	NA	NA	NA	No	NUT
7439-96-5	Manganese	56.7		2980		ug/L	S37TW0010001-D	3/3	NA	1050	2980	28160	73 N	50	SMCL	No	BKG
7440-09-7	Potassium	4400		7640		ug/L	S37TW0030001	3/3	NA	6253	7640	83058	NA	NA	NA	No	NUT, BKG
7782-49-2	Selenium	2.5	K	3.4	K	ug/L	S37TW0010001-D	2/3	2	2.35	3.4	NA	18 N	50	MCL	No	BSL
7440-22-4	Silver	0.86	J	0.86	J	ug/L	S37TW0030001	1/3	0.5	0.453	0.86	NA	18 N	100	SMCL	No	BSL
7440-23-5	Sodium	72900		216000		ug/L	S37TW0030001	3/3	NA	148467	216000	79585	NA	NA	NA	No	NUT
7440-62-2	Vanadium	0.3	K	0.3	K	ug/L	S37TW0030001	1/3	0.3	0.200	0.3	24.1	26 N	NA	NA	No	BSL, BKG
Explosives																	
121-82-4	RDX	1.2		1.2		ug/L	S37TW0020001	1/3	0.5	0.567	1.2	NA	0.61 C	NA	NA	Yes	ASL
Inorganics, Filtered																	
7429-90-5	Aluminum	18.9		23.4		ug/L	S37TW0010001-F-D	1/3	31.8 - 55.5	21.6	23.4	286545198	3700 N	50 to 200	SMCL	No	BSL, BKG
7440-38-2	Arsenic	3.2	K	3.2	K	ug/L	S37TW0030001-F	1/3	2	1.73	3.2	NA	0.045 C	10	MCL	Yes	ASL
7440-39-3	Barium	127	J	229		ug/L	S37TW0030001-F	3/3	NA	164	229	254	260 N	2000	MCL	No	BSL, BKG
7440-43-9	Cadmium	0.76	J	0.98	J	ug/L	S37TW0020001-F	2/3	0.2	0.613	0.98	2.8	1.8 N	5	MCL	No	BSL, BKG
7440-70-2	Calcium	91700		171000		ug/L	S37TW0020001-F	3/3	NA	137383	171000	599450	NA	NA	NA	No	NUT, BKG
7440-47-3	Chromium	0.66	K	0.66	K	ug/L	S37TW0020001-F	1/3	0.4 - 0.86	0.423	0.66	20.9	11 N	100	MCL	No	BSL, BKG
7440-48-4	Cobalt	11.4	K	11.4	K	ug/L	S37TW0020001-F	1/3	2.5 - 4.3	4.92	11.4	39.6	73 N	NA	NA	No	BSL, BKG
7439-89-6	Iron	2290		15100		ug/L	S37TW0020001-F	3/3	NA	10192	15100	57199	1100 N	300	SMCL	No	BKG
7439-95-4	Magnesium	23800	J	34900		ug/L	S37TW0020001-F	3/3	NA	28483	34900	31254	NA	NA	NA	No	NUT
7439-96-5	Manganese	2050		3310		ug/L	S37TW0020001-F	3/3	NA	2687	3310	28160	73 N	50	SMCL	No	BKG
7440-02-0	Nickel	14.9	K	14.9	K	ug/L	S37TW0020001-F	1/3	4 - 5.6	6.61	14.9	39	73 N	NA	NA	No	BSL, BKG
7440-09-7	Potassium	4570		6630	J	ug/L	S37TW0010001-F-D	3/3	NA	5863	6630	83058	NA	NA	NA	No	NUT, BKG
7440-23-5	Sodium	153000		717000		ug/L	S37TW0030001-F	3/3	NA	397000	717000	79585	NA	NA	NA	No	NUT, BKG

Notes:
1 - Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - 95% UTL from Background Soil Investigation Report for Indian Head Stump Neck Annex, Indian Head and Stump Neck Annex, TtNUS, February 2002 (Draft).
5 - EPA Region 3 Risk-Based Concentration Table, April 2, 2002. (RBCs for noncarcinogenic compounds are divided by 10).
6 - Drinking Water Standards and Health Advisories, EPA 2000.
7 - Rationale Codes Selection Reason: Above Screening Levels (ASL)
No Toxicity Information (NTX)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Level (BSL)
8 - Value is for pyrene.
Shading Indicates that the maximum detected concentration exceeded the screening criteria therefore the chemical was retained as a COPC.

Definitions:
NA = Not Applicable
SQL = Sample Quantitation Limit
COPC = Chemical of Potential Concern
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered
J = Estimated Value
K = Estimated value, biased high
MCL - Maximum Contaminant Level.
SMCL - Secondary Maximum Contaminant Level.
C = Carcinogenic
N - Noncarcinogenic

Associated Samples:

S37TW0010001	S37TW0010001-F
S37TW0010001-D	S37TW0010001-F-D
S37TW0020001	S37TW0020001-F
S37TW0030001	S37TW0030001-F

TABLE 9-6

SUMMARY OF POSITIVE DETECTIONS - SURFACE WATER - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location	S37SD001/SW001	S37SD001/SW001	S37SD002/SW002	S37SD003/SW003
Sample Number	S37SW0010001	FD01310202	S37SW0020001	S37SW0030001
Duplicate of:		S37SW0010001		
Collection Date	01/31/02	01/31/02	01/31/02	02/05/02
Semivolatile Organics (ug/L)				
2-METHYLNAPHTHALENE	2 J	5 U	5 U	5 U
4-METHYLPHENOL	5 U	5 U	5 U	3 J
NAPHTHALENE	5	5 U	5 U	5 U
PHENOL	5 U	2 J	5 U	5 U
Pesticides/PCBs (ug/L)				
4,4'-DDD	0.02 U	0.02 U	0.02 U	0.032
Inorganics (ug/L)				
ALUMINUM	91.9 U	99.5 U	134 U	1350
BARIUM	74.4 J	74.2 J	73.7 J	124 J
CADMIUM	0.21 K	0.24 K	0.27 K	0.41 K
CALCIUM	72200	71600	70600	17300
COBALT	1.1 U	1.1 U	0.99 U	29.6 K
IRON	124 U	155 U	140 U	9080
LEAD	0.4 U	0.4 U	0.4 U	9.1
MAGNESIUM	127000 J	126000 J	124000 J	12900 J
MANGANESE	61 J	63.9 J	61.5 J	2430 J
NICKEL	2.4 U	2.1 U	2.3 U	10.3 K
POTASSIUM	54400 J	54600 J	50400 J	3340 J
SELENIUM	2.1 K	2 U	2 U	2 U
SODIUM	980000	988000	978000	112000
THALLIUM	5 K	7.7 K	6.2 K	2 U
VANADIUM	8.4 K	8.1 K	8.2 K	1.9 K
ZINC	2 U	2 U	2 U	42.7

Notes:
U - Not detected at detection limit value shown.
J - Estimated value.
K - Estimated value, biased high.

TABLE 9-7

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH SURFACE WATER - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Scenario Timeframe: Current/Future
Medium: Surface Water
Exposure Medium: Surface Water
Exposure Point: Site 37

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency (1)	Range of Nondetects(2)	Average Concentration	Concentration Used for Screening(3)	Background Value(4)	U.S. EPA Region 3 RBC-Tap Water (5)	Potential ARAR/TBC Value	Potential ARAR/TBC Source(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Semivolatile Organic Compounds																	
91-57-6	2-Methylnaphthalene	2	J	2	J	ug/L	S37SW0010001	1/3	5	2.33	2	NA	12 N	NA	NA	No	BSL
106-44-5	4-Methylphenol	3	J	3	J	ug/L	S37SW0030001	1/3	5	2.67	3	NA	18 N	NA	NA	No	BSL
91-20-3	Naphthalene	5		5		ug/L	S37SW0010001	1/3	5	3.33	5	NA	0.65 N	NA	NA	Yes	ASL
108-95-2	Phenol	2	J	2	J	ug/L	S37SW0010001-D	1/3	5	2.33	2	NA	2200 N	21000	NRWQC	No	BSL
Pesticides/PCBs																	
72-54-8	4,4'-DDD	0.032		0.032		ug/L	S37SW0030001	1/3	0.02	0.017	0.032	NA	0.28 C	0.00083	NRWQC	Yes	ASL
Inorganics																	
7429-90-5	Aluminum	1350		1350		ug/L	S37SW0030001	1/3	91.9 - 134	488	1350	NA	3700 N	NA	NA	No	BSL
7440-39-3	Barium	73.7	J	124	J	ug/L	S37SW0030001	3/3	NA	90.7	124	NA	260 N	1000	NRWQC	No	BSL
7440-43-9	Cadmium	0.21	K	0.41	K	ug/L	S37SW0030001	3/3	NA	0.302	0.41	NA	1.8 N	NA	NA	No	BSL
7440-70-2	Calcium	17300		72200		ug/L	S37SW0010001	3/3	NA	53267	72200	NA	NA	NA	NA	No	NUT
7440-48-4	Cobalt	29.6	K	29.6	K	ug/L	S37SW0030001	1/3	0.99 - 1.1	10.2	29.6	NA	73 N	NA	NA	No	BSL
7439-89-6	Iron	9080		9080		ug/L	S37SW0030001	1/3	124 - 155	3073	9080	NA	1100 N	300	NRWQC	Yes	ASL
7439-92-1	Lead	9.1		9.1		ug/L	S37SW0030001	1/3	0.4	3.17	9.1	NA	15 (8)	NA	NA	No	BSL
7439-95-4	Magnesium	12900	J	127000	J	ug/L	S37SW0010001	3/3	NA	87800	127000	NA	NA	NA	NA	No	NUT
7439-96-5	Manganese	61	J	2430	J	ug/L	S37SW0030001	3/3	NA	851	2430	NA	73 N	50	NRWQC	Yes	ASL
7440-02-0	Nickel	10.3	K	10.3	K	ug/L	S37SW0030001	1/3	2.1 - 2.4	4.19	10.3	NA	73 N	610	NRWQC	No	BSL
7440-09-7	Potassium	3340	J	54600	J	ug/L	S37SW0010001-D	3/3	NA	36080	54600	NA	NA	NA	NA	No	NUT
7782-49-2	Selenium	2.1	K	2.1	K	ug/L	S37SW0010001	1/3	2	1.18	2.1	NA	18 N	170	NRWQC	No	BSL
7440-23-5	Sodium	112000		988000		ug/L	S37SW0010001-D	3/3	NA	691333	988000	NA	NA	NA	NA	No	NUT
7440-28-0	Thallium	5	K	7.7	K	ug/L	S37SW0010001-D	2/3	2	4.52	7.7	NA	0.26 N	1.7	NRWQC	Yes	ASL
7440-62-2	Vanadium	1.9	K	8.4	K	ug/L	S37SW0010001	3/3	NA	6.12	8.4	NA	26 N	NA	NA	No	BSL
7440-66-6	Zinc	42.7		42.7		ug/L	S37SW0030001	1/3	2	14.9	42.7	NA	1100 N	9100	NRWQC	No	BSL

Notes:
(1) - Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
(2) - Values presented are sample-specific quantitation limits.
(3) - The maximum detected concentration is used for screening purposes.
(4) - No Background data available.
(5) - EPA Region 3 Risk-Based Concentration Table, April 2, 2002. (RBCs for noncarcinogenic compounds are divided by 10).
(6) - EPA National Recommend Water Quality Criteria (NRWQC), April 1999.
(7) - Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Level (BSL)
(8) - Action Level, Drinking Water Standards and Health Advisories, U.S. EPA 2000.
Shading indicates that the maximum detected concentration exceeded the screening criteria therefore the chemical was retained as a COPC.

Definitions:
NA = Not Applicable.
SQL = Sample Quantitation Limit.
COPC = Chemical of Potential Concern.
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered.
J = Estimated Value.
K = Estimated value, biased high.
NRWQC = National Recommended Water Quality Criteria.
C = Carcinogenic.
N = Noncarcinogenic.

Associated Samples:
S37SW0010001
S37SW0010001-D
S37SW0020001
S37SW0030001

TABLE 9-8

SUMMARY OF POSITIVE DETECTIONS - SEDIMENT - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location	S37SD001/SW001	S37SD001/SW001	S37SD002/SW002	S37SD003/SW003
Sample Number	S37SD0010001	FD01310201	S37SD0020001	S37SD0030001
Duplicate of:		S37SD0010001		
Collection Date	01/31/02	01/31/02	01/31/02	02/05/02
Interval, feet bgs	0 - 1	0 - 1	0 - 1	0 - 1
Volatile Organics (ug/kg)				
ACETONE	12 U	11 U	12 U	85 J
Semivolatile Organics (ug/kg)				
2-METHYLNAPHTHALENE	390	370 U	400 U	2000 J
ACENAPHTHYLENE	61 J	370 U	400 U	2300 UJ
BENZALDEHYDE	360 U	370 U	400 U	700 J
BENZO(A)ANTHRACENE	360 U	710	400 U	2300 UJ
BENZO(A)PYRENE	360 U	630	400 U	2300 UJ
BENZO(B)FLUORANTHENE	360 U	320 J	400 U	2300 UJ
BENZO(G,H,I)PERYLENE	360 U	150 J	400 U	2300 UJ
BENZO(K)FLUORANTHENE	360 U	83 J	400 U	2300 UJ
CHRYSENE	360 U	1100	400 U	2300 UJ
DIBENZO(A,H)ANTHRACENE	360 U	57 J	400 U	2300 UJ
FLUORANTHENE	360 U	170 J	400 U	2300 UJ
INDENO(1,2,3-CD)PYRENE	360 U	79 J	400 U	2300 UJ
NAPHTHALENE	360 U	370 U	400 U	640 J
PHENANTHRENE	360 U	260 J	400 U	2300 UJ
PYRENE	360 U	1100	400 U	520 J
Pesticides/PCBs (ug/kg)				
4,4'-DDD	3.6 U	3.7 U	4 U	180 J
4,4'-DDE	3.6 U	3.7 U	4 U	73 J
Explosives (mg/kg)				
NITROCELLULOSE	0.49 U	0.69 U	0.69 U	4.5 J
Inorganics (mg/kg)				
ALUMINUM	356 J	356 J	208 J	10200 J
ARSENIC	0.69 K	2.6 K	0.64 K	11.5 J
BARIUM	4.2 J	4.1 J	3 J	140 J
BERYLLIUM	0.17 K	0.14 K	0.071 K	2 J
CADMIUM	0.076 K	0.058 K	0.16 K	1.5 J
CALCIUM	129	72.7	82.7	4550 J
CHROMIUM	4 K	3.3 K	2.3 K	18 J
COBALT	0.95 K	0.95 K	0.56 U	34.2 J
COPPER	0.55 U	2.3 U	1.2 U	100 J
IRON	5970 J	5030 J	1620 J	25800 J
LEAD	6.8	5.7	8.5	456 J
MAGNESIUM	101	104	70.1	2550 J
MANGANESE	73.6 J	61.9 J	34.2 J	435 J
NICKEL	1.5 K	1.7 K	0.78 K	51.9 J
POTASSIUM	101 U	77.6 U	75.2 U	1590 J
SILVER	0.7 K	0.58 K	0.22 K	0.69 UJ
SODIUM	101	70.8	112	1530 U
VANADIUM	5.3 K	8.4 K	3.1 K	43.5 J
ZINC	11.6	13.5	10.5 U	141 J

Notes:
U - Not detected at detection limit value shown.
J - Estimated value
K - Estimated value, biased high.

TABLE 9-9

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH SEDIMENT - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Site 37

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Nondetects(2)	Average Concentration	Concentration Used for Screening(3)	Background Value(4)	U.S. EPA Region 3 RBC-Residential (5)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)
Volatile Organic Compounds															
67-64-1	Acetone	85	J	85	J	ug/kg	S37SD0030001	1/3	11 - 12	32.3	85	NA	780000 N	No	BSL
Semivolatile Organic Compounds															
91-57-6	2-Methylnaphthalene	390		2000	J	ug/kg	S37SD0030001	2/3	370 - 400	829	2000	NA	160000 N	No	BSL
208-96-8	Acenaphthylene	61	J	61	J	ug/kg	S37SD0010001	1/3	370 - 2300	470	61	NA	470000 (8) N	No	BSL
100-52-7	Benzaldehyde	700	J	700	J	ug/kg	S37SD0030001	1/3	360 - 400	361	700	NA	780000 N	No	BSL
56-55-3	Benzo(a)anthracene	710		710		ug/kg	S37SD0010001-D	1/3	360 - 2300	598	710	NA	870 C	No	BSL
50-32-8	**Benzo(a)pyrene**	630		630		ug/kg	S37SD0010001-D	1/3	360 - 2300	585	630	NA	**87 C**	**Yes**	ASL
205-99-2	Benzo(b)fluoranthene	320	J	320	J	ug/kg	S37SD0010001-D	1/3	360 - 2300	557	320	NA	870 C	No	BSL
191-24-2	Benzo(g,h,i)perylene	150	J	150	J	ug/kg	S37SD0010001-D	1/3	360 - 2300	500	150	NA	230000 (9) N	No	BSL
207-08-9	Benzo(k)fluoranthene	83	J	83	J	ug/kg	S37SD0010001-D	1/3	360 - 2300	478	83	NA	8700 C	No	BSL
218-01-9	Chrysene	1100		1100		ug/kg	S37SD0010001-D	1/3	360 - 2300	663	1100	NA	87000 C	No	BSL
53-70-3	Dibenzo(a,h)anthracene	57	J	57	J	ug/kg	S37SD0010001-D	1/3	360 - 2300	469	57	NA	87 C	No	BSL
206-44-0	Fluoranthene	170	J	170	J	ug/kg	S37SD0010001-D	1/3	360 - 2300	507	170	NA	310000 N	No	BSL
193-39-5	Indeno(1,2,3-cd)pyrene	79	J	79	J	ug/kg	S37SD0010001-D	1/3	360 - 2300	476	79	NA	870 C	No	BSL
91-20-3	Naphthalene	640	J	640	J	ug/kg	S37SD0030001	1/3	360 - 400	341	640	NA	160000 N	No	BSL
85-01-8	Phenanthrene	260	J	260	J	ug/kg	S37SD0010001-D	1/3	360 - 2300	537	260	NA	230000 (9) N	No	BSL
129-00-0	Pyrene	520	J	1100		ug/kg	S37SD0010001-D	2/3	360 - 400	453	1100	NA	230000 N	No	BSL
Pesticides/PCBs															
72-54-8	4,4'-DDD	180	J	180	J	ug/kg	S37SD0030001	1/3	3.6 - 4	61.3	180	NA	2700 C	No	BSL
72-55-9	4,4'-DDE	73	J	73	J	ug/kg	S37SD0030001	1/3	3.6 - 4	25.6	73	NA	1900 C	No	BSL
Explosives															
9004-70-0	Nitrocellulose	4.5	J	4.5	J	mg/kg	S37SD0030001	1/3	0.49 - 0.69	1.71	4.5	NA	NA	No	NTX
Inorganics															
7429-90-5	**Aluminum**	208	J	10200	J	mg/kg	S37SD0030001	3/3	NA	3588	10200	52362	**7800 N**	**Yes**	ASL
7440-38-2	**Arsenic**	0.64	K	11.5	J	mg/kg	S37SD0030001	3/3	NA	4.60	11.5	63	**0.43 C**	**Yes**	ASL
7440-39-3	Barium	3	J	140	J	mg/kg	S37SD0030001	3/3	NA	49.1	140	577	550 N	No	BSL
7440-41-7	Beryllium	0.071	K	2	J	mg/kg	S37SD0030001	3/3	NA	0.742	2	10.9	16 N	No	BSL
7440-43-9	Cadmium	0.058	K	1.5	J	mg/kg	S37SD0030001	3/3	NA	0.576	1.5	1.85	3.9 N	No	BSL
7440-70-2	Calcium	72.7		4550	J	mg/kg	S37SD0030001	3/3	NA	1578	4550	88137	NA	No	NUT
7440-47-3	Chromium	2.3	K	18	J	mg/kg	S37SD0030001	3/3	NA	7.98	18	79.2	23 (10) N	No	BSL
7440-48-4	Cobalt	0.95	K	34.2	J	mg/kg	S37SD0030001	2/3	0.56	11.8	34.2	118	160 N	No	BSL
7440-50-8	Copper	100	J	100	J	mg/kg	S37SD0030001	1/3	0.55 - 2.3	33.8	100	297	310 N	No	BSL
7439-89-6	**Iron**	1620	J	25800	J	mg/kg	S37SD0030001	3/3	NA	10973	25800	193218	**2300 N**	**Yes**	ASL
7439-92-1	**Lead**	5.7		456	J	mg/kg	S37SD0030001	3/3	NA	157	456	476	**400 (11)**	**Yes**	ASL
7439-95-4	Magnesium	70.1		2550	J	mg/kg	S37SD0030001	3/3	NA	908	2550	19043	NA	No	NUT
7439-96-5	**Manganese**	34.2	J	435	J	mg/kg	S37SD0030001	3/3	NA	179	435	2561	**160 N**	**Yes**	ASL
7440-02-0	Nickel	0.78	K	51.9	J	mg/kg	S37SD0030001	3/3	NA	18.1	51.9	382	160 N	No	BSL
7440-09-7	Potassium	1590	J	1590	J	mg/kg	S37SD0030001	1/3	75.2 - 101	557	1590	5061	NA	No	NUT
7440-22-4	Silver	0.22	K	0.7	K	mg/kg	S37SD0010001	2/3	0.69	0.402	0.7	0.92	39 N	No	BSL
7440-23-5	Sodium	70.8		112		mg/kg	S37SD0020001	2/3	1530	321	112	472	NA	No	NUT
7440-62-2	Vanadium	3.1	K	43.5	J	mg/kg	S37SD0030001	3/3	NA	17.8	43.5	196	55 N	No	BSL
7440-66-6	Zinc	11.6		141	J	mg/kg	S37SD0030001	2/3	10.5	52.9	141	1660	2300 N	No	BSL

TABLE 9-9

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH SEDIMENT - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Notes:

1 - Minimum and maximum detected concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - Background Soil Investigation Report for Indian Head Stump Neck Annex, Indian Head and Stump Neck Annex, TtNUS, February 2002 (Draft).
The 95% UTL is shown for informational purposes only. Sediment is not screened against background, see text.
5 - EPA Region 3 Risk-Based Concentration Table, April 2, 2002. (RBCs for noncarcinogenic compounds are divided by 10).
6 - Soil Screening Levels for Inhalation EPA, May 1996. Soil Screening Guidance.
7 - Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Essential Nutrient (NUT)
8 - Value is for acenaphthene. Below Screening Level (BSL)
9 - Value is for pyrene. Below Background Value (BKG)
10 - Value is for hexavalent chromium. No Toxicity Information (NTX)
11 - OSWER screening level. EPA, 1994: Guidance on Residential Lead-Based Paint, Lead Contaminated Dust, and Lead Contaminated Soil.
Shaded cells indicate that the specified criterion has been exceeded or that the chemical has been selected as a COPC.

Definitions:

NA = Not Applicable.
SQL = Sample Quantitation Limit.
COPC = Chemical of Potential Concern.
J = Estimated Value.
K = Estimated value, biased high.
C = Carcinogenic.
N = Noncarcinogenic.
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered

Associated Samples:

S37SD0010001
S37SD0010001-D
S37SD0020001
S37SD0030001

TABLE 9-10

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - GROUNDWATER - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Chemical	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)		
	Concentration µg/L	RBC[1] µg/L	Estimated ILCR	Primary	RBC[1] µg/L	Estimated HQ
Naphthalene	10	NA	NA	Body Weight	6.5	1.5
RDX	1.2	0.61	2.0E-06	Prostate	110	0.01
Arsenic	6.1	0.045	1.4E-04	Skin, Vascular	11	0.6
Barium	299	NA	NA	Kidney	2,600	0.1
		Total Carcinogenic Risk	**1.4E-04**		**Total HI**	**2.2**

Target Organ HIs

Total Skin HI =	0.6
Total Vascular HI =	0.6
Total Body Weight HI =	1.5
Total Prostate HI =	0.01
Total Kidney HI =	0.1

Notes:
1 Risk-Based Concentration (RBC) Table (EPA Region 3, 2002). Some noncarcinogenic RBCs not presented in the EPA Region 3 RBC Table were calculated per the methodology detailed in Appendix I.
2 NA - Not applicable. The EPA has not established a cancer slope factor (CSF) or noncarcinogenic reference dose (RfD).

TABLE 9-11

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - SURFACE WATER - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Chemical	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)		
	Concentration µg/L	RBC[1] µg/L	Estimated ILCR	Primary	RBC[1] µg/L	Estimated HQ
Naphthalene	5	NA	NA	Body Weight	6.5	0.8
4,4'-DDD	0.032	0.28	1.1E-07	NA	NA	NA
Iron	9080	NA	NA	Blood, GS	11000	0.8
Manganese	2430	NA	NA	CNS	730	3.3
Thallium	7.7	NA	NA	Liver	2.6	3.0
		Total Carcinogenic Risk	**1.1E-07**		**Total HI**	**7.9**

Target Organ HIs

Total Body Weight HI =	0.8
Total Blood HI =	0.8
Total GS HI =	0.8
Total CNS HI =	3.3
Total Liver HI =	3.0

Notes:
1 Risk-Based Concentration (RBC) Table (EPA Region 3, 2002). Some noncarcinogenic RBCs not presented in the EPA Region 3 RBC Table were calculated per the methodology detailed in Appendix I.
2 NA - Not applicable. The EPA has not established a cancer slope factor (CSF) or noncarcinogenic reference dose (RfD).

Definition:
GS - Gastrointestinal.
CNS - Central nervous system.

TABLE 9-12

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - SEDIMENT - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Chemical	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)		
	Concentration (mg/kg)	RBC[1] (mg/kg)	Estimated ILCR	Primary	RBC[1] (mg/kg)	Estimated HQ
Benzo(a)pyrene	0.63	0.087	7.2E-06	NA	NA	NA
Aluminum	10200	NA	NA	Immune, Nails	78000	0.1
Arsenic	11.5	0.43	2.7E-05	Skin, Vascular	23	0.5
Iron	25800	NA	NA	Blood, GS	23000	1.1
Lead	456	NA	NA	NA	NA	NA
Manganese	435	NA	NA	CNS	1600	0.3
	Total Carcinogenic Risk		**3.4E-05**		**Total HI**	**2.0**

Target Organ HIs

Total Skin HI =	0.5
Total Vascular HI =	0.5
Total Immune HI =	0.1
Total Nails HI =	0.1
Total Blood HI =	1.1
Total GS HI =	1.1

Notes:

1 Risk-Based Concentration (RBC) Table (EPA Region 3, 2002). Some noncarcinogenic RBCs not presented in the EPA Region 3 RBC Table were calculated per the methodology detailed in Appendix I.

Definition:
GS - Gastrointestinal.
CNS - Central nervous system.

TABLE 9-13

SELECTION OF ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN - GROUNDWATER - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND
PAGE 1 OF 2

Parameter	Frequency of Detection	Minimum Concentration	Maximum Concentration[1]	Location of Maximum Concentration	Average of Positive Results	Average of All Results	Groundwater COPC Screening Level[2]	Ecological Effects Quotient[3]	Retain as a COPC?	Rationale for Contaminant Deletion or Selection[4]
Volatile Organics (ug/L)										
Total Xylenes	1/3	2	2	S37TW0020001	2	1	6000	0.0003	NO	BSL
Semivolatile Organics (ug/L)										
2-Methylnaphthalene	1/3	6	6	S37TW0020001	6	3.7	12	0.5	NO	BSL
Acenaphthene	1/3	2 J	2 J	S37TW0020001	2	2.3	520	0.00	NO	BSL
Bis(2-Ethylhexyl)phthalate	1/3	2 J	2 J	S37TW0010001-D	2	2.3	30	0.07	NO	BSL
Fluorene	1/3	3 J	3 J	S37TW0020001	3	2.7	430	0.0	NO	BSL
Naphthalene	1/3	10	10	S37TW0020001	10	5	100	0.1	NO	BSL
Nitrobenzene	1/5	0.1 J	0.1 J	S37TW0030001	0.1	1.1	27000	3.2E-06	NO	BSL
Phenanthrene	1/3	4 J	4 J	S37TW0020001	4	3	6.3	0.63	NO	BSL
Inorganics, Total (ug/L)										
Aluminum	1/3	93	214	S37TW0010001	153	55	25	8.6	YES	ASL
Arsenic	1/3	5.8 K	6.1 K	S37TW0010001	6.0	2.7	48	0.1	NO	BSL
Barium	3/3	92 J	299	S37TW0020001	181	181	10000	0.03	NO	BSL
Cadmium	1/3	0.4 K	0.5 K	S37TW0010001-D	0.4	0.2	0.53	0.9	NO	BSL
Calcium	3/3	94600	231000	S37TW0020001	153083	153083	NA	NA	NO	NT
Cobalt	1/3	4.7 K	4.7 K	S37TW0010001	4.7	1.8	35000	0.0001	NO	BSL
Iron	3/3	194	11000	S37TW0010001-D	3796	3796	320	34	YES	ASL
Magnesium	3/3	13900	47400	S37TW0030001	28933	28933	NA	NA	NO	NT
Manganese	3/3	57	2980 J	S37TW0010001-D	1050	1050	14500	0.2	NO	BSL
Potassium	3/3	4400	7640	S37TW0030001	6253	6253	NA	NA	NO	NT
Selenium	2/3	2.5 K	3.4 K	S37TW0010001-D	3	2.4	5	0.7	NO	BSL
Silver	1/3	0.9 J	0.9 J	S37TW0030001	0.9	0.5	0.0001	8600	YES	ASL
Sodium	3/3	72900	216000	S37TW0030001	148467	148467	NA	NA	NO	NT
Vanadium	1/3	0.3 K	0.3 K	S37TW0030001	0.3	0.2	10000	0.00003	NO	BSL
Inorganics, Filtered (ug/L)										
Aluminum	1/3	18.9	23.4	S37TW0010001-F-D	21.2	21.6	25	0.9	NO	BSL
Arsenic	1/3	3.2 K	3.2 K	S37TW0030001-F	3.2	1.7	48	0.07	NO	BSL
Barium	3/3	127 J	229	S37TW0030001-F	164	164	10000	0.02	NO	BSL
Cadmium	2/3	0.76 J	0.98 J	S37TW0020001-F	0.9	0.6	0.53	1.8	YES	ASL
Calcium	3/3	91700	171000	S37TW0020001-F	137383	137383	NA	NA	NO	NT
Chromium	1/3	0.66 K	0.66 K	S37TW0020001-F	0.7	0.4	2	0.3	NO	BSL
Cobalt	1/3	11.4 K	11.4 K	S37TW0020001-F	11.4	4.9	35000	0.0003	NO	BSL
Iron	3/3	2290	15100	S37TW0020001-F	10192	10192	320	47	YES	ASL
Magnesium	3/3	23800 J	34900	S37TW0020001-F	28483	28483	NA	NA	NO	NT
Manganese	3/3	2050	3310	S37TW0020001-F	2687	2687	14500	0.2	NO	BSL
Nickel	1/3	14.9 K	14.9 K	S37TW0020001-F	14.9	6.6	160	0.1	NO	BSL
Potassium	3/3	4570	6630 J	S37TW0010001-F-D	5863	5863	NA	NA	NO	NT
Sodium	3/3	153000	717000	S37TW0030001-F	397000	397000	NA	NA	NO	NT
Explosives (ug/L)										
RDX	1/3	1.2	1.2	S37TW0020001	1.2	0.6	NA	NA	YES	NTX

TABLE 9-13

SELECTION OF ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN - GROUNDWATER - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Notes:
Shaded cells indicate that the chemical was selected as a COPC.
COPC = Chemical of Potential Concern
NA = Not Available
J = Estimated value
K - Estimated value, biased high
The sample and duplicate were counted as two separate samples when determining the minimum and maximum detected concentrations and location of maximum concentration, but were only counted as one sample when determining the frequency of detection. One-half of the detection limit was used when averaging non-detected data.
1 The maximum detected concentration was used to calculate the ecological effects quotient.
2 Refer to Table 4-5 for sources of groundwater screening criteria
3 Refer to Section 4.4.4 for ecological effects quotient calculation.
4 Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level
BIO = Bioaccumulative Chemical
NTX = No Toxicity Information Available
For Elimination as a COPC:
BSL = Below COPC Screening Level
NT = Nontoxic
NZ = Not applicable because these parameters are used to characterize the sediments and/or cannot be used to evaluate ecological risks

Associated Samples:

S37TW0010001
S37TW0010001-AVG
S37TW0010001-D
S37TW0020001
S37TW0030001
S37TW0010001-F
S37TW0010001-F-AVG
S37TW0010001-F-D
S37TW0020001-F
S37TW0030001-F

TABLE 9-14

SELECTION OF ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN - SURFACE WATER - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Parameter	Frequency of Detection	Minimum Concentration	Maximum Concentration[1]	Location of Maximum Concentration	Average of Positive Results	Average of All Results	SW COPC Screening Level[2]	Ecological Effects Quotient[3]	Retain as a COPC?	Rationale for Contaminant Deletion or Selection[4]
Semivolatile Organics (ug/L)										
2-METHYLNAPHTHALENE	1/3	2 J	2 J	S37SW0010001	2	2.3	12	0.17	NO	BSL
4-METHYLPHENOL	1/3	3 J	3 J	S37SW0030001	3	2.7	NA	NA	YES	NTX
NAPHTHALENE	1/3	5	5	S37SW0010001	5	3.3	100	0.1	NO	BSL
PHENOL	1/3	2 J	2 J	S37SW0010001-D	2	2.3	79	0.03	NO	BSL
Pesticides/PCBs (ug/L)										
4,4'-DDD	1/3	0.032	0.032	S37SW0030001	0.03	0.02	0.6	0.1	YES	ASL
Inorganics (ug/L)										
ALUMINUM	1/3	1350	1350	S37SW0030001	1350	488	25	54	YES	ASL
BARIUM	3/3	73.7 J	124 J	S37SW0030001	90.7	90.7	10000	0.01	NO	BSL
CADMIUM	3/3	0.21 K	0.41 K	S37SW0030001	0.3	0.3	0.53	0.8	NO	BSL
CALCIUM	3/3	17300	72200	S37SW0010001	53267	53267	NA	NA	NO	NT
COBALT	1/3	29.6 K	29.6 K	S37SW0030001	29.6	10.2	35000	0.001	NO	BSL
IRON	1/3	9080	9080	S37SW0030001	9080	3073	320	28.4	YES	ASL
LEAD	1/3	9.1	9.1	S37SW0030001	9.1	3.2	3.2	2.8	YES	ASL
MAGNESIUM	3/3	12900 J	127000 J	S37SW0010001	87800	87800	NA	NA	NO	NT
MANGANESE	3/3	61 J	2430 J	S37SW0030001	851	851.3	14500	0.2	NO	BSL
NICKEL	1/3	10.3 K	10.3 K	S37SW0030001	10.3	4.2	160	0.1	NO	BSL
POTASSIUM	3/3	3340 J	54600 J	S37SW0010001-D	36080	36080	NA	NA	NO	NT
SELENIUM	1/3	2.1 K	2.1 K	S37SW0010001	1.6	1.2	5	0.4	NO	BSL
SODIUM	3/3	112000	988000	S37SW0010001-D	691333	691333	NA	NA	NO	NT
THALLIUM	2/3	5 K	7.7 K	S37SW0010001-D	6.3	4.5	40	0.19	NO	BSL
VANADIUM	3/3	1.9 K	8.4 K	S37SW0010001	6.1	6.1	10000	0.001	NO	BSL
ZINC	1/3	42.7	42.7	S37SW0030001	42.7	14.9	30	1.4	YES	ASL

Notes:
Shaded cells indicate that the chemical was selected as a COPC.
COPC = Chemical of Potential Concern
NA = Not Available
J = Estimated value
K = Estimated value, biased high
The sample and duplicate were counted as two separate samples when determining the minimum and maximum detected concentrations and location of maximum concentration, but were only counted as one sample when determining the frequency of detection. One-half of the detection limit was used when averaging non-detected data.
1 The maximum detected concentration was used to calculate the ecological effects quotient.
2 Refer to Table 4-5 for sources of surface water screening criteria
3 Refer to Section 4.4.4 for ecological effects quotient calculation.
4 Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level
BIO = Bioaccumulative Chemical
NTX = No Toxicity Information Available
For Elimination as a COPC:
BSL = Below COPC Screening Level
NT = Nontoxic

Associated Samples:

S37SW0010001,DUP
S37SW0010001-AVG,AVG
S37SW0010001-D,DUP
S37SW0020001,NORMAL
S37SW0030001,NORMAL

TABLE 9-15

SELECTION OF ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN - SEDIMENT - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Chemical	Frequency of Detection	Minimum Concentration	Maximum Concentration[1]	Location of Maximum Concentration	Average of Positive Results	Average of All Results	Sediment COPC Screening Level[2]	Ecological Effects Quotient[3]	Retain as a COPC?	Rationale for Contaminant Deletion or Selection[4]
Volatile Organics (ug/kg)										
ACETONE	1/3	85 J	85 J	S37SD0030001	85	32.3	NA	NA	YES	NTX
Semivolatile Organics (ug/kg)										
2-METHYLNAPHTHALENE	2/3	390	2000 J	S37SD0030001	1144	829	70	28.6	YES	ASL
ACENAPHTHYLENE	1/3	61 J	61 J	S37SD0010001	61	470	44	1.4	YES	ASL
BENZALDEHYDE	1/3	700 J	700 J	S37SD0030001	700	361	NA	NA	YES	NTX
BENZO(A)ANTHRACENE	1/3	710	710	S37SD0010001-D	445	598	261	2.7	YES	ASL
BENZO(A)PYRENE	1/3	630	630	S37SD0010001-D	405	585	430	1.5	YES	ASL
BENZO(B)FLUORANTHENE	1/3	320 J	320 J	S37SD0010001-D	320	557	3200	0.1	NO	BSL
BENZO(G,H,I)PERYLENE	1/3	150 J	150 J	S37SD0010001-D	150	500	670	0.2	NO	BSL
BENZO(K)FLUORANTHENE	1/3	83 J	83 J	S37SD0010001-D	83	478	240	0.35	NO	BSL
CHRYSENE	1/3	1100	1100	S37SD0010001-D	640	663	384	2.9	YES	ASL
DIBENZO(A,H)ANTHRACENE	1/3	57 J	57 J	S37SD0010001-D	57	469	63.4	0.9	NO	BSL
FLUORANTHENE	1/3	170 J	170 J	S37SD0010001-D	170	507	600	0.3	NO	BSL
INDENO(1,2,3-CD)PYRENE	1/3	79 J	79 J	S37SD0010001-D	79	476	600	0.1	NO	BSL
NAPHTHALENE	1/3	640 J	640 J	S37SD0030001	640	341	160	4	YES	ASL
PHENANTHRENE	1/3	260 J	260 J	S37SD0010001-D	260	537	240	1.1	YES	ASL
PYRENE	2/3	520 J	1100	S37SD0010001-D	580	453	665	1.7	YES	ASL
Pesticides/PCBs (ug/kg)										
4,4'-DDD	1/3	180 J	180 J	S37SD0030001	180	61.3	16	11.3	YES	ASL
4,4'-DDE	1/3	73 J	73 J	S37SD0030001	73	25.6	2.2	33	YES	ASL
Explosives (mg/kg)										
NITROCELLULOSE	1/3	4.5 J	4.5 J	S37SD0030001	4.5	1.71	NA	NA	YES	NTX
Inorganics (mg/kg)										
ALUMINUM	3/3	208 J	10200 J	S37SD0030001	3588	3588	58030	0.2	NO	BSL
ARSENIC	3/3	0.6 K	11.5 J	S37SD0030001	4.6	4.6	8.2	1.4	YES	ASL
BARIUM	3/3	3 J	140 J	S37SD0030001	49.1	49.1	48	2.9	YES	ASL
BERYLLIUM	3/3	0.1 K	2 J	S37SD0030001	0.7	0.7	NA	NA	YES	NTX
CADMIUM	3/3	0.1 K	1.5 J	S37SD0030001	0.6	0.6	1.2	1.3	YES	ASL
CALCIUM	3/3	72.7	4550 J	S37SD0030001	1578	1578	NA	NA	NO	NT
CHROMIUM	3/3	2.3 K	18 J	S37SD0030001	8.0	8.0	81	0.2	NO	BSL
COBALT	2/3	1.0 K	34.2 J	S37SD0030001	17.6	11.8	50	0.684	NO	BSL
COPPER	1/3	100 J	100 J	S37SD0030001	100	33.8	34	2.9	YES	ASL
IRON	3/3	1620 J	25800 J	S37SD0030001	10973	10973	2	12900	YES	ASL
LEAD	3/3	5.7	456 J	S37SD0030001	157	157	46.7	9.8	YES	ASL
MAGNESIUM	3/3	70.1	2550 J	S37SD0030001	908	908	NA	NA	NO	NT
MANGANESE	3/3	34.2 J	435 J	S37SD0030001	179	179	460	0.9	NO	BSL
NICKEL	3/3	0.8 K	51.9 J	S37SD0030001	18.1	18.1	20.9	2.5	YES	ASL
POTASSIUM	1/3	1590 J	1590 J	S37SD0030001	1590	557	NA	NA	NO	NT
SILVER	2/3	0.2 K	0.7 K	S37SD0010001	0.4	0.4	1	0.7	NO	BSL
SODIUM	2/3	70.8	112	S37SD0020001	99	321	NA	NA	NO	NT
VANADIUM	3/3	3.1 K	43.5 J	S37SD0030001	17.8	17.8	57	0.8	NO	BSL
ZINC	2/3	11.6	141 J	S37SD0030001	76.8	52.9	150	0.94	NO	BSL

TABLE 9-15

SELECTION OF ECOLOGICAL CHEMICALS OF POTENTIAL CONCERN - SEDIMENT - SITE 37
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Notes:
Shaded cells indicate that the chemical was selected as a COPC.
COPC = Chemical of Potential Concern
NA = Not Available
J = Estimaed value
K = Estimated value, biased high
The sample and duplicate were counted as two separate samples when determining the minimum and maximum detected concentrtions and location of maximum concentration, but were only counted as one sample when determining the frequency of detection. One-half of the detection limit was used when averaging non-detected data.
1 The maximum detected concentration was used to calculate the ecological effects quotient.
2 Refer to Table 4-4 for sources of sediment screening criteria
3 Refer to Section 4.4.4 for ecological effects quotient calculation.
4 Rationale Codes:
For Selection as a COPC:
ASL = Above COPC Screening Level
BIO = Bioaccumulative Chemical
NTX = No Toxicity Information Available
For Elimination as a COPC:
BSL = Below COPC Screening Level
NT = Nontoxic

Associated Samples:

S37SD0010001,DUP
S37SD0010001-AVG,AVG
S37SD0010001-D,DUP
S37SD0020001,NORMAL
S37SD0030001,NORMAL

ACAD: 0525CM65.dwg 05/20/02 HJB PIT

MATTAWOMAN CREEK

SITE 37

ARCHER AVENUE

GRASS

MARSH/WETLAND

2075

GRASS

CHICAMUXEN CREEK

N

LEGEND:

- TREELINE
- 25 — TOPOGRAPHIC CONTOUR (1-FOOT INTERVAL)
- STREAM
- WETLAND
- APPROXIMATE SITE LOCATION
- 2075 BUILDING OR STRUCTURE

0 80 160

SCALE IN FEET

DRAWN BY / DATE	HJB 5/20/02
CHECKED BY / DATE	
REVISED BY / DATE	
SCALE	AS NOTED

Tetra Tech NUS, Inc.

SITE LAYOUT
SITE 37 – CAUSEWAY
INDIV–NSWC, INDIAN HAED, MARYLAND

CONTRACT NO.	0525
OWNER NO.	0325
APPROVED BY / DATE	11/25/02
DRAWING NO.	FIGURE 9–1
REV.	0

FORM CADD NO. TTNUS-BH.DWG – REV 1 – 9/10/98

ACAD: 0525GM15.dwg 05/21/02 HJB PIT

MATTAWOMAN CREEK

S37SD0010001/S37SW0010001

S37SB0030201/S37TW0030001

S37SD0020001/S37SW0020001

S37SB0010101/S37TW0010001

SITE 37

ARCHER AVENUE

GRASS

S37SB0020101/S37TW0020001

S37SD0030001/S37SW0030001

MARSH/WETLAND

2075

GRASS

CHICAMUXEN CREEK

N

LEGEND:

- TEMPORARY MONITORING WELL LOCATION
- SEDIMENT AND SURFACE WATER LOCATION
- TREELINE
- 25 TOPOGRAPHIC CONTOUR (1-FOOT INTERVAL)
- STREAM
- WETLAND
- APPROXIMATE SITE LOCATION
- 2075 BUILDING OR STRUCTURE

0 80 160
SCALE IN FEET

DRAWN BY / DATE	HJB 5/20/02
CHECKED BY / DATE	
REVISED BY / DATE	
SCALE	AS NOTED

Tetra Tech NUS, Inc.

SAMPLE LOCATION MAP
SITE 37 - CAUSEWAY
INDIV-NSWC, INDIAN HEAD, MARYLAND

CONTRACT NO.	0525
OWNER NO.	0325
APPROVED BY / DATE	11/25/02
DRAWING NO.	FIGURE 9-2
REV.	0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

ACAD: 0525TM02.dwg 05/29/02 HJB PIT

S37TW0020001	
SEMIVOLATILE ORGANICS	(UG/L)
NAPHTHALENE	10 H
INORGANICS	(UG/L)
BARIUM	299 H
EXPLOSIVES	(UG/L)
RDX	1.2 H

S37TW0010001	
INORGANICS	(UG/L)
ARSENIC	6.1 K H

S37TW0010001-D	
INORGANICS	(UG/L)
ARSENIC	5.8 K H

S37TW0030001-F	
INORGANICS, FILTERED	(UG/L)
ARSENIC	3.2 K H

MATTAWOMAN CREEK

S37SD0020001/S37SW0020001

S37SB0010101/S37TW0010001
(0.87)

S37SD0010001/S37SW0010001

S37SB0030201/S37TW0030001
(1.04)

SITE 37

ARCHER AVENUE

GRASS

S37SB0020101/S37TW0020001
(1.25)

S37SD0030001/S37SW0030001

MARSH/WETLAND

2075

GRASS

CHICAMUXEN CREEK

N

LEGEND:

- TEMPORARY MONITORING WELL LOCATION
- SEDIMENT AND SURFACE WATER LOCATION
- TREELINE
- 25 — TOPOGRAPHIC CONTOUR (1-FOOT INTERVAL)
- 1.0 — POTENTIOMETRIC CONTOUR (0.5 FOOT INTERVAL)(DASHED WHERE INFERRED)
- (1.25) GROUNDWATER ELEVATION (FEET MSL)
- STREAM
- WETLAND
- APPROXIMATE SITE LOCATION
- 2075 BUILDING OR STRUCTURE
- H COPC DETERMINED BY HUMAN HEALTH EVALUATION
- K ESTIMATED VALUE, BIASED HIGH
- UG/L MICROGRAMS PER LITER

NOTE:

ONLY CONCENTRATIONS THAT ARE GREATER THAN RISK SCREENING LEVELS AND BACKGROUND CONCENTRATIONS ARE SHOWN.

0 80 160
SCALE IN FEET

DRAWN BY / DATE	HJB 5/20/02
CHECKED BY / DATE	
REVISED BY / DATE	
SCALE	AS NOTED

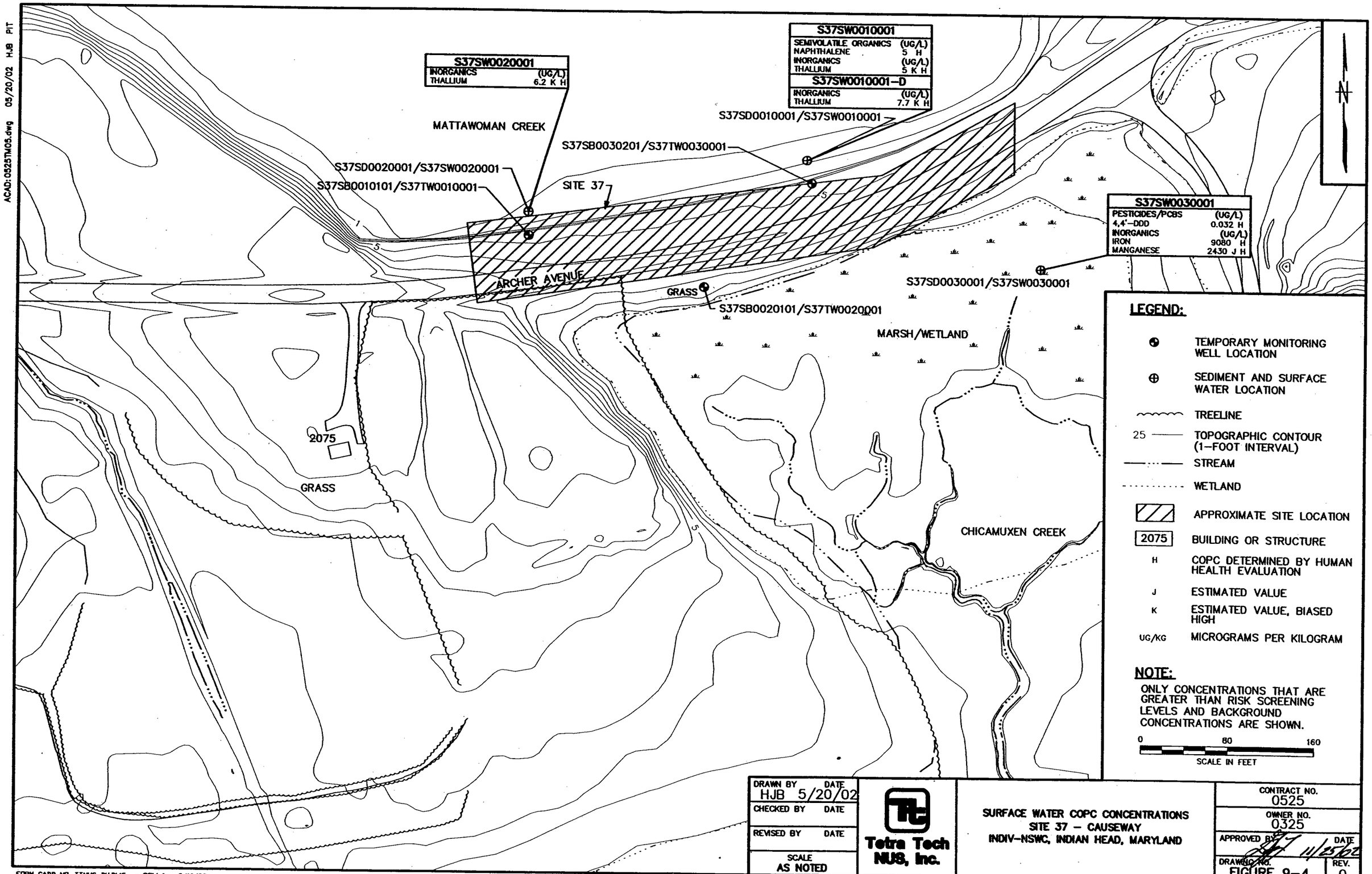
Tetra Tech NUS, Inc.

GROUNDWATER COPC CONCENTRATIONS
SITE 37 – CAUSEWAY
INDIV-NSWC, INDIAN HEAD, MARYLAND

CONTRACT NO.	0525
OWNER NO.	0325
APPROVED BY / DATE	11/25/02
DRAWING NO.	FIGURE 9-3
REV.	0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

ACAD:0525TM05.dwg 05/20/02 HJB PIT



DRAWN BY / DATE	HJB 5/20/02
CHECKED BY / DATE	
REVISED BY / DATE	
SCALE	AS NOTED

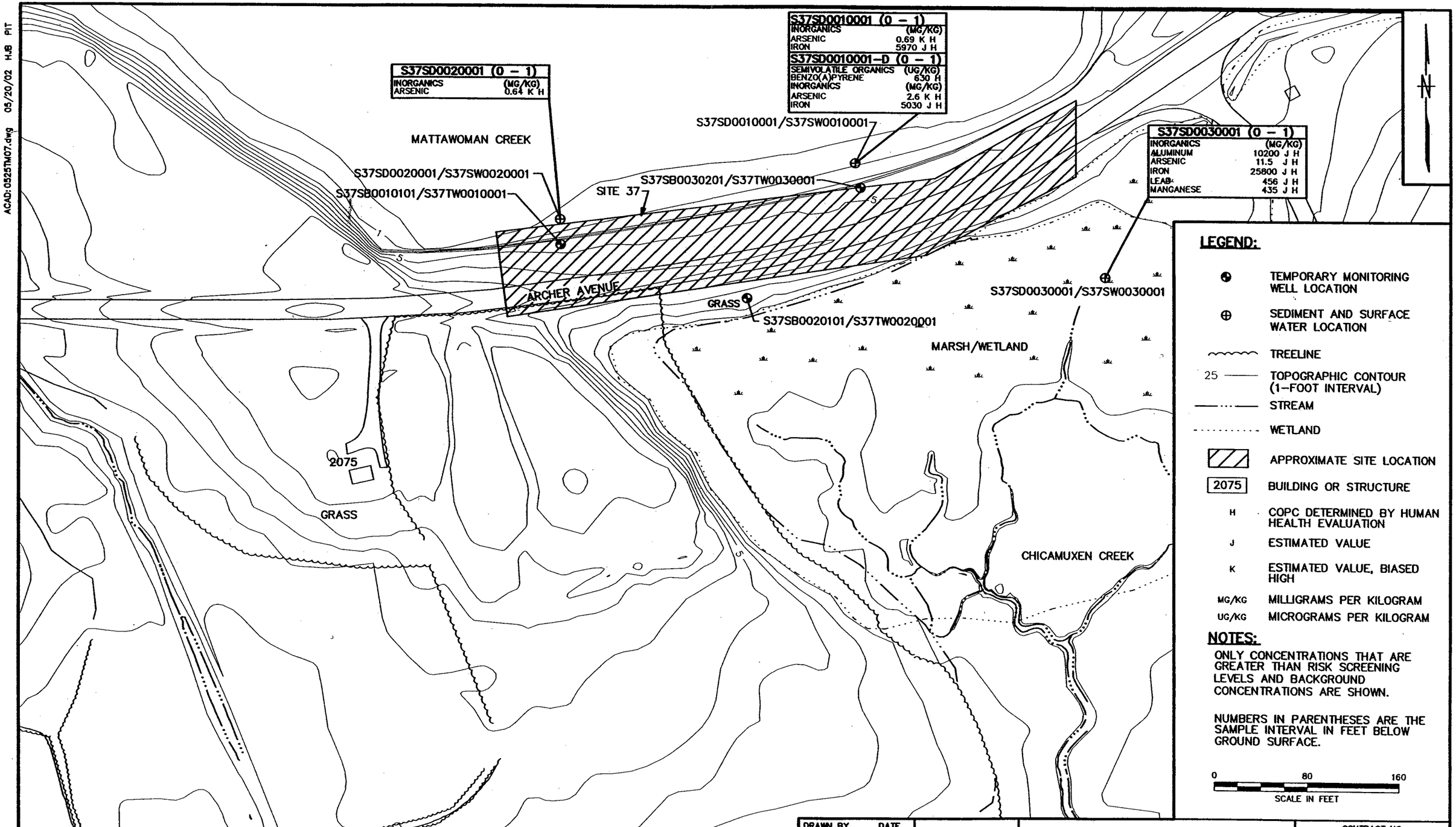
Tetra Tech NUS, Inc.

SURFACE WATER COPC CONCENTRATIONS
SITE 37 – CAUSEWAY
INDIV-NSWC, INDIAN HEAD, MARYLAND

CONTRACT NO.	0525
OWNER NO.	0325
APPROVED BY / DATE	11/25/02
DRAWING NO.	FIGURE 9-4
REV.	0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

ACAD: 0525TM07.dwg 05/20/02 HJB PIT



LEGEND:

- TEMPORARY MONITORING WELL LOCATION
- SEDIMENT AND SURFACE WATER LOCATION
- TREELINE
- 25 TOPOGRAPHIC CONTOUR (1-FOOT INTERVAL)
- STREAM
- WETLAND
- APPROXIMATE SITE LOCATION
- 2075 BUILDING OR STRUCTURE
- H COPC DETERMINED BY HUMAN HEALTH EVALUATION
- J ESTIMATED VALUE
- K ESTIMATED VALUE, BIASED HIGH
- MG/KG MILLIGRAMS PER KILOGRAM
- UG/KG MICROGRAMS PER KILOGRAM

NOTES:

ONLY CONCENTRATIONS THAT ARE GREATER THAN RISK SCREENING LEVELS AND BACKGROUND CONCENTRATIONS ARE SHOWN.

NUMBERS IN PARENTHESES ARE THE SAMPLE INTERVAL IN FEET BELOW GROUND SURFACE.

0 80 160
SCALE IN FEET

DRAWN BY / DATE	HJB 5/20/02
CHECKED BY / DATE	
REVISED BY / DATE	
SCALE	AS NOTED

Tetra Tech NUS, Inc.

SEDIMENT COPC CONCENTRATIONS
SITE 37 – CAUSEWAY
INDIV–NSWC, INDIAN HEAD, MARYLAND

CONTRACT NO.	0525
OWNER NO.	0325
APPROVED BY / DATE	11/25/02
DRAWING NO.	FIGURE 9-5
REV.	0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

10.0 SITE 51 - BUILDING 101 DRY WELL

10.1 BACKGROUND

Building 101 is located in the restricted area of the base near Thames and Evans Roads, next to Building 102, as shown on Figure 10-1. Site 51 is reportedly located between Buildings 101 and 102.

Department of the Navy, Bureau of Yards and Docks drawings 1028836, 1028837, and 1028839 (from the 1994 PA) show a dry well at Building 101. The flash tank detail, dry well detail, and the utilities site plan show a 1-inch steam condensate line leading to the dry well. No wastewater lines on the drawings lead to the dry well. Furthermore, the crushed stone of the dry well was 2 feet below grade, making it difficult to locate and access. It was therefore determined unlikely that any surface disposal took place at the well location (NEESA, 1991). The flash tank/steam condensate system no longer exists (NEESA, 1991).

Based on the drawings, the 1994 PA concluded that there is a lack of evidence to indicate the dry well was used for laboratory waste and that no hazardous waste disposal was suspected in the dry well. Therefore, the PA recommended no further work under the Navy Installation Restoration program (NEESA, 1991). However, this Site Screening investigation is being performed at Site 51 to field-verify the results of the PA. This site is not listed as an SSA in the FFA.

10.2 SITE CHARACTERISTICS

10.2.1 Topography

As illustrated on Figure 10-1, the land surface at Site 51 is relatively flat, with a very slight slope to the south. The land surface elevation across the site is approximately 102 feet above msl.

10.2.2 Surface Water

Precipitation most likely infiltrates the soil and possibly runs off across the ground surface into a drainage swale approximately 75 feet to the south.

10.2.3 Geology/Soils

The soil boring installed at the site indicated that the shallow geologic conditions consist primarily of silt and clay overlying gravel nearby the dry well. Soil boring logs are provided in Appendix B.

10.3 FIELD INVESTIGATION

A geophysical survey was completed at the site to locate the steam lines feeding into dry well(s). Subsurface soil samples were collected and submitted to a fixed-base laboratory for chemical analysis to evaluate the potential presence or absence of contaminants.

Observations made during the field investigation showed that there was only one dry well serving both Building 101 and Building 102. This dry well has been arbitrarily designated as Site 51.

Three pipes feed into the one identified dry well. One of the three pipes was still being used to discharge steam condensate from Building 101. This line was set approximately 0.5 foot below the ground surface and was indicated at the ground surface by distressed vegetation. The other two lines were approximately 1.5 to 2 feet bgs and appeared to be inactive. These two lines are suspected to be the lines from both Buildings 101 and 102 abandoned flash tanks. The dry well was constructed with a 2-foot by 2-foot by 2-foot pit covered with a steel grate at the ground surface. Gravel was encountered below the well at approximately 2 to 2.5 feet bgs and extended to at least 3 feet from the edges of the sidewalls.

10.3.1 Geophysical Investigation

A GPR system was used to perform a geophysical survey at Sites 51 and 52. The GPR transmits a 450 MHz electromagnetic signal into the ground and receives and measures the speed and amplitude of the reflected signal from the subsurface. The survey was conducted along eight north-south lines and ten east-west lines. The effective exploration depth of the instrument is approximately 10 feet. The results of the survey are shown on Figure 10-2, which shows the locations of buried pipes and other items identified by the GPR. A detailed report of the geophysical survey results is provided in Appendix D.

10.3.2 Subsurface Soil Sampling

Two subsurface soil samples were collected from a soil boring (S51SB001) installed adjacent to the dry well. The sample location is shown on Figure 10-2. The soil samples were collected using hand auger drilling techniques.

The sample depths were selected based upon field conditions in combination with the proposed depths from the work plan. No elevated PID readings or waste were encountered during the subsurface investigation. The soil consisted primarily of silt and clay overlying gravel that was encountered at 2 to 2.5 feet bgs. The samples were submitted to a fixed-base laboratory to be analyzed for TCL VOCs. The samples and analyses are summarized on Table 10-1. Soil sample log sheets are provided in Appendix C.

One field duplicate S51SBDUP0101 was collected at the same location as S51SB0010201 and analyzed for TCL VOCs.

10.4 ANALYTICAL RESULTS AND COPC SELECTION

This section provides the data, evaluation, and human health COPC selection of subsurface soil at Site 51. This screening evaluation is based on the following samples:

- Two subsurface soil samples

The results were evaluated as described below. Complete chemical analytical results are presented in Appendix H.

10.4.1 Data And Risk-Based Evaluation of Subsurface Soil Contamination

Positive analytical results and summary statistics for subsurface soil samples are provided in Tables 10-2 and 10-3, respectively.

Based on the laboratory results, concentrations of VOCs were less than the direct contact screening criteria (EPA Region 3 RBCs or EPA SSLs for soil to air). The maximum detected concentration of benzene exceeded the EPA Region 3 SSL for migration from soil to groundwater. Because the reported concentrations of these chemicals were less than the direct contact screening criteria, potential risks from direct exposure to these COPCs in soil are expected to be minimal. However, exceedances of EPA Region 3 migration to groundwater SSLs may indicate the potential for chemicals to leach to groundwater and impact water quality.

Toluene was also detected but at a concentration less than the screening levels. No other VOCs were detected in the subsurface soil. The COPC concentrations are shown on Figure 10-3.

10.5 HUMAN HEALTH RISK SCREENING EVALUATION

No COPCs were identified for direct exposure at Site 51. Therefore, no further human health risk screening is necessary.

There was only one sample with a benzene concentration greater than the EPA Region 3 SSL for migration to groundwater. However, the depth to groundwater is over 30 feet and the silty, clayey soil limits migration. Further, there is a layer of very low permeability above the water table that will further

limit contaminant migration (E/A&H, 1994). Therefore, the depth to the water table, the presence of the lower permeability unit, and the low benzene concentration lead to the conclusion that there is no significant risk to human health.

10.6 ECOLOGICAL RISK SCREENING EVALUATION

No surface soil, groundwater, surface water, or sediment samples were collected, so a quantitative ecological risk evaluation cannot be performed. The results of the subsurface samples further suggest that there are no chemicals of concern. Therefore, there is no risk to ecological receptors.

10.7 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

10.7.1 Summary and Conclusions

There is only one dry well in the vicinity of Buildings 101 and 102. This dry well has been designated as Site 51. There were no COPCs, so no unacceptable risks to human health and ecological receptors were identified.

Note that activities may occur near this site incidental to the activities being performed as part of the larger Lab Area Investigation (Sites 14, 15, 16, 49, 50, 53, 54, and 55).

10.7.2 Recommendations

No action is required for Site 51, and a no action decision document should be prepared, following the same procedures as for an SSA.

TABLE 10-1

ENVIRONMENTAL SAMPLING AND ANALYSIS SUMMARY – SITE 51
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location	Sample Designation	Sample Depth (feet below ground surface) [1]	Sample Analysis					
			TCL VOCs	TCL SVOCs	TAL Metals[2]	Beryllium and Copper[2]	TCL Pesticides/ PCBs	Explosives (with nitrocellulose, nitroguanidine, and nitroglycerine)
SUBSURFACE SOIL								
S51SB001	S51SB0010101	1.5-2	•					
S51SB001	S51SB0010201	2-3	•					
Duplicate of S51SB0010101	SS51SBDUP0101	1.5-2	•					

Notes:

1 Sample depths are as collected in the field.

TABLE 10-2

SUMMARY OF POSITIVE DETECTIONS - SUBSURFACE SOIL - SITE 51
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Sample Location	S51SB001	S51SB001	S51SB001
Sample Number	S51SB0010101	S51SBDUP0101	S51SB0010201
Duplicate of:		S51SB0010101	
Collection Date	02/11/02	02/11/02	02/11/02
Interval, feet bgs	1.5 - 2	1.5 - 2	2 - 3
Volatile Organics (ug/kg)			
BENZENE	11 U	11 U	3 J
TOLUENE	11 U	11 U	2 J

Notes:
U - Not detected at detection limit value shown.
J - Estimated value.

TABLE 10-3

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH SUBSURFACE SOIL - SITE 51
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Site 51

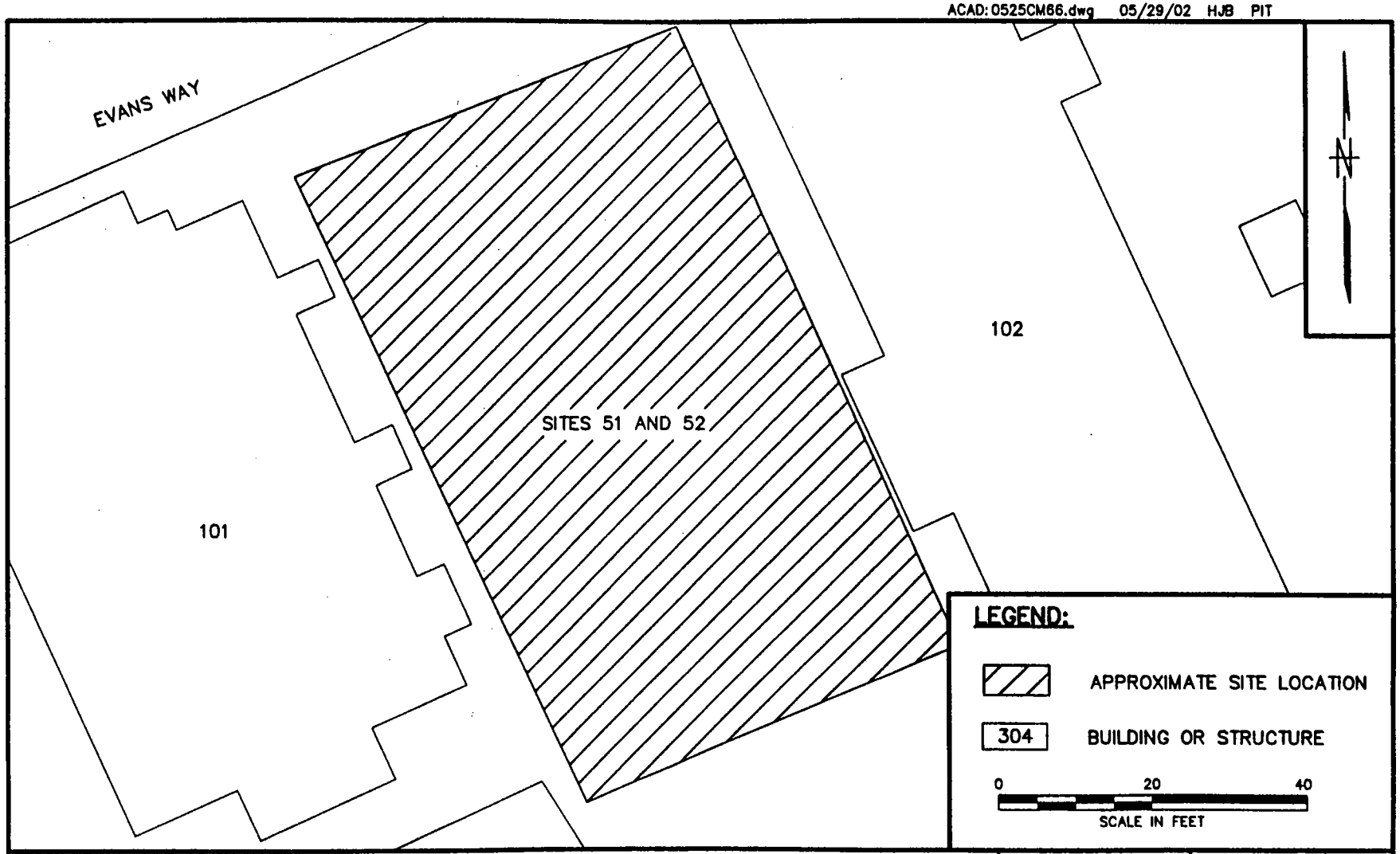
CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Nondetects[2]	Average Concentration	Concentration Used for Screening[3]	Background Value[4]	U.S. EPA Region 3 RBC-Residential [5]	EPA SSLs Soil to Air[6]	U.S. EPA Region 3 SSLs Soil to Groundwater[7]	COPC Flag	Rationale for Contaminant Deletion or Selection[8]
Volatile Organic Compounds																	
108-88-3	Toluene	2	J	2	J	ug/kg	S51SB0010201	1/2	11	3.75	2	NA	16000000 N	650000	8800	No	BSL
71-43-2	Benzene	3	J	3	J	ug/kg	S51SB0010201	1/2	11	4.25	3	NA	12000 C	800	1.8	Yes	ASL

Notes:
1 - Minimum and maximum detected concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - Background Soil Investigation Report for Indian Head Stump Neck Annex, Indian Head and Stump Neck Annex, TtNUS, February 2002 (Draft).
5 - EPA Region 3 Risk-Based Concentration Table, April 2, 2002. (RBCs for noncarcinogenic compounds are divided by 10).
6 - Soil Screening Levels for Inhalation U.S. EPA, May 1996. Soil Screening Guidance.
7 - EPA Region 3 Risk-Based Concentration Table, April 2, 2002. DAF (Dilution attenuation factor) of 20.
8 - Rationale Codes Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Level (BSL)
Below Background Value (BKG)
Shaded cells indicate that the specified criterion has been exceeded or that the chemical has been selected as a COPC.

Definitions:
NA = Not Applicable.
SQL = Sample Quantitation Limit.
COPC = Chemical of Potential Concern.
J = Estimated Value.
C = Carcinogenic.
N = Noncarcinogenic.

Associated Samples:
S51SB0010101
S51SB0010101-D
S51SB0010201

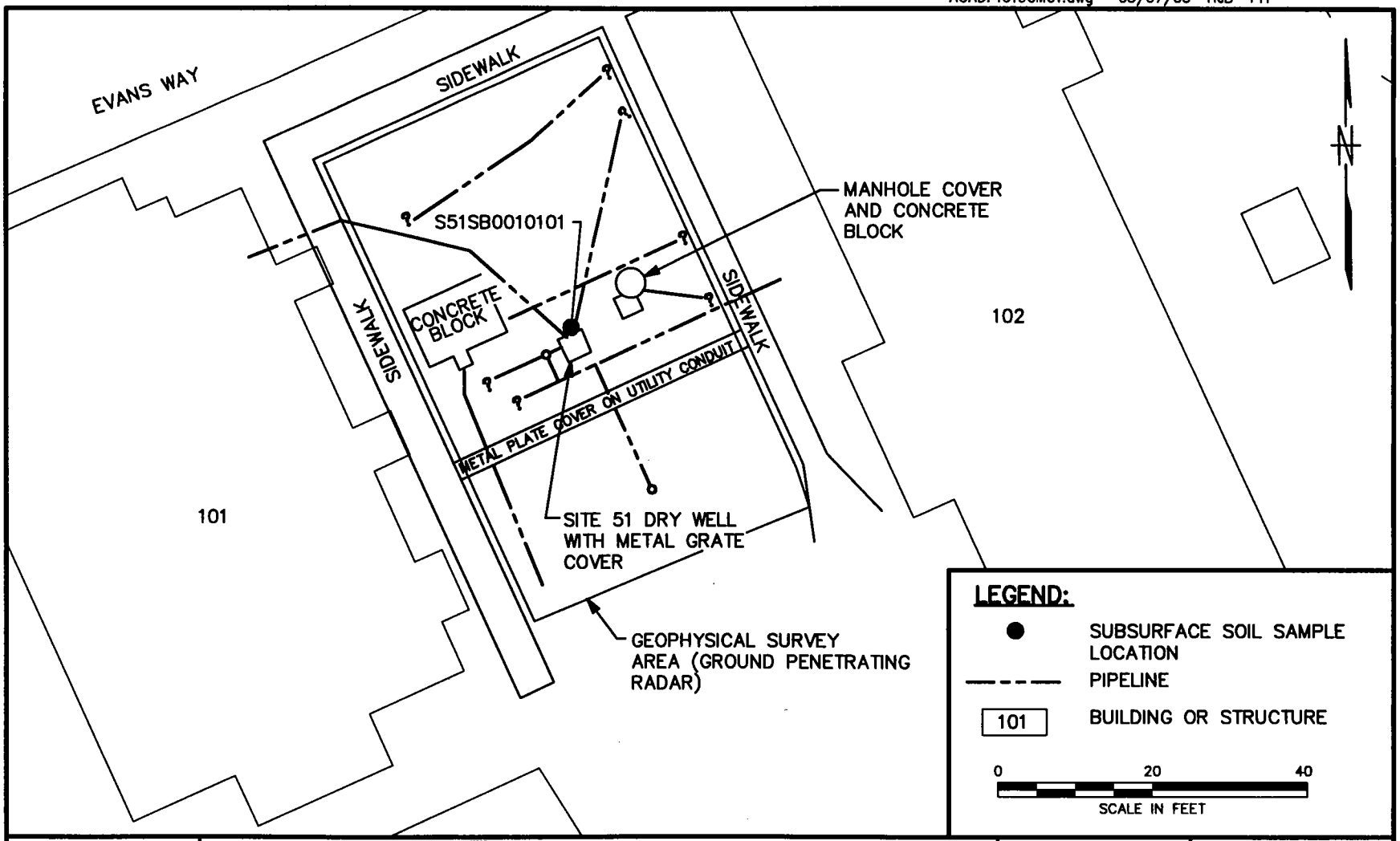
ACAD: 0525CM66.dwg 05/29/02 HJB PIT



DRAWN BY HJB DATE 5/15/02	Tetra Tech NUS, Inc.	CONTRACT NO. 0525	OWNER NO. 0325
CHECKED BY DATE	SITE LAYOUT SITES 51 AND 52 – DRY WELLS INDIV–NSWC, INDIAN HEAD, MARYLAND	APPROVED BY	DATE 11/25/02
COST/SCHED–AREA		APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 10–1	REV. 0

FORM CADD NO. T+NUS_AH.DWG - REV 0 - 1/22/98

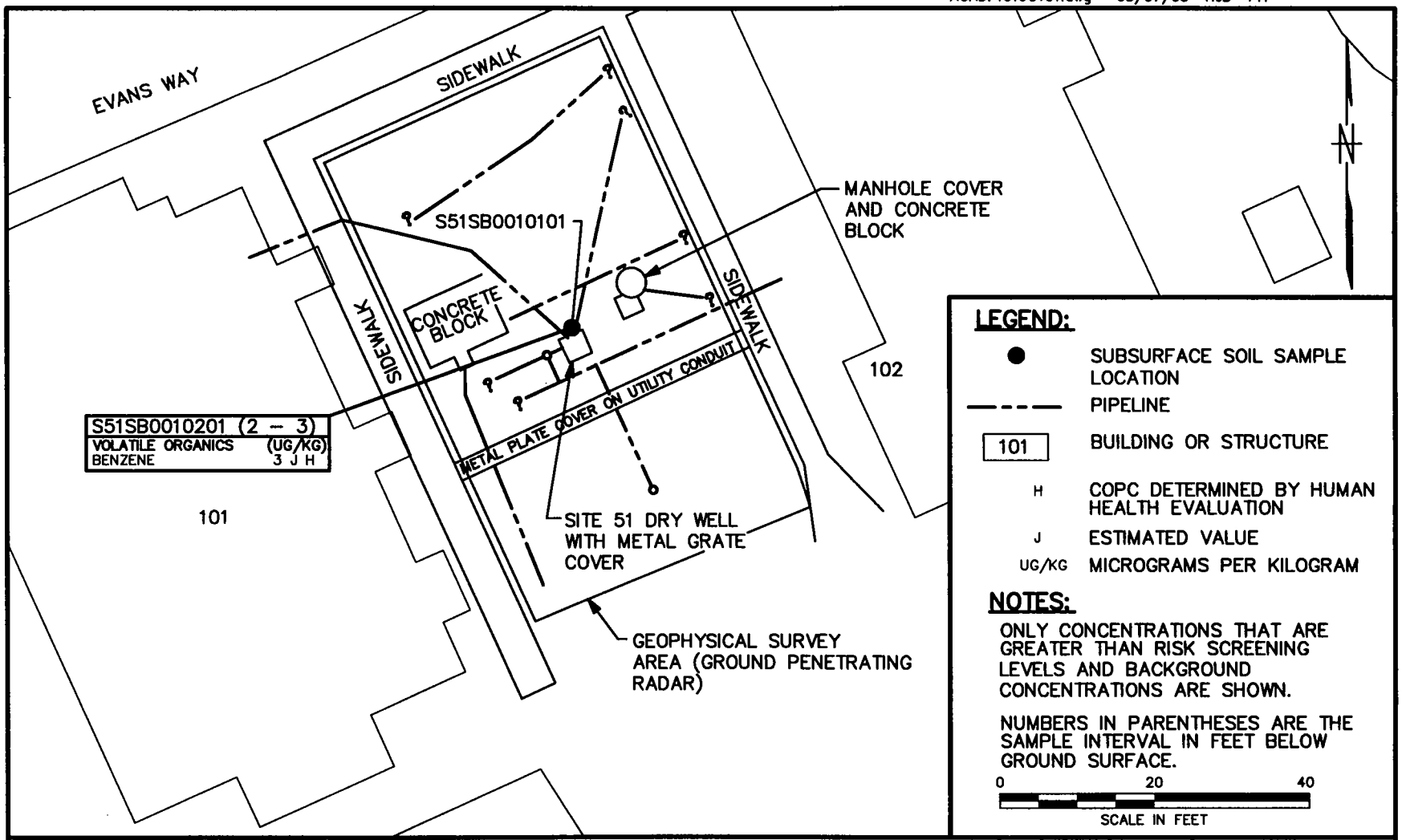
ACAD: 4019GM01.dwg 03/07/03 HJB PIT



DRAWN BY HJB DATE 3/7/03	Tetra Tech NUS, Inc.	CONTRACT NO. 4019	OWNER NO. 0803
CHECKED BY DATE		APPROVED BY DATE	
COST/SCHED--AREA	SAMPLE LOCATION MAP SITES 51 AND 52 – DRY WELLS INDIV–NSWC, INDIAN HEAD, MARYLAND	APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 10–2	REV. 0

FORM CADD NO. T:tNUS_AH.DWG - REV 0 - 1/22/98

ACAD: 4019GT01.dwg 03/07/03 HJB PIT



DRAWN BY HJB DATE 3/7/03	Tetra Tech NUS, Inc.	CONTRACT NO. 4019	OWNER NO. 0803
CHECKED BY DATE		APPROVED BY	DATE
COST/SCHED–AREA	SUBSURFACE SOIL COPC CONCENTRATIONS SITES 51 AND 52 – DRY WELLS INDIV–NSWC, INDIAN HEAD, MARYLAND	APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 10–3	REV. 0

FORM CADD NO. T+NUS_AH.DWG – REV 0 – 1/22/98

11.0 SITE 52 - BUILDING 102 DRY WELL

11.1 BACKGROUND

Building 102 is located in the restricted area of the base near, Thames and Evans Roads next to Building 101, as shown on Figure 10-1. Site 52 was reportedly located within the same general area shown on Figure 10-2 between Buildings 101 and 102.

Naval Ordnance Station Indian Head personnel who were interviewed about the laboratory area buildings spoke of a flash tank room and a dry well near Building 102. There was some speculation as to whether the flash tank was used to vaporize volatile components of a laboratory waste stream and whether the dry well had received the remaining liquid phase of the waste (NEESA, 1991).

Department of the Navy, Bureau of Yards and Docks drawings 1028836, 1028837, and 1028839 (from the 1994 PA) show a dry well at Building 102. The flash tank detail, dry well detail, and the utilities site plan show a 1-inch steam condensate line leading to the dry well. No wastewater lines on the drawings lead to the dry well. Furthermore, the crushed stone of the dry well was 2 feet below grade, making it difficult to locate and access. It was therefore determined unlikely that any surface disposal took place at the well location (NEESA, 1991).

The flash tank/steam condensate system no longer exists (NEESA, 1991).

Based on the drawings, the 1994 PA concluded that there is a lack of evidence to indicate the dry well was used for laboratory waste and that no hazardous waste disposal was suspected in the dry well. Therefore, the PA recommended no further work under the Navy Installation Restoration program (NEESA, 1991). However, this Site Screening investigation is being performed at Site 52 to field-verify the results of the PA. This site is not listed as an SSA in the FFA.

11.2 SITE CHARACTERISTICS

As described below, there is only one dry well between Buildings 101 and 102. The site characteristics of this area are included in Section 10.2.

11.3 FIELD INVESTIGATION

Observations made during the field investigation showed that there was only one dry well serving both Building 101 and Building 102. This dry well was arbitrarily designated as Site 51. Therefore, there is no Site 52 dry well. See the Site 51 discussion in Section 10.3 for details.

11.4 ANALYTICAL RESULTS

Based on field observations described in Section 10.0, there is only one dry well in the vicinity of Buildings 101 and 102, and that dry well was designated as Site 51. The results of samples that were collected at the dry well are described in Section 10.0.

11.5 HUMAN HEALTH SCREENING EVALUATION

As noted in Section 10.0, there is only one dry well in the vicinity of Buildings 101 and 102. The human health risk evaluation of the results from the single dry well, designated as Site 51, are included in Section 10.0 and that evaluation determined that there is no unacceptable risk to human health.

11.6 ECOLOGICAL RISK EVALUATION

As noted in Section 10.0, there is only one dry well in the vicinity of Buildings 101 and 102. The ecological risk evaluation of the results from the single dry well, designated as Site 51, are included in Section 10.0, and that evaluation determined that there is no unacceptable risk to ecological receptors.

11.7 SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

11.7.1 Summary and Conclusions

There is only one dry well in the vicinity of Buildings 101 and 102. This dry well has been designated as Site 51. Because there is no dry well specifically associated with Building 102, Site 52 does not exist, and, therefore, no action needs to be taken at Site 52.

11.7.2 Recommendations

No action is required for Site 52, and a no action decision document should be prepared, following the same procedures as for an SSA.

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APPENDIX A

WELL ABANDONMENT REPORTS AND COMPLETION REPORTS

A.1 TtNUS Monitoring Well Completion Forms
A.2 State of Maryland Well Reports and Abandonment Reports

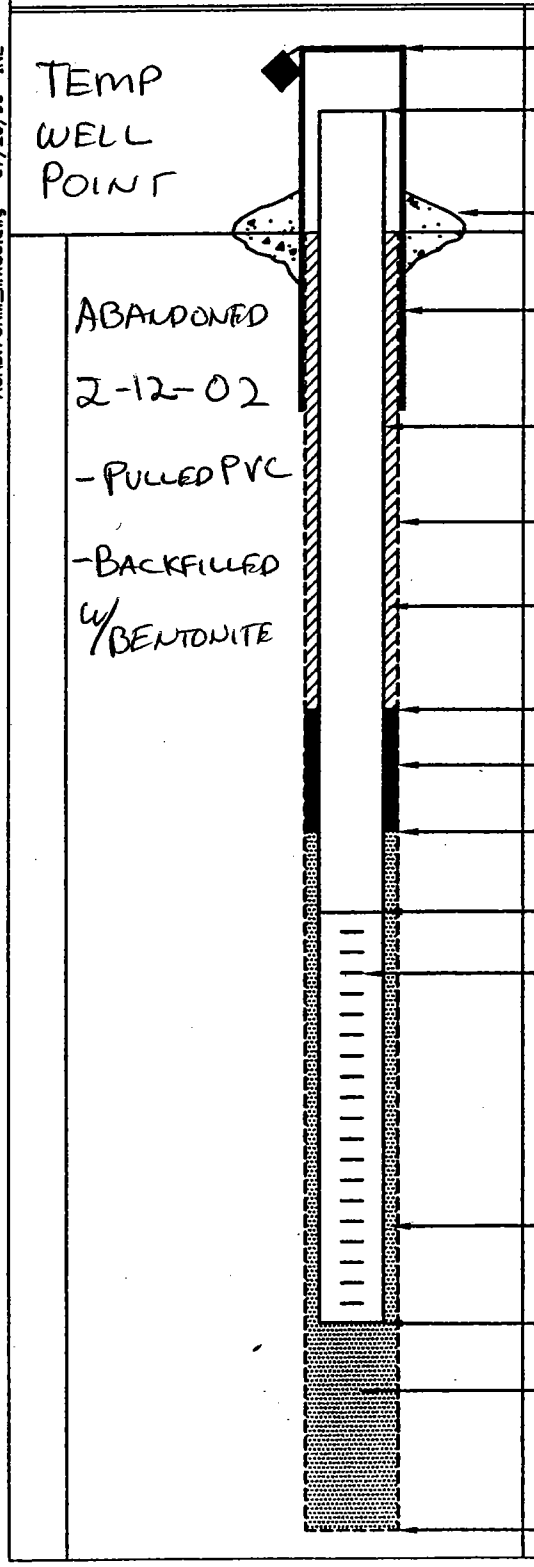
A.1 TtNUS MONITORING WELL COMPLETION FORMS

WELL NO.: S33TW001

Tetra Tech NUS, Inc.

OVERBURDEN
MONITORING WELL SHEET
STICK-UP

PROJECT SEVEN SITE INV.	LOCATION IHDIV STUMPNECK	DRILLER AARON F.
PROJECT NO. 0525	BORING S33TW001	DRILLING METHOD HSA
DATE BEGUN 2-7-02	DATE COMPLETED 2-7-02	DEVELOPMENT METHOD PUMP
FIELD GEOLOGIST FRED W RAMSER		
GROUND ELEVATION 80.96	DATUM NGVD 29	



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: NA/NA

ELEVATION/HEIGHT OF TOP OF RISER PIPE: 82.11/1.15

TYPE OF SURFACE SEAL: —

I.D. OF SURFACE CASING: —

TYPE OF SURFACE CASING:

RISER PIPE I.D.: 2"

TYPE OF RISER PIPE: PVC

BOREHOLE DIAMETER: 8"

TYPE OF BACKFILL: —

ELEVATION/DEPTH TOP OF SEAL: 69.96/11'

TYPE OF SEAL: BENTONITE 3/8" CHIPS

DEPTH TOP OF SAND PACK: 16

ELEVATION/DEPTH TOP OF SCREEN: 62.96/18'

TYPE OF SCREEN: PVC

SLOT SIZE x LENGTH: .010 x 10'

I.D. OF SCREEN: 2"

TYPE OF SAND PACK: RICCI BROS #00N SILICA SAND

ELEVATION/DEPTH BOTTOM OF SCREEN: 52.96/28

ELEVATION/DEPTH BOTTOM OF SAND PACK: 50.96/30

BACKFILL MATERIAL BELOW SAND:

ELEVATION/DEPTH OF HOLE: 50.96/30

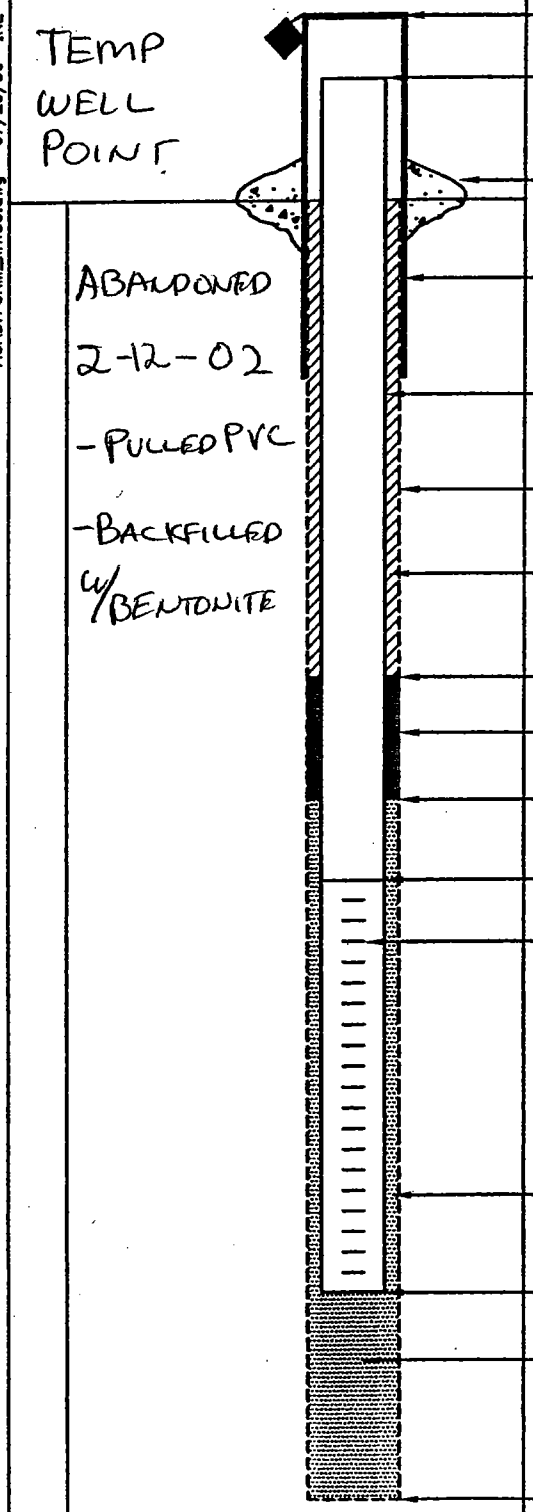
ACAD:FORM_HWSU.dwg 07/20/99 INL

WELL NO.: S33TW002

Tetra Tech NUS, Inc.

OVERBURDEN
MONITORING WELL SHEET
STICK-UP

PROJECT SEVEN SITE INV.	LOCATION IHDIV STUMPNECK	DRILLER AARON F.
PROJECT NO. 0525	BORING S33TW002	DRILLING METHOD HSA
DATE BEGUN 2-8-02	DATE COMPLETED 2-8-02	
FIELD GEOLOGIST FRED W RAMSER		DEVELOPMENT METHOD PUMP
GROUND ELEVATION 81.35	DATUM NGVD 29	



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: NA/NA

ELEVATION/HEIGHT OF TOP OF RISER PIPE: 82.82/1.47

TYPE OF SURFACE SEAL: —

I.D. OF SURFACE CASING: —

TYPE OF SURFACE CASING:

RISER PIPE I.D.: 2"

TYPE OF RISER PIPE: PVC

BOREHOLE DIAMETER: 8"

TYPE OF BACKFILL: —

ELEVATION/DEPTH TOP OF SEAL: 68.35/13

TYPE OF SEAL: BENTONITE 3/8" CHIPS

DEPTH TOP OF SAND PACK: 66.35/15

ELEVATION/DEPTH TOP OF SCREEN: 63.35/18

TYPE OF SCREEN: PVC

SLOT SIZE x LENGTH: .010 x 10'

I.D. OF SCREEN: 2"

TYPE OF SAND PACK: RICCI BROS #00N SILICA SAND

ELEVATION/DEPTH BOTTOM OF SCREEN: 53.35/28

ELEVATION/DEPTH BOTTOM OF SAND PACK: 51.35/30

BACKFILL MATERIAL BELOW SAND:

ELEVATION/DEPTH OF HOLE: 51.35/30

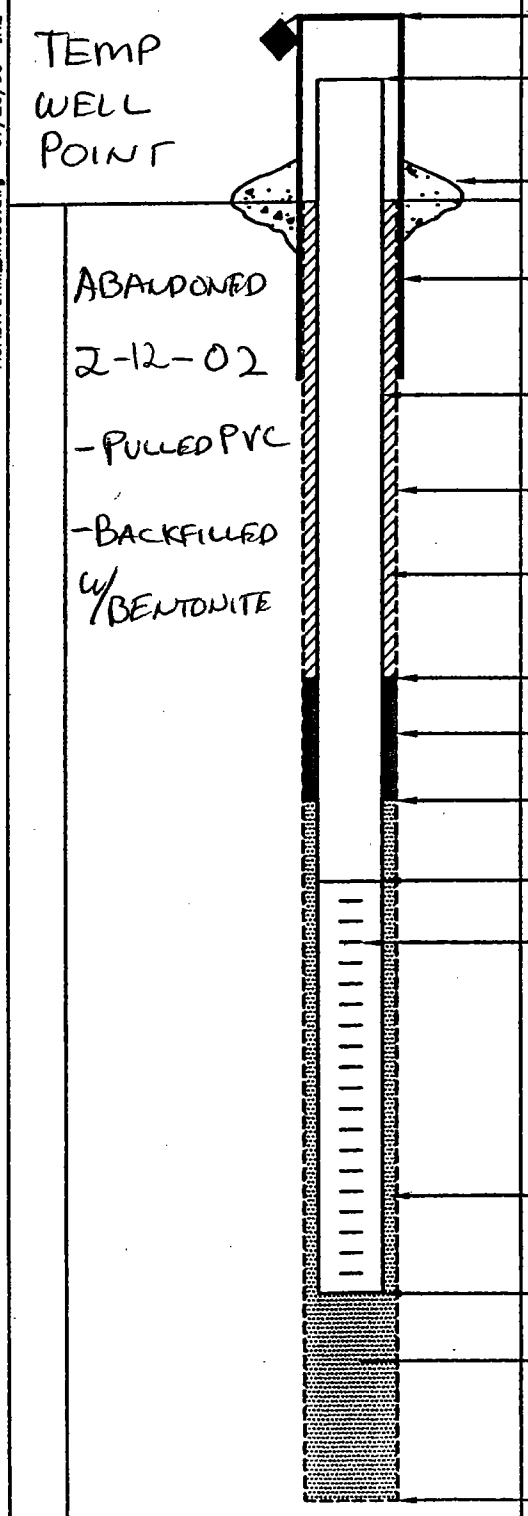
ACAD:FORM_MWSU.dwg 07/20/99 INL

WELL NO.: S33TW003

Tetra Tech NUS, Inc.

OVERBURDEN
MONITORING WELL SHEET
STICK-UP

PROJECT SEVEN SITE INV.	LOCATION IHDIV STUMPNECK	DRILLER AARON F.
PROJECT NO. 0525	BORING S33TW003	DRILLING METHOD HSA
DATE BEGUN 2-6-02	DATE COMPLETED 2-6-02	DEVELOPMENT METHOD PUMP
FIELD GEOLOGIST FRED W RAMSER		
GROUND ELEVATION 78.78	DATUM NGVD 29	



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: NA/NA

ELEVATION/HEIGHT OF TOP OF RISER PIPE: 79.50/0.72

TYPE OF SURFACE SEAL: —

I.D. OF SURFACE CASING: —

TYPE OF SURFACE CASING:

RISER PIPE I.D.: 2"

TYPE OF RISER PIPE: PVC

BOREHOLE DIAMETER: 8"

TYPE OF BACKFILL: —

ELEVATION/DEPTH TOP OF SEAL: 64.78'/14'

TYPE OF SEAL: BENTONITE 3/8" CHIPS

DEPTH TOP OF SAND PACK: 60.78'/18'

ELEVATION/DEPTH TOP OF SCREEN: 58.78'/20'

TYPE OF SCREEN: PVC

SLOT SIZE x LENGTH: .010 x 10'

I.D. OF SCREEN: 2"

TYPE OF SAND PACK: RICCI BROS #00N SILICA SAND

ELEVATION/DEPTH BOTTOM OF SCREEN: 48.78'/30'

ELEVATION/DEPTH BOTTOM OF SAND PACK: 48.78'/30'

BACKFILL MATERIAL BELOW SAND:

ELEVATION/DEPTH OF HOLE: 48.78'/30'

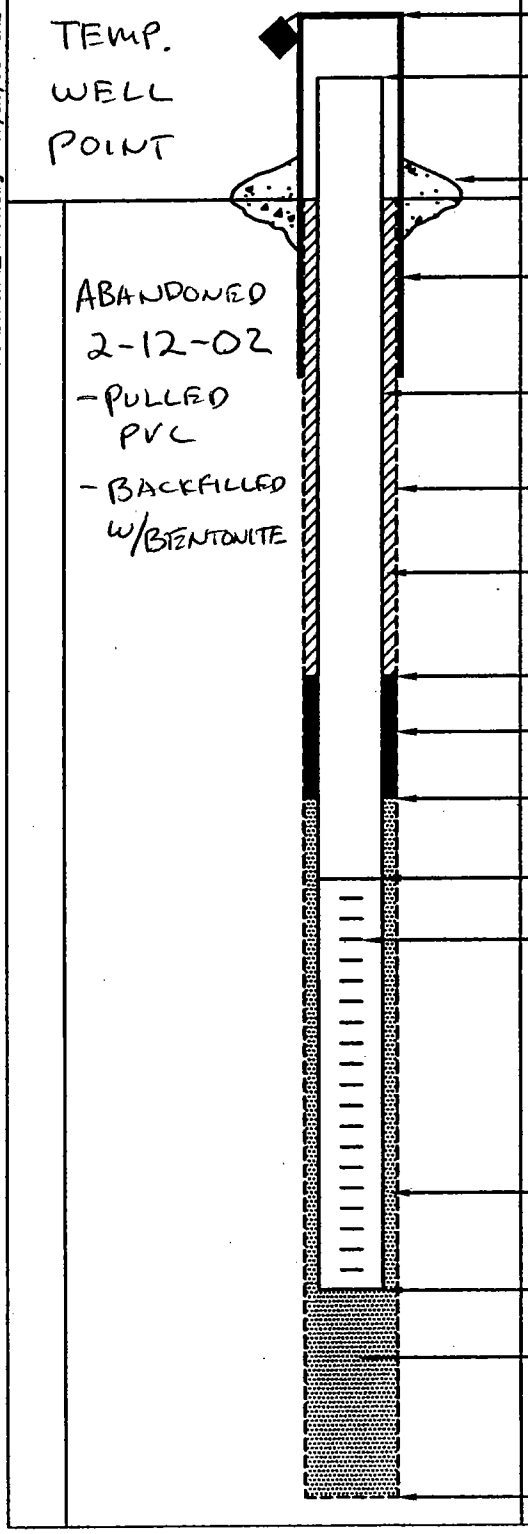
ACAD:FORM_MWSU.dwg 07/28/99 INL

WELL NO.: S34TW001

Tetra Tech NUS, Inc.

OVERBURDEN MONITORING WELL SHEET STICK-UP

PROJECT SEVEN SITE INV	LOCATION IHDIV STUMPNECK	DRILLER AARON E.	
PROJECT NO. 0525	BORING S34TW001	DRILLING METHOD HSA	
DATE BEGUN 2-1-02	DATE COMPLETED 2-1-02	DEVELOPMENT METHOD PUMP	
FIELD GEOLOGIST FRED WRAMSER			
GROUND ELEVATION 4.72	DATUM NGVD 29		



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: NA / NA

ELEVATION/HEIGHT OF TOP OF RISER PIPE: 7.20 / 2.48

TYPE OF SURFACE SEAL: —

I.D. OF SURFACE CASING: —

TYPE OF SURFACE CASING:

RISER PIPE I.D.: ~1"

TYPE OF RISER PIPE: PVC

BOREHOLE DIAMETER: ~8"

TYPE OF BACKFILL: —

ELEVATION/DEPTH TOP OF SEAL: 4.72' / 0'

TYPE OF SEAL: BENTONITE CHIPS SHUR-PLUG 3/8" DSI

DEPTH TOP OF SAND PACK: 2'

ELEVATION/DEPTH TOP OF SCREEN: 0.72' / 4'

TYPE OF SCREEN: PVC

SLOT SIZE x LENGTH: .010 X 5'

I.D. OF SCREEN: 1"

TYPE OF SAND PACK: RICCI BROS #00 N SILICA SAND

ELEVATION/DEPTH BOTTOM OF SCREEN: -4.28 / 9'

ELEVATION/DEPTH BOTTOM OF SAND PACK: -5.28 / 10'

BACKFILL MATERIAL BELOW SAND:

ELEVATION/DEPTH OF HOLE: -5.28 / 10'

ACAD:FORM_MWSU.dwg 07/28/99 INL

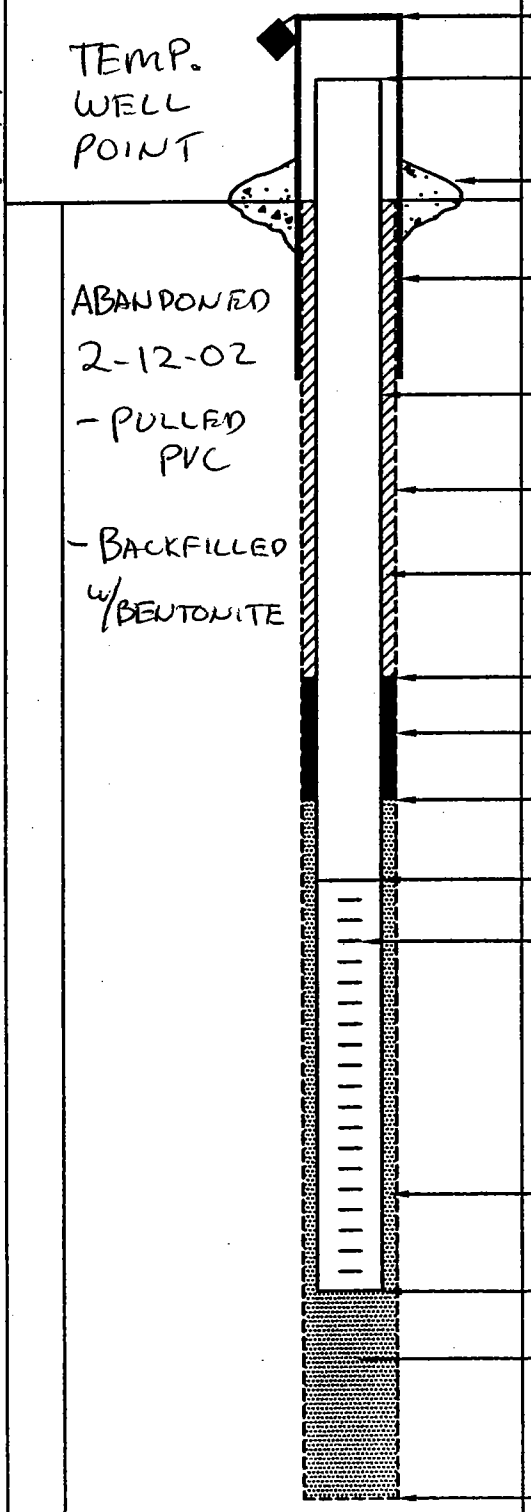
WELL NO.: S34TW002

Tetra Tech NUS, Inc.

OVERBURDEN MONITORING WELL SHEET STICK-UP

PROJECT SEVEN SITE IRV	LOCATION IHDIV STUMP NECK	DRILLER AARON E.	
PROJECT NO. 0525	BORING S34TW002	DRILLING METHOD HSA	
DATE BEGUN 2-1-02	DATE COMPLETED 2-1-02		
FIELD GEOLOGIST FRED W. RAMSER		DEVELOPMENT METHOD PUMP	
GROUND ELEVATION 2.72	DATUM NGVD 29		

ACAD:FORM_MWSU.dwg 07/20/99 INL



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: NA/NA

ELEVATION/HEIGHT OF TOP OF RISER PIPE: 5.30/2.58

TYPE OF SURFACE SEAL: —

I.D. OF SURFACE CASING: —

TYPE OF SURFACE CASING: —

RISER PIPE I.D.: 1"

TYPE OF RISER PIPE:

BOREHOLE DIAMETER: 8"

TYPE OF BACKFILL: —

ELEVATION/DEPTH TOP OF SEAL: 2.72/ 0'

TYPE OF SEAL: BENTONITE CHIPS SHUR-PLUG 3/8" DSI

DEPTH TOP OF SAND PACK: 2'

ELEVATION/DEPTH TOP OF SCREEN: -1.28/ 4'

TYPE OF SCREEN: PVC

SLOT SIZE x LENGTH: .010 X 5'

I.D. OF SCREEN: 1"

TYPE OF SAND PACK: RICCI BROS #00N SILICA SAND

ELEVATION/DEPTH BOTTOM OF SCREEN: -6.28/ 9'

ELEVATION/DEPTH BOTTOM OF SAND PACK: -7.28/ 10'

BACKFILL MATERIAL BELOW SAND:

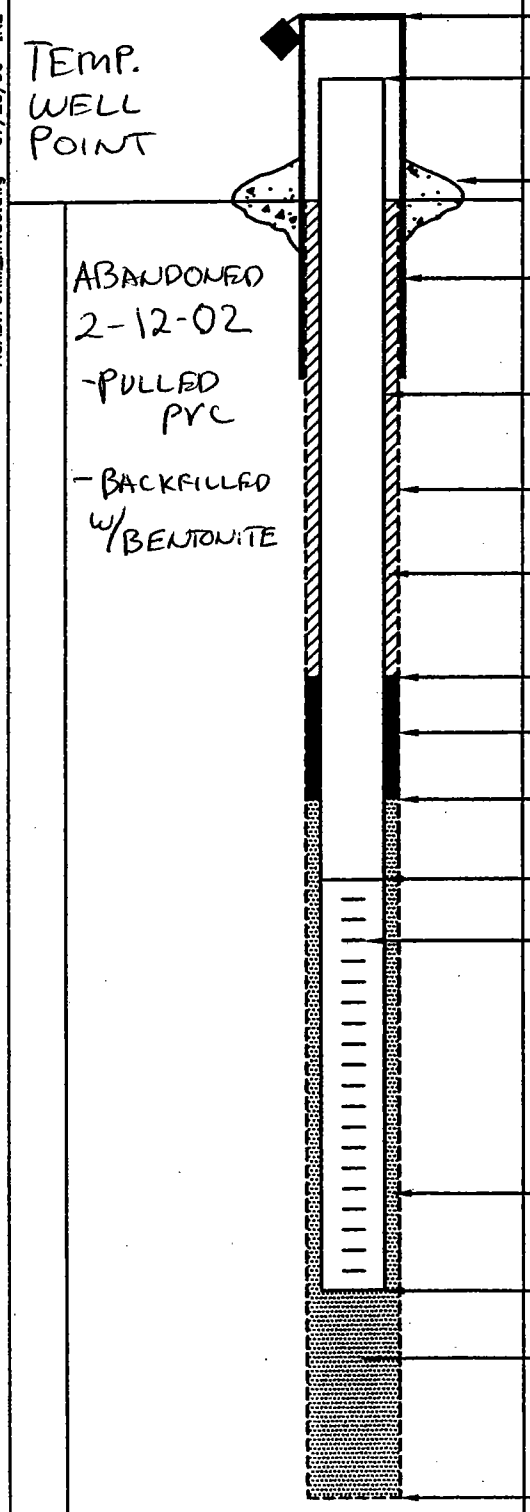
ELEVATION/DEPTH OF HOLE: -7.28/ 10'

WELL NO.: S34TW003

Tetra Tech NUS, Inc.

OVERBURDEN
MONITORING WELL SHEET
STICK-UP

PROJECT SEVEN SITE INV	LOCATION IHDIV STUMPNECK	DRILLER AARON E.	
PROJECT NO. 0525	BORING S34TW003	DRILLING METHOD HSA	
DATE BEGUN 2-1-02	DATE COMPLETED 2-4-02		
FIELD GEOLOGIST FRED W RAMSER		DEVELOPMENT METHOD PUMP	
GROUND ELEVATION 4.97	DATUM NGVD 29		



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: NA / NA

ELEVATION/HEIGHT OF TOP OF RISER PIPE: 7.40/2.43

TYPE OF SURFACE SEAL: —

I.D. OF SURFACE CASING: —

TYPE OF SURFACE CASING: —

RISER PIPE I.D.: ~1"

TYPE OF RISER PIPE:

BOREHOLE DIAMETER: 8"

TYPE OF BACKFILL: —

ELEVATION/DEPTH TOP OF SEAL: 4.97'/ 0'

TYPE OF SEAL: BENTONITE CHIP SHUR-PLUG 3/8 DSI

DEPTH TOP OF SAND PACK: 3'

ELEVATION/DEPTH TOP OF SCREEN: 0.97'/ 4'

TYPE OF SCREEN: PVC

SLOT SIZE x LENGTH: .010 X 10'

I.D. OF SCREEN: ~1"

TYPE OF SAND PACK: RICCI BROS #000N SILICA SAND

ELEVATION/DEPTH BOTTOM OF SCREEN: -9.03/ 14'

ELEVATION/DEPTH BOTTOM OF SAND PACK: -10.03/ 15'

BACKFILL MATERIAL BELOW SAND:

ELEVATION/DEPTH OF HOLE: -10.03/ 15'

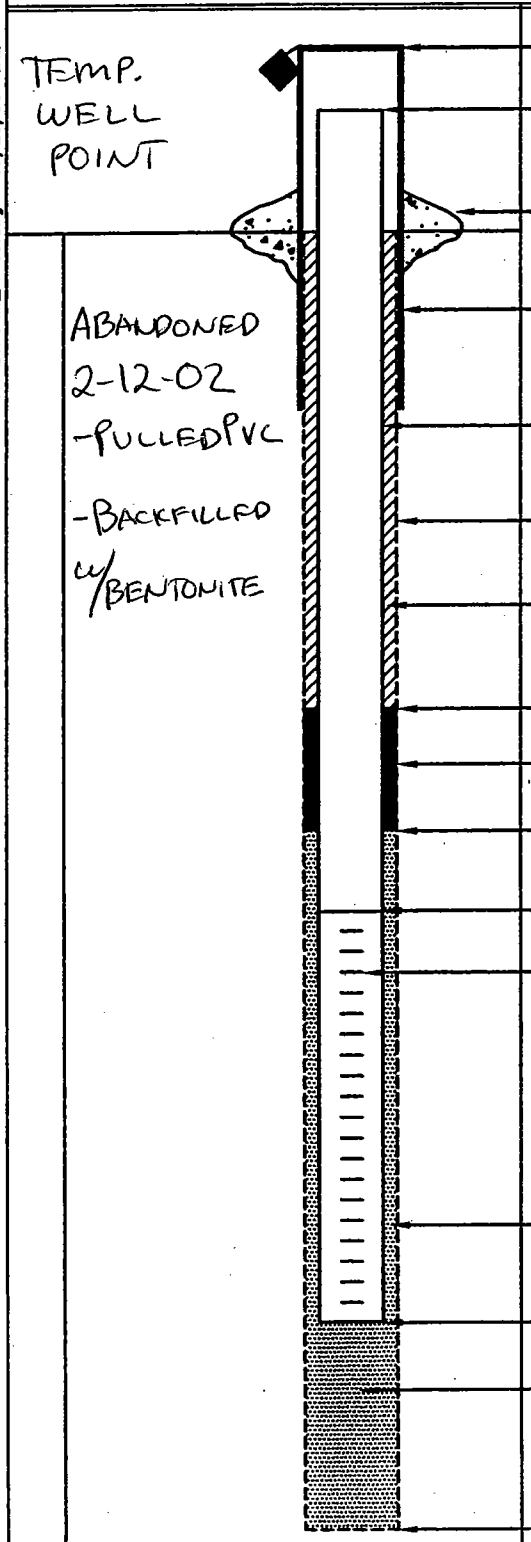
ACAD:FORM_MWSU.dwg 07/20/99 INL

WELL NO.: S37TW001

Tetra Tech NUS, Inc.

OVERBURDEN
MONITORING WELL SHEET
STICK-UP

PROJECT: SEVEN SITE INV	LOCATION: IHDIV STUMPNECK	DRILLER: AARON E.	
PROJECT NO.: 0525	BORING: S37TW001	DRILLING METHOD: HSA	
DATE BEGUN: 2-5-02	DATE COMPLETED: 2-5-02		
FIELD GEOLOGIST: FRED W. RAMSER		DEVELOPMENT METHOD: PUMP	
GROUND ELEVATION: 3.93	DATUM: NGVD 29		



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: NA / NA

ELEVATION/HEIGHT OF TOP OF RISER PIPE: 6.89 / 2.96

TYPE OF SURFACE SEAL: —

I.D. OF SURFACE CASING: —

TYPE OF SURFACE CASING:

RISER PIPE I.D.: 1"

TYPE OF RISER PIPE: PVC

BOREHOLE DIAMETER: 8"

TYPE OF BACKFILL: —

ELEVATION/DEPTH TOP OF SEAL: 3.93 / 0'

TYPE OF SEAL: BENTONITE 3/8" CHIPS

DEPTH TOP OF SAND PACK: 3'

ELEVATION/DEPTH TOP OF SCREEN: -1.07 / 5'

TYPE OF SCREEN: PVC

SLOT SIZE x LENGTH: .010 x 5'

I.D. OF SCREEN: 1"

TYPE OF SAND PACK: RICCI BROS #00N SILICA SAND

ELEVATION/DEPTH BOTTOM OF SCREEN: -6.07 / 10'

ELEVATION/DEPTH BOTTOM OF SAND PACK: -6.07 / 10'

BACKFILL MATERIAL BELOW SAND:

ELEVATION/DEPTH OF HOLE: -6.07 / 10'

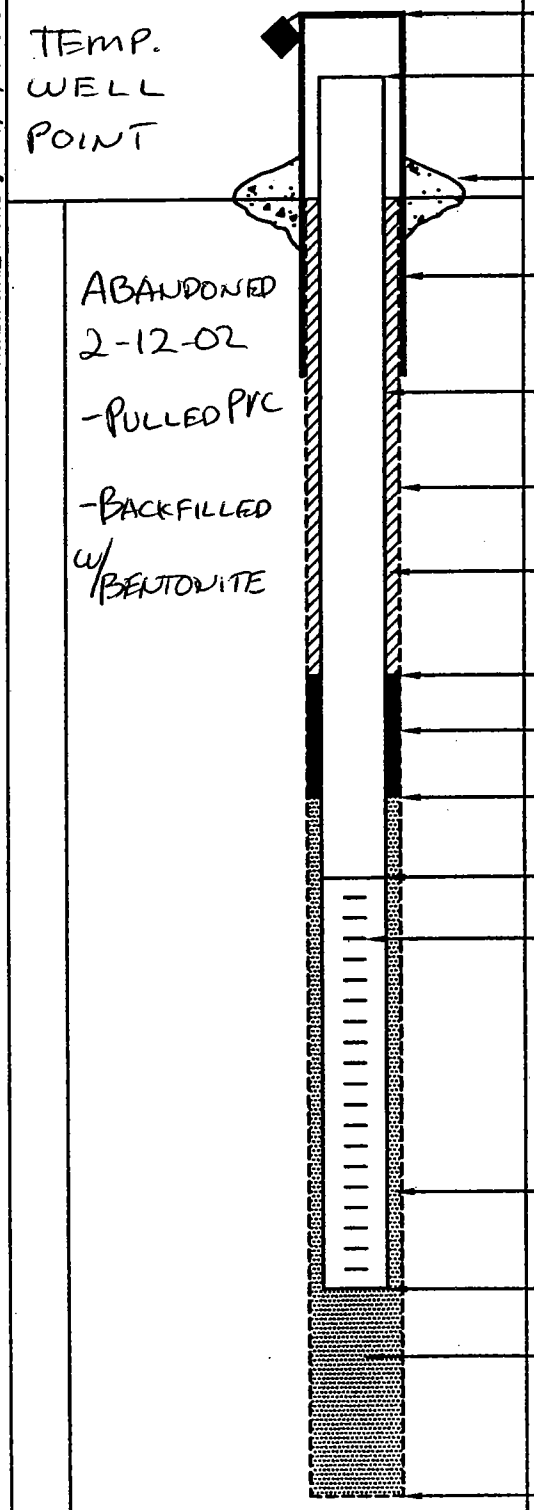
ACAD:FORM_MWSU.dwg 07/20/99 INL

WELL NO.: S37TW002

Tetra Tech NUS, Inc.

OVERBURDEN MONITORING WELL SHEET STICK-UP

PROJECT SEVEN SITE INV	LOCATION INDIV STUMPNECK	DRILLER AARON E.
PROJECT NO. 0525	BORING S37TW002	DRILLING METHOD HSA
DATE BEGUN 2-5-02	DATE COMPLETED 2-5-02	
FIELD GEOLOGIST FRED W RAMSER		DEVELOPMENT METHOD PUMP
GROUND ELEVATION 3.63	DATUM NGVD 29	



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: NA / NA

ELEVATION/HEIGHT OF TOP OF RISER PIPE: 6.24/2.61

TYPE OF SURFACE SEAL: —

I.D. OF SURFACE CASING: —

TYPE OF SURFACE CASING: —

RISER PIPE I.D.: 1"

TYPE OF RISER PIPE: PVC

BOREHOLE DIAMETER: 8"

TYPE OF BACKFILL: BENTONITE

ELEVATION/DEPTH TOP OF SEAL: 3.63/ 0'

TYPE OF SEAL: BENTONITE 3/8" CHIPS

DEPTH TOP OF SAND PACK: 0.63'/ 3'

ELEVATION/DEPTH TOP OF SCREEN: -1.37/ 5'

TYPE OF SCREEN: PVC

SLOT SIZE x LENGTH: .010 x 5'

I.D. OF SCREEN: 1"

TYPE OF SAND PACK: RICCI BROS #00N SILICA SAND

ELEVATION/DEPTH BOTTOM OF SCREEN: -6.37/ 10'

ELEVATION/DEPTH BOTTOM OF SAND PACK: -6.37/ 10'

BACKFILL MATERIAL BELOW SAND:

ELEVATION/DEPTH OF HOLE: -6.37/ 10'

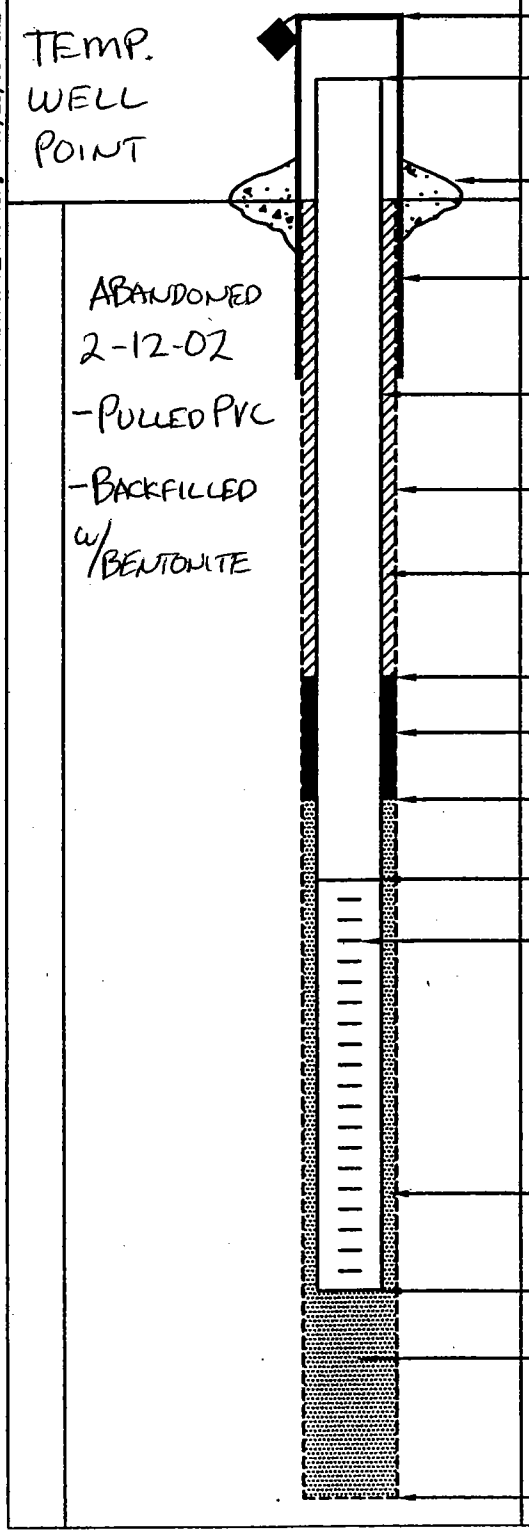
ACAD:FORM_MWSU.dwg 07/20/99 INL

WELL NO.: S37TW003

Tetra Tech NUS, Inc.

OVERBURDEN MONITORING WELL SHEET STICK-UP

PROJECT SEVEN SITE INV.	LOCATION IHDIV STUMPNECK	DRILLER AARON E.	
PROJECT NO. 0525	BORING S37TW003	DRILLING METHOD HSA	
DATE BEGUN 2-5-02	DATE COMPLETED 2-5-02		
FIELD GEOLOGIST FRED W RAMSER		DEVELOPMENT METHOD PUMP	
GROUND ELEVATION 4.21	DATUM NGVD 29		



ELEVATION/HEIGHT OF TOP OF SURFACE CASING: NA / NA

ELEVATION/HEIGHT OF TOP OF RISER PIPE: 6.98 / 2.77

TYPE OF SURFACE SEAL: —

I.D. OF SURFACE CASING: —

TYPE OF SURFACE CASING:

RISER PIPE I.D.: 1"

TYPE OF RISER PIPE: PVC

BOREHOLE DIAMETER: 8"

TYPE OF BACKFILL: BENTONITE

ELEVATION/DEPTH TOP OF SEAL: 4.21 / 0'

TYPE OF SEAL: BENTONITE 3/8" CHIPS

DEPTH TOP OF SAND PACK: 3'

ELEVATION/DEPTH TOP OF SCREEN: -0.79 / 5'

TYPE OF SCREEN: PVC

SLOT SIZE x LENGTH: .010 x 5'

I.D. OF SCREEN: 1"

TYPE OF SAND PACK: RICCI BROS #00N SILICA SAND

ELEVATION/DEPTH BOTTOM OF SCREEN: -5.79 / 10'

ELEVATION/DEPTH BOTTOM OF SAND PACK: -5.79 / 10'

BACKFILL MATERIAL BELOW SAND:

ELEVATION/DEPTH OF HOLE: -5.79 / 10'

ACAD:FORM_MWSU.dwg 07/20/99 INL

A.2 STATE OF MARYLAND WELL REPORTS AND ABANDONMENT REPORTS

APR-09-2002 11:05 Chesapeake Geosystems Inc 4107895029 P.02/15

U02393 (MDE USE ONLY)

1 2 3 6 (THIS NUMBER IS TO BE PUNCHED IN COLS. 3-6 ON ALL CARDS)

WELL COMPLETION REPORT

FILL IN THIS FORM COMPLETELY
PLEASE TYPE

COUNTY NUMBER 02-14500-W(M)

ST/CO USE ONLY DATE Received MM DD YY (8–13)

DATE WELL COMPLETED MM 02 DD 06 YY 02 (15–20)

Depth of Well (TO NEAREST FOOT) 22 30 26

PERMIT NO. FROM "PERMIT TO DRILL WELL" CH - 94 - 4453 (26 29 30 31 32 33 34 35 36 37)

OWNER Naval Surface Warfare Center (7th/29/11/6)

STREET OR RFD Indian Head Division (first name) TOWN Indian Head, MD 20640

SUBDIVISION ____ SECTION ____ LOT ____

WELL LOG

Not required for driven wells

STATE THE KIND OF FORMATIONS PENETRATED, THEIR COLOR, DEPTH, THICKNESS AND IF WATER BEARING

DESCRIPTION (Use additional sheets if needed)	FEET FROM	FEET TO	check if water bearing
Wet, Black & green, very soft clay	0	3	
Dry, Gray Meddence clay	3	8	
Moist, Tan, clay with some very fine sand	8	12	
Dry, Brown to Gray, clay	12	~~XX~~ 30	
water @ 6'			
S33TW001			
~~S33TW002~~			
S33TW003			

NUMBER OF UNSUCCESSFUL WELLS none

WELL HYDROFRACTURED yes Y no N

CIRCLE APPROPRIATE LETTER

- A A WELL WAS ABANDONED AND SEALED WHEN THIS WELL WAS COMPLETED
- E ELECTRIC LOG OBTAINED
- P TEST WELL CONVERTED TO PRODUCTION WELL

I HEREBY CERTIFY THAT THIS WELL HAS BEEN CONSTRUCTED IN ACCORDANCE WITH COMAR 26.04.04 "WELL CONSTRUCTION" AND IN CONFORMANCE WITH ALL CONDITIONS STATED IN THE ABOVE CAPTIONED PERMIT, AND THAT THE INFORMATION PRESENTED HEREIN IS ACCURATE AND COMPLETE TO THE BEST OF MY KNOWLEDGE.

DRILLERS LIC. NO. W 3 3 6

DRILLERS SIGNATURE (MUST MATCH SIGNATURE ON APPLICATION)

LIC. NO. ____ D ____

SITE SUPERVISOR (sign, if driller or journeyman responsible for sitework if different from permittee)

GROUTING RECORD

WELL HAS BEEN GROUTED (Circle Appropriate Box) yes X no N (44)

TYPE OF GROUTING MATERIAL (Circle one)

CEMENT CM (45 46) BENTONITE CLAY BC

NO. OF BAGS 12 NO. OF POUNDS (15–19) 1,128

GALLONS OF WATER 84

DEPTH OF GROUT SEAL (to nearest foot)

from 0 (48 TOP 52) ft. to 18 (54 BOTTOM 58) ft.

(enter 0 if from surface)

CASING RECORD

casing types insert appropriate code below

ST STEEL, CO CONCRETE, PL PLASTIC, OT OTHER

MAIN CASING TYPE	Nominal diameter top (main) casing (nearest inch)!	Total depth of main casing (nearest foot)
PL (60 61)	2 (63 64)	20 (66 70)

EACH CASING

OTHER CASING (if used)

	diameter inch	depth (feet) from	to

SCREEN RECORD

screen type or open hole insert appropriate code below

ST STEEL, BR BRASS BRONZE, PL PLASTIC, HO OPEN HOLE, OT OTHER

C 2 (1 2)

DEPTH (nearest ft.)

EACH SCREEN		from	to
1	PL (8 9)	20 (11–15)	30 (17–21)
2	(23 24)	(26–30)	(32–36)
3	(38 39)	(41–45)	(47–51)

SLOT SIZE 1 010 2 ____ 3 ____

DIAMETER OF SCREEN 2 (56 60) (NEAREST INCH)

GRAVEL PACK IF WELL DRILLED WAS FLOWING WELL INSERT F IN BOX 68

from	to
18	30

MDE USE ONLY (NOT TO BE FILLED IN BY DRILLER)

T (70) (E.R.O.S.) (72) W Q (74 75 76)

TELESCOPE CASING | LOG INDICATOR | OTHER DATA

C 3 (1 2) N/A

PUMPING TEST

HOURS PUMPED (nearest hour) (8 9)

PUMPING RATE (gal. per min.) (11–15)

METHOD USED TO MEASURE PUMPING RATE

WATER LEVEL (distance from land surface)

BEFORE PUMPING (17–20) ft.

WHEN PUMPING (22–25) ft.

TYPE OF PUMP USED (for test)

A air (27), P piston (27), T turbine (27), O other (describe below) (27) Monitoring

C centrifugal (27), R rotary (27), J jet (27), S submersible (27)

PUMP INSTALLED

DRILLER INSTALLED PUMP (CIRCLE) (YES or NO) YES (NO)

IF DRILLER INSTALLS PUMP, THIS SECTION MUST BE COMPLETED FOR ALL WELLS.

TYPE OF PUMP INSTALLED PLACE (A,C,J,P,R,S,T,O) IN BOX 29. (29)

CAPACITY: GALLONS PER MINUTE (to nearest gallon) (31–35)

PUMP HORSE POWER (37–41)

PUMP COLUMN LENGTH (nearest ft.) (43–47)

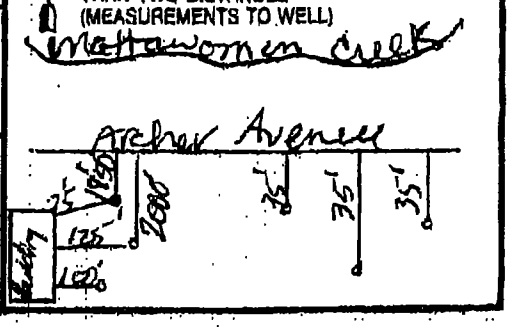
CASING HEIGHT (circle appropriate box and enter casing height)

+ above, – below (48) LAND SURFACE

2 (nearest foot) (50 51)

LOCATION OF WELL ON LOT

SHOW PERMANENT STRUCTURE SUCH AS BUILDING, SEPTIC TANKS, AND /OR LANDMARKS AND INDICATE NOT LESS THAN TWO DISTANCES (MEASUREMENTS TO WELL)



STATE

C 1 | 06292 (MDE USE ONLY)

(THIS NUMBER IS TO BE PUNCHED IN COLS. 3-6 ON ALL CARDS)

WELL COMPLETION REPORT

FILL IN THIS FORM COMPLETELY
PLEASE TYPE

45 DAYS AFTER WELL IS COMPLETED.

COUNTY NUMBER 02-15402-W(M)

ST/CO USE ONLY
DATE Received MM DD YY

DATE WELL COMPLETED MM 02 DD 05 YY 02

Depth of Well 10 (TO NEAREST FOOT)

PERMIT NO. FROM "PERMIT TO DRILL WELL" CH 04 4452

OWNER Naval Surface Warfare Center (7th/2911/6)
STREET OR RFD Indian Head Division TOWN Indian Head, MD 20640
SUBDIVISION SECTION LOT

WELL LOG

Not required for driven wells

STATE THE KIND OF FORMATIONS PENETRATED, THEIR COLOR, DEPTH, THICKNESS AND IF WATER BEARING

DESCRIPTION (Use additional sheets if needed)	FEET FROM	FEET TO	check if water bearing
Wet, Blanck and green very soft clay	0	3	
Dry, Gray Meddence Clay	3	8	
Moist, Tan Clay with some very fine sands	8	10	
water @ 6'			
S34TW001			
S34TW002			
S34TW003			
S37TW001			
S37TW002			
S37TW003			

NUMBER OF UNSUCCESSFUL WELLS: none

WELL HYDROFRACTURED Y N

CIRCLE APPROPRIATE LETTER
- A A WELL WAS ABANDONED AND SEALED WHEN THIS WELL WAS COMPLETED
- E ELECTRIC LOG OBTAINED
- P TEST WELL CONVERTED TO PRODUCTION WELL

I HEREBY CERTIFY THAT THIS WELL HAS BEEN CONSTRUCTED IN ACCORDANCE WITH COMAR 26.04.04 "WELL CONSTRUCTION" AND IN CONFORMANCE WITH ALL CONDITIONS STATED IN THE ABOVE CAPTIONED PERMIT, AND THAT THE INFORMATION PRESENTED HEREIN IS ACCURATE AND COMPLETE TO THE BEST OF MY KNOWLEDGE.

DRILLERS LIC NO MD W 3 36

DRILLERS SIGNATURE
(MUST MATCH SIGNATURE ON APPLICATION)

LIC. NO.: D

SITE SUPERVISOR (sign. of driller or journeyman responsible for sitework if different from permittee)

GROUTING RECORD

WELL HAS BEEN GROUTED (Circle Appropriate Box) Y N

TYPE OF GROUTING MATERIAL (Circle one)
CEMENT (CM) BENTONITE CLAY (BC)
NO. OF BAGS 6 NO. OF POUNDS 564
GALLONS OF WATER 36

DEPTH OF GROUT SEAL (to nearest foot)
from 0 ft. TOP to 3 ft. BOTTOM
(enter 0 if from surface)

CASING RECORD

casing types insert appropriate code below

ST STEEL CO CONCRETE PL PLASTIC OT OTHER

MAIN CASING TYPE	Nominal diameter top (main) casing (nearest inch)	Total depth of main casing (nearest foot)
PL	2	5

OTHER CASING (if used)

EACH CASING	diameter inch	depth (feet) from	to

SCREEN RECORD

screen type or open hole insert appropriate code below

ST STEEL BR BRASS BRONZE PL PLASTIC HO OPEN HOLE OT OTHER

EACH SCREEN	TYPE	DEPTH (nearest ft.) from	to
1	PL	5	10
2			
3			

SLOT SIZE 1 010 2 3

DIAMETER OF SCREEN X 1 (NEAREST INCH)

GRAVEL PACK from 3 to 10
IF WELL DRILLED WAS FLOWING WELL INSERT F IN BOX 88

MDE USE ONLY
(NOT TO BE FILLED IN BY DRILLER)
T (E.R.O.S.) W Q

TELESCOPE CASING | LOG INDICATOR | OTHER DATA

C 3 N/A

PUMPING TEST

HOURS PUMPED (nearest hour)

PUMPING RATE (gal. per min.)

METHOD USED TO MEASURE PUMPING RATE

WATER LEVEL (distance from land surface)

BEFORE PUMPING ft.

WHEN PUMPING ft.

TYPE OF PUMP USED (for test)
A air P piston T turbine C centrifugal R rotary O other (describe below) J jet S submersible Monitoring

PUMP INSTALLED

DRILLER INSTALLED PUMP (CIRCLE) (YES or NO) YES (NO)

IF DRILLER INSTALLS PUMP, THIS SECTION MUST BE COMPLETED FOR ALL WELLS.

TYPE OF PUMP INSTALLED PLACE (A,C,J,P,R,S,T,O) IN BOX 29.

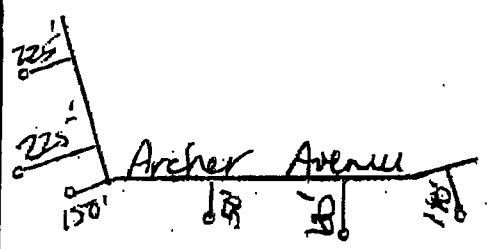
CAPACITY: GALLONS PER MINUTE (to nearest gallon)

PUMP HORSE POWER

PUMP COLUMN LENGTH (nearest ft.)

CASING HEIGHT (circle appropriate box and enter casing height)
(+) above LAND SURFACE
(–) below
2 (nearest foot)

LOCATION OF WELL ON LOT
SHOW PERMANENT STRUCTURE SUCH AS BUILDING, SEPTIC TANKS, AND /OR LANDMARKS AND INDICATE NOT LESS THAN TWO DISTANCES (MEASUREMENTS TO WELL)



MARYLAND DEPARTMENT OF THE ENVIRONMENT, WATER MANAGEMENT ADMINISTRATION
2500 BROENING HIGHWAY, BALTIMORE, MARYLAND 21224, (410) 631-3784

WATER WELL ABANDONMENT-SEALING REPORT FORM

SUBMIT COPIES OF COMPLETED FORM TO:
* COUNTY ENVIRONMENT AGENCY (contact MDE, WMA if address needed)
* WELL OWNER
* MDE, WATER MANAGEMENT ADMINISTRATION, WELL PROGRAM

DATE WELL ABANDONED: 02/13/2002 (month/day/year)

* PERMIT NUMBER OF ABANDONED WELL (if any) CH — 94 — 4452

* PERMIT NUMBER OF REPLACEMENT WELL — —

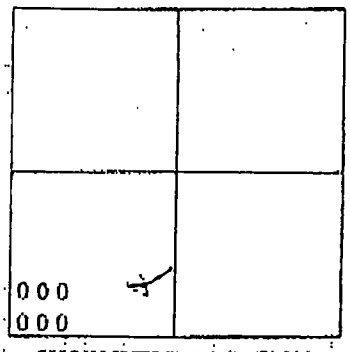
* PERSON ABANDONING WELL: A. Eichelberger

WELL DRILLERS LICENSE NUMBER: AWD 709
CIRCLE: MWD/MSD/MGD

* OWNER'S NAME: Naval Surface Warfare Center

* WELL LOCATION:
COUNTY: Charles
NEAREST TOWN: Indian Head
TAX MAP ____ BLOCK ____ PARCEL ____
SUBDIVISION: ____
SECTION: ____ LOT: ____
NEAREST ROAD: Archer Road

MARYLAND GRID COORDINATES
BOX NUMBER
E 740
N 262



SHOW WELL LOCATION BY X WITHIN BOX

* TYPE OF WELL BEING ABANDONED:

____ DRILLED ____ JETTED
X BORED/AUGUERED ____ HAND DUG
____ OTHER (specify) ____

USE CODE:

____ DOMESTIC ____ MUNICIPAL/PUBLIC
____ IRRIGATION ____ INDUSTRIAL
X TEST/OBSERVATION

TYPE OF CASING:

____ STEEL X PLASTIC
____ CONCRETE ____ OTHER (specify)

SIZE OF CASING: 1 INCHES IN DIAMETER

DEPTH OF WELL: 10 FEET DEEP

WAS ANY CASING REMOVED? X YES ____ NO
if yes, length removed, in feet: 10

WAS CASING RIPPED OR PERFORATED? ____ YES X NO

LOG OF SEALING MATERIAL

MATERIAL	FEET FROM	FEET TO
Bentonite Slurry	0	10

Michael W. Huber 336 MWD/MSD/MGD
SIGNATURE-MASTER WELL DRILLER OR SUPERVISING SANITARIAN LICENSE # CIRCLE ONE DATE

MARYLAND DEPARTMENT OF THE ENVIRONMENT, WATER MANAGEMENT ADMINISTRATION
2500 BROENING HIGHWAY, BALTIMORE, MARYLAND 21224, (410) 631-3784

****

WATER WELL ABANDONMENT-SEALING REPORT FORM

****

SUBMIT COPIES OF COMPLETED FORM TO:
* COUNTY ENVIRONMENT AGENCY (contact MDE, WMA if address needed)
* WELL OWNER
* MDE, WATER MANAGEMENT ADMINISTRATION, WELL PROGRAM

DATE WELL ABANDONED: 02/13/2002 (month/day/year)

* PERMIT NUMBER OF ABANDONED WELL (if any) CH — 94 — 4452

* PERMIT NUMBER OF REPLACEMENT WELL — —

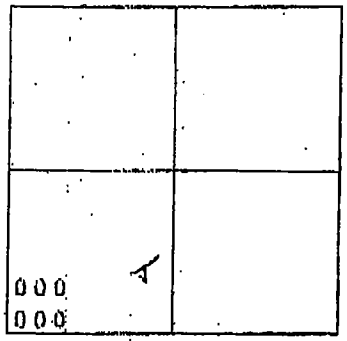
* PERSON ABANDONING WELL: A. Eichelberger

WELL DRILLERS LICENSE NUMBER: AWD 709
CIRCLE: MWD/MSD/MGD

* OWNER'S NAME: Naval Surface Warfare Center

* WELL LOCATION:
COUNTY: Charels
NEAREST TOWN: Indian Head
TAX MAP ____ BLOCK ____ PARCEL ____
SUBDIVISION: ____
SECTION: ____ LOT: ____
NEAREST ROAD: Archer Road

MARYLAND GRID COORDINATES
BOX NUMBER
E 740
N 262



SHOW WELL LOCATION BY X WITHIN BOX

* TYPE OF WELL BEING ABANDONED:

____ DRILLED ____ JETTED
X BORED/AUGUERED ____ HAND DUG
____ OTHER (specify) ____

* USE CODE:

____ DOMESTIC ____ MUNICIPAL/PUBLIC
____ IRRIGATION ____ INDUSTRIAL
X TEST/OBSERVATION

* TYPE OF CASING:

____ STEEL X PLASTIC
____ CONCRETE ____ OTHER (specify)
____

* SIZE OF CASING: 1 INCHES IN DIAMETER

* DEPTH OF WELL: 10 FEET DEEP

* WAS ANY CASING REMOVED? X YES ____ NO
if yes, length removed, in feet: 10

* WAS CASING RIPPED OR PERFORATED? ____ YES X NO

LOG OF SEALING MATERIAL

MATERIAL	FEET FROM	FEET TO
Bentonite Slurry	0	10

Mark W. Weber 336 MWD/MSD/MGD
SIGNATURE-MASTER WELL DRILLER OR SUPERVISING SANITARIAN LICENSE # CIRCLE ONE DATE

MARYLAND DEPARTMENT OF THE ENVIRONMENT, WATER MANAGEMENT ADMINISTRATION
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* PERMIT NUMBER OF ABANDONED WELL (if any) CH — 94 — 4452

* PERMIT NUMBER OF REPLACEMENT WELL ____ — ____

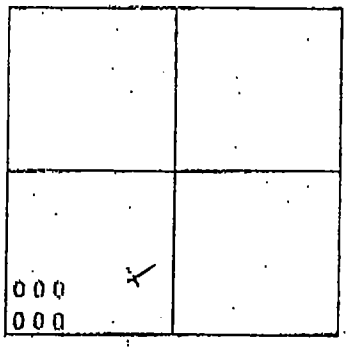
* PERSON ABANDONING WELL: A. Eichelberger

WELL DRILLERS LICENSE NUMBER: ____
CIRCLE: MWD/MSD/MGD

* OWNER'S NAME: Naval Surface Warfare Center

* WELL LOCATION:
COUNTY: Charels
NEAREST TOWN: Indian Head
TAX MAP ____ BLOCK ____ PARCEL ____
SUBDIVISION: ____
SECTION: ____ LOT: ____
NEAREST ROAD: Archer Road

MARYLAND GRID COORDINATES
E 740
BOX NUMBER <——
N 262



SHOW WELL LOCATION
BY X WITHIN BOX

* TYPE OF WELL BEING ABANDONED:

____ DRILLED ____ JETTED
X BORED/AUGUERED ____ HAND DUG
____ OTHER (specify) ____

* USE CODE:

____ DOMESTIC ____ MUNICIPAL/PUBLIC
____ IRRIGATION ____ INDUSTRIAL
X TEST/OBSERVATION

* TYPE OF CASING:

____ STEEL X PLASTIC
____ CONCRETE ____ OTHER (specify)
____

SIZE OF CASING: 1 INCHES IN DIAMETER

DEPTH OF WELL: 10 FEET DEEP

WAS ANY CASING REMOVED? X YES ____ NO
if yes, length removed, in feet: 10

WAS CASING RIPPED OR PERFORATED? ____ YES X NO

LOG OF SEALING MATERIAL

MATERIAL	FEET	
	FROM	TO
Bentonite Slurry	0	10

Michael W. Kibler 336 MWD/MSD/MGD
SIGNATURE-MASTER WELL DRILLER OR SUPERVISING SANITARIAN LICENSE # CIRCLE ONE DATE

MARYLAND DEPARTMENT OF THE ENVIRONMENT, WATER MANAGEMENT ADMINISTRATION
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* PERMIT NUMBER OF ABANDONED WELL (if any) CH — 94 — 4452

* PERMIT NUMBER OF REPLACEMENT WELL — —

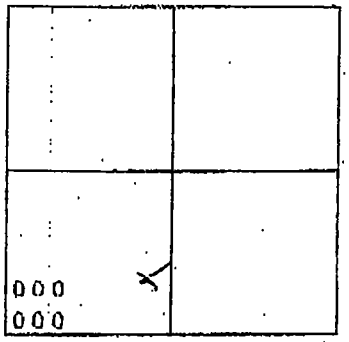
* PERSON ABANDONING WELL: A. Eichelberger WELL DRILLERS LICENSE NUMBER: AWD 709

CIRCLE: MWD/MSD/MGD

* OWNER'S NAME: Naval Surface Warfare Center

* WELL LOCATION:
COUNTY: Charles
NEAREST TOWN: Indian Head
TAX MAP _____ BLOCK _____ PARCEL _____
SUBDIVISION: _____
SECTION: _____ LOT: _____
NEAREST ROAD: Archer Raod

MARYLAND GRID COORDINATES
E 740
BOX NUMBER
N 262



SHOW WELL LOCATION BY X WITHIN BOX

* TYPE OF WELL BEING ABANDONED:

_____ DRILLED _____ JETTED
__X__ BORED/AUGUERED _____ HAND DUG
_____ OTHER (specify) _____

* USE CODE:

_____ DOMESTIC _____ MUNICIPAL/PUBLIC
_____ IRRIGATION _____ INDUSTRIAL
__X__ TEST/OBSERVATION

* TYPE OF CASING:

_____ STEEL __X__ PLASTIC
_____ CONCRETE _____ OTHER (specify)

SIZE OF CASING: 1 INCHES IN DIAMETER

DEPTH OF WELL: 15 FEET DEEP

WAS ANY CASING REMOVED? X YES _____ NO
if yes, length removed, in feet: 15

WAS CASING RIPPED OR PERFORATED? _____ YES X NO

LOG OF SEALING MATERIAL

MATERIAL	FEET	
	FROM	TO
Bentonite Slurry	0	15

Michael W. Eichelberger 336 MWD/MSD/MGD
SIGNATURE-MASTER WELL DRILLER OR SUPERVISING SANITARIAN LICENSE # CIRCLE ONE DATE

MARYLAND DEPARTMENT OF THE ENVIRONMENT, WATER MANAGEMENT ADMINISTRATION
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WATER WELL ABANDONMENT-SEALING REPORT FORM

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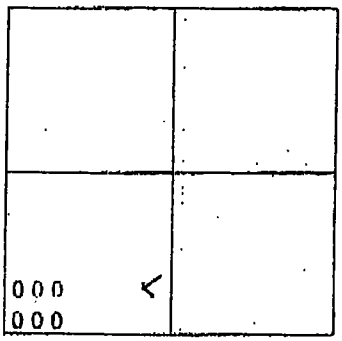
DATE WELL ABANDONED: 02/15/2002 (month/day/year)

* PERMIT NUMBER OF ABANDONED WELL (if any) CH — 94 — 4452
* PERMIT NUMBER OF REPLACEMENT WELL — —
* PERSON ABANDONING WELL: A. Eichelberger
WELL DRILLERS LICENSE NUMBER: AWD 709
CIRCLE: MWD/MSD/MGD
* OWNER'S NAME: Naval Surface Warfare Center
* WELL LOCATION:
COUNTY: Charles
NEAREST TOWN: Indian Head
TAX MAP ____ BLOCK ____ PARCEL ____
SUBDIVISION: ____
SECTION: ____ LOT: ____
NEAREST ROAD: Archer Road

MARYLAND GRID COORDINATES
BOX NUMBER
E 740
N 262



SHOW WELL LOCATION BY X WITHIN BOX

TYPE OF WELL BEING ABANDONED:

____ DRILLED ____ JETTED
X BORED/AUGUERED ____ HAND DUG
____ OTHER (specify) ____

USE CODE:

____ DOMESTIC ____ MUNICIPAL/PUBLIC
____ IRRIGATION ____ INDUSTRIAL
X TEST/OBSERVATION

TYPE OF CASING:

____ STEEL X PLASTIC
____ CONCRETE ____ OTHER (specify)

SIZE OF CASING: 1 INCHES IN DIAMETER

DEPTH OF WELL: 9 FEET DEEP

WAS ANY CASING REMOVED? X YES ____ NO
if yes, length removed, in feet: 9

WAS CASING RIPPED OR PERFORATED? ____ YES X NO

LOG OF SEALING MATERIAL

MATERIAL	FEET FROM	FEET TO
Bentonite Slurry	0	9

Michael W. Kluber 336 MWD/MSD/MGD
SIGNATURE-MASTER WELL DRILLER OR SUPERVISING SANITARIAN LICENSE # CIRCLE ONE DATE

MARYLAND DEPARTMENT OF THE ENVIRONMENT, WATER MANAGEMENT ADMINISTRATION
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WATER WELL ABANDONMENT-SEALING REPORT FORM

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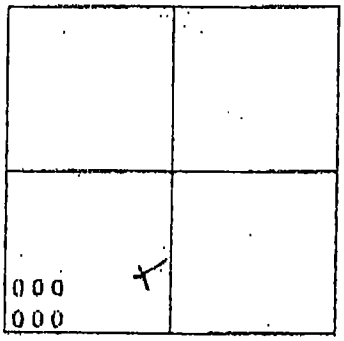
- PERMIT NUMBER OF ABANDONED WELL (if any): CH — 94 — 4452
- PERMIT NUMBER OF REPLACEMENT WELL: — —
- PERSON ABANDONING WELL: A. Eichelberger
- WELL DRILLERS LICENSE NUMBER: AWD 709
  CIRCLE: MWD/MSD/MGD
- OWNER'S NAME: Naval Surface Warfare Center
- WELL LOCATION:
  COUNTY: Charles
  NEAREST TOWN: Indian Head
  TAX MAP _____ BLOCK _____ PARCEL _____
  SUBDIVISION: _____
  SECTION: _____ LOT: _____
  NEAREST ROAD: Archer Road

MARYLAND GRID COORDINATES
BOX NUMBER
E 740
N 262



SHOW WELL LOCATION BY X WITHIN BOX

TYPE OF WELL BEING ABANDONED:

_____ DRILLED _____ JETTED
X BORED/AUGUERED _____ HAND DUG
_____ OTHER (specify) _____

USE CODE:

_____ DOMESTIC _____ MUNICIPAL/PUBLIC
_____ IRRIGATION _____ INDUSTRIAL
X TEST/OBSERVATION

TYPE OF CASING:

_____ STEEL X PLASTIC
_____ CONCRETE _____ OTHER (specify)

SIZE OF CASING: 1 INCHES IN DIAMETER

DEPTH OF WELL: 9 FEET DEEP

WAS ANY CASING REMOVED? X YES _____ NO
if yes, length removed, in feet: 9

WAS CASING RIPPED OR PERFORATED? _____ YES X NO

LOG OF SEALING MATERIAL

MATERIAL	FEET	
	FROM	TO
Bentonite Slurry	0	9

Michael W. Kibler 336 MWD/MSD/MGD
SIGNATURE MASTER WELL DRILLER OR SUPERVISING SANITARIAN LICENSE # CIRCLE ONE DATE

MARYLAND DEPARTMENT OF THE ENVIRONMENT, WATER MANAGEMENT ADMINISTRATION
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WATER WELL ABANDONMENT-SEALING REPORT FORM

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DATE WELL ABANDONED: 02/14/2002 (month/day/year)

* PERMIT NUMBER OF ABANDONED WELL (if any) CH — 94 — 4453

* PERMIT NUMBER OF REPLACEMENT WELL — —

* PERSON ABANDONING WELL: A. Eichelberger

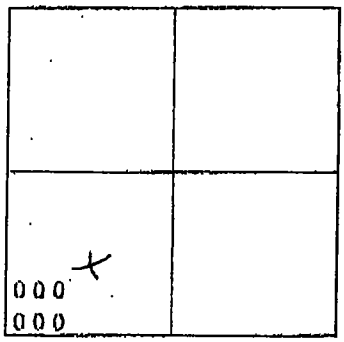
WELL DRILLERS LICENSE NUMBER: AWD 709

CIRCLE: MWD/MSD/MGD

* OWNER'S NAME: Naval Surface Warfare Center

* WELL LOCATION:
COUNTY: Charles
NEAREST TOWN: Indian Head
TAX MAP _____ BLOCK _____ PARCEL _____
SUBDIVISION: _____
SECTION: _____ LOT: _____
NEAREST ROAD: Archer Road

MARYLAND GRID COORDINATES
BOX NUMBER
E 740
N 262



SHOW WELL LOCATION BY X WITHIN BOX

* TYPE OF WELL BEING ABANDONED:

_____ DRILLED _____ JETTED
X BORED/AUGUERED _____ HAND DUG
_____ OTHER (specify) _____

* USE CODE:

_____ DOMESTIC _____ MUNICIPAL/PUBLIC
_____ IRRIGATION _____ INDUSTRIAL
X TEST/OBSERVATION

* TYPE OF CASING:

_____ STEEL X PLASTIC
_____ CONCRETE _____ OTHER (specify)

SIZE OF CASING: 1 INCHES IN DIAMETER

DEPTH OF WELL: 28 FEET DEEP

WAS ANY CASING REMOVED? X YES _____ NO
if yes, length removed, in feet: 28

WAS CASING RIPPED OR PERFORATED? ____ YES X NO

LOG OF SEALING MATERIAL

MATERIAL	FEET	
	FROM	TO
Bentonite Slurry	0	28

IGNATURE-MASTER WELL DRILLER OR SUPERVISING SANITARIAN LICENSE # 336 CIRCLE ONE MWD/MSD/MGD DATE

MARYLAND DEPARTMENT OF THE ENVIRONMENT, WATER MANAGEMENT ADMINISTRATION
2500 BROENING HIGHWAY, BALTIMORE, MARYLAND 21224, (410) 631-3784

****

WATER WELL ABANDONMENT-SEALING REPORT FORM

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* PERMIT NUMBER OF ABANDONED WELL (if any) CH — 94 — 4453

* PERMIT NUMBER OF REPLACEMENT WELL — —

* PERSON ABANDONING WELL: A. Eichelberger

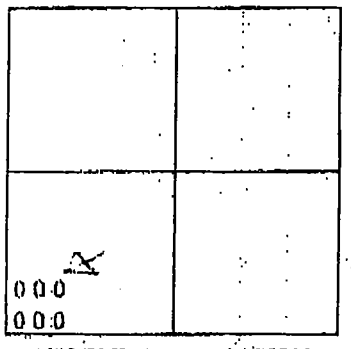
WELL DRILLERS LICENSE NUMBER: AWD 709

CIRCLE: MWD/MSD/MGD

* OWNER'S NAME: Naval Surface Warfare Center

* WELL LOCATION:
COUNTY: Charles
NEAREST TOWN: Indian Head
TAX MAP _____ BLOCK _____ PARCEL _____
SUBDIVISION: _____
SECTION: _____ LOT: _____
NEAREST ROAD: Archer Road

MARYLAND GRID COORDINATES
E 740
BOX NUMBER <———
N 262



SHOW WELL LOCATION BY X WITHIN BOX

* TYPE OF WELL BEING ABANDONED:

_____ DRILLED _____ JETTED
__X__ BORED/AUGUERED _____ HAND DUG
_____ OTHER (specify) _____

* USE CODE:

_____ DOMESTIC _____ MUNICIPAL/PUBLIC
_____ IRRIGATION _____ INDUSTRIAL
__X__ TEST/OBSERVATION

* TYPE OF CASING:

_____ STEEL __X__ PLASTIC
_____ CONCRETE _____ OTHER (specify)
_____

* SIZE OF CASING: 1 INCHES IN DIAMETER

* DEPTH OF WELL: 28 FEET DEEP

* WAS ANY CASING REMOVED? X YES _____ NO
if yes, length removed, in feet: 28

* WAS CASING RIPPED OR PERFORATED? ___ YES X NO

LOG OF SEALING MATERIAL

MATERIAL	FEET FROM	FEET TO
Bentonite Slurry	0	28

Mitchell W. Kuhn 336 MWD/MSD/MGD

SIGNATURE-MASTER WELL DRILLER OR SUPERVISING SANITARIAN LICENSE # CIRCLE ONE DATE

MARYLAND DEPARTMENT OF THE ENVIRONMENT, WATER MANAGEMENT ADMINISTRATION
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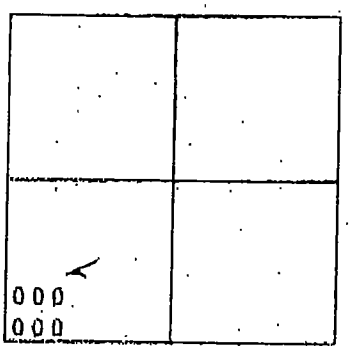
* PERMIT NUMBER OF ABANDONED WELL (if any) CH — 94 — 4453
* PERMIT NUMBER OF REPLACEMENT WELL — —
* PERSON ABANDONING WELL: A. Eichelberger
WELL DRILLERS LICENSE NUMBER: AWD 709
CIRCLE: MWD/MSD/MGD
* OWNER'S NAME: Naval Surface Warfare Center
* WELL LOCATION:
COUNTY: Charles
NEAREST TOWN: Indian Head
TAX MAP _____ BLOCK _____ PARCEL _____
SUBDIVISION: _____
SECTION: _____ LOT: _____
NEAREST ROAD: Archer Road

MARYLAND GRID COORDINATES
BOX NUMBER
E 740
N 262



SHOW WELL LOCATION BY X WITHIN BOX

* TYPE OF WELL BEING ABANDONED:

_____ DRILLED _____ JETTED
X BORED/AUGUERED _____ HAND DUG
_____ OTHER (specify) _____

USE CODE:

_____ DOMESTIC _____ MUNICIPAL/PUBLIC
_____ IRRIGATION _____ INDUSTRIAL
X TEST/OBSERVATION

TYPE OF CASING:

_____ STEEL X PLASTIC
_____ CONCRETE _____ OTHER (specify)
_____

SIZE OF CASING: 1 INCHES IN DIAMETER

DEPTH OF WELL: 30 FEET DEEP

WAS ANY CASING REMOVED? X YES _____ NO
if yes, length removed, in feet: 30

WAS CASING RIPPED OR PERFORATED? _____ YES X NO

LOG OF SEALING MATERIAL

MATERIAL	FEET FROM	FEET TO
Bentonite Slurry	0	30

Michael W. Kline 336 (MWD)/MSD/MGD
SIGNATURE OF MASTER WELL DRILLER OR SUPERVISING SANITARIAN LICENSE # CIRCLE ONE DATE

APPENDIX B

TEST PIT AND SOIL BORING LOGS

B.1 Test Pit Logs
B.2 Soil Boring Logs

B.1 TEST PIT LOGS

TEST PIT LOG

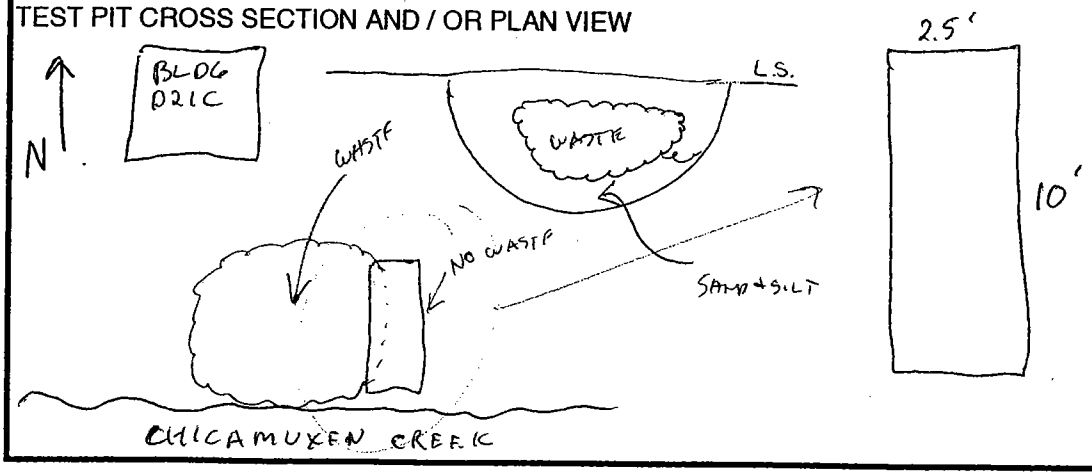
Tetra Tech NUS, Inc.

Page ___ of ___

PROJECT NAME: SEVEN SITES SCREENING INV. TEST PIT No.: S34TP001
PROJECT NUMBER: 0525 DATE: 1-30-02
LOCATION: INDIAN HEAD NSWC (STUMP NECK) GEOLOGIST: FRED W RAMSER

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READING: Source (ppm)	PID/FID READING: BZ (ppm)
1		YEL BRN SAND + SILT	SM		0	0
2		↓	↓			
3		↓	↓			
4		ENCOUNTER METAL DEBRIS @ 3'		-GREEN OXIDIZED TOOLS AND		
5		COLLECTED SAMPLES		FE TOOLS		
6		@ 4-4.5' ABUNDANT		COPPER WIRE MISC WASTE		
7		WASTE FOUND TO DEPTH H_2O @ 4.5		PLASTIC		
8		-5' BELOW GS WITHIN SILTY SAND	SM	OUT OFF		
		W/TR CLAY.		WASTE @ 7' BGS		
		SOME H_2O WITH IN THE				
		WASTE, SAND + SILT WET 7-8'				
		LOOKS NATURAL				
		NO WASTE ON THE				
		EAST WALL OF				
		TEST PIT				

TEST PIT CROSS SECTION AND / OR PLAN VIEW



REMARKS: STOPPED DIGGING DEBRIS MAY BE SOME TYPE OF ORDINANCE JACK MYER ARR AT SITE SAYS OK TO CONTINUE DIG.

PHOTO LOG: NONE

TEST PIT LOG

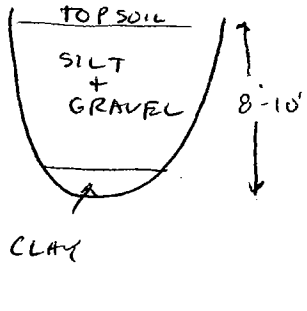
Page ___ of ___

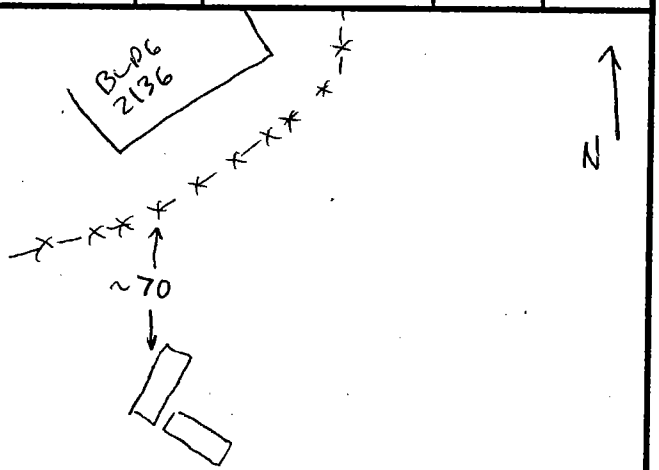
Tetra Tech NUS, Inc.

PROJECT NAME: SEVEN SITE SCREENING
PROJECT NUMBER: 0525
LOCATION: IHDIV STUMPNECK
TEST PIT No.: S33TP001
DATE: 2-11-02
GEOLOGIST: FRED W RAMSER

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READING: Source (ppm)	PID/FID READING: BZ (ppm)
1		DK BRN SILT + SAND (TOPSOIL)	OL/SC			
2		MED YEL BRN SILT, SAND	GM			
3		+ GRAVEL	GM	LARGE GRAVELS		
4		CLAY CONTENT INC		≤ 15cm dia		
5		DOWNWARD	GC	WELL ROUNDED		
6			↓	TO SUBRD.		
7						
8						
9		GREY CLAY MOTTLED YEL	CL			
10		BRN, GREENISH GREY				
		+ LARGE DIAMETER				
		REBAR ~ 6"-1' BELOW				
		GROUND SURFACE				
		~ 40' LONG				

TEST PIT CROSS SECTION AND / OR PLAN VIEW
(BOTH TEST PITS)





REMARKS: EXCAVATED AT LARGE MAG ANOMALY AS PER GEOPHYSICAL SURVEY. NO WASTE FOUND. DECIDED TO DIG ANOTHER PIT PERPINDICULAR TO THE 1ST TOWARD NORTH

PHOTO LOG: NONE

TEST PIT LOG

Page ___ of ___

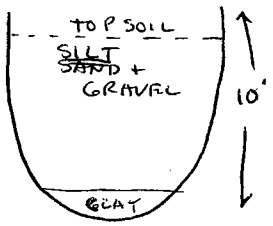
Tetra Tech NUS, Inc.

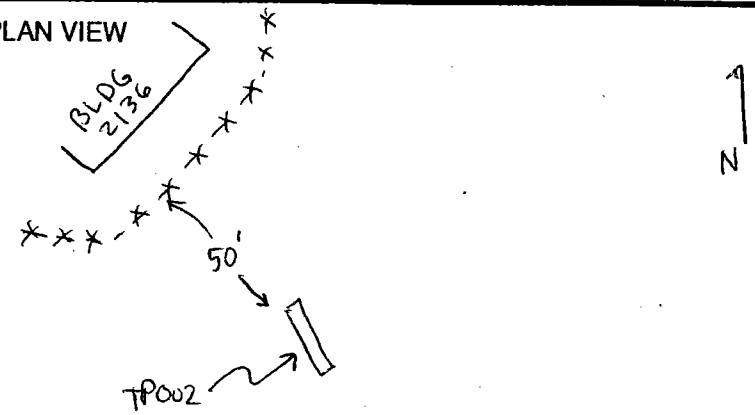
PROJECT NAME: SEVEN SITE SCREENING TEST PIT No.: S33TP002
PROJECT NUMBER: 0525 DATE: 2-11-02, 2-12-02
LOCATION: IHDIV STUMPNECK GEOLOGIST: FRED W. RAMSER

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READING: Source (ppm)	PID/FID READING: BZ (ppm)
1		DK BRN TOP SOIL	OL/SC			
2		MED BRN TO YEL BRN SILT,	↓			
3		SAND + GRAVEL TR CLAY	GM	LARGE GRAVELS		
4		MOSTLY SILT + GRAVEL	↓	≤ 15cm dia		
5		INC CLAY CONT. DRY	GC	Well Rounded		
6		↓	↓	TO SUB ROUNDED		
7		GRAVELLY CLAY		NO WASTE		
8		↓	↓	↓		
9		↓	↓	↓		
10		GREENISH GREY CLAY + SILT	CL	MOIST		

TEST PIT CROSS SECTION AND / OR PLAN VIEW

4' x 2' x 10'





REMARKS: EXCAVATED AT SMALL MAG. ANOMALLY AS PER GEOPHYSICAL SURVEY NO WASTE FOUND. HYDRAULIC LINE BROKE RIG DOWN

PHOTO LOG: NONE

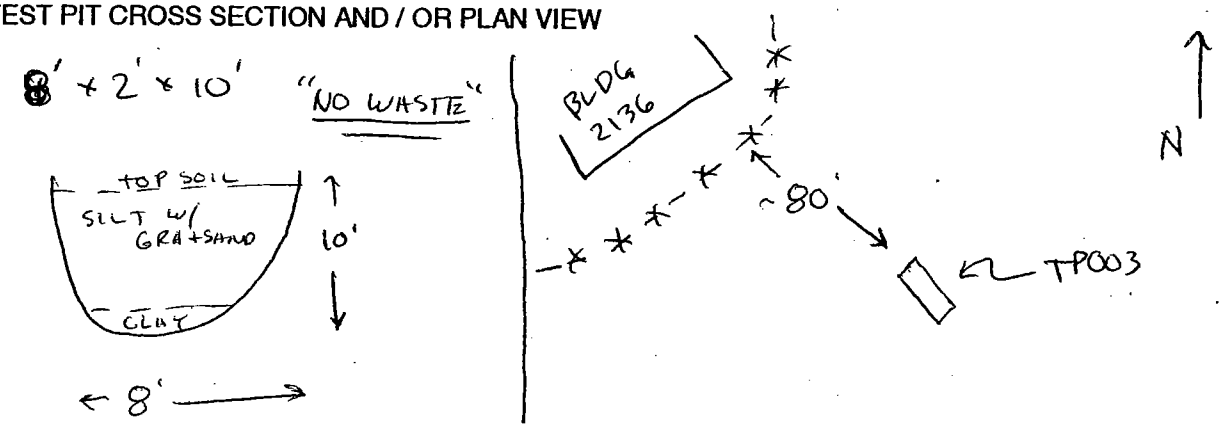
Tetra Tech NUS, Inc.

TEST PIT LOG

PROJECT NAME: SEVEN SITE SCREENING TEST PIT No.: S33TP003
PROJECT NUMBER: 0525 DATE: 2-12-02
LOCATION: IHDIV STUMPNECK GEOLOGIST: FRED W. RAMSER

Depth (Ft.)	Lithology Change (Depth/Ft.)	MATERIAL DESCRIPTION: Soil/Waste Characteristics (lithology, density, color, etc.)	USCS	Remarks	PID/FID READING: Source (ppm)	PID/FID READING: BZ (ppm)
1		DK BRN TOP SOIL	O/SC			
2		MED BRN TO YEL BRN SILT	GM			
3		W/ GRAVEL AND SAND				
4				COLLECTED S33SB0030101		
5		INC CLAY CONTENT DOWN	GC	@ 4'-5' FROM		
6		WARD.		BUCKET.		
7						
8						
9				COLLECTED S33SB0030201		
10		GREENISH GREY CLAY + SILT	CL	8-10'		
		MOTTLED GREY		+ DUP,		
		TD = 10'		S33SBDUP0101		
		NO WASTE				

TEST PIT CROSS SECTION AND / OR PLAN VIEW



REMARKS: EXCAVATED AT SMALL MAG ANOMALY AS PER GEOPHYSICAL SURVEY
NO WASTE FOUND

PHOTO LOG: NONE

B.2 SOIL BORING LOGS

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: SEVEN SITES INV
PROJECT NUMBER: 0525
DRILLING COMPANY: CHESAPEAKE GEOSYSTEMS
DRILLING RIG: ATV B-47
BORING NUMBER: S33TW001
DATE: 2-7-02
GEOLOGIST: FRED WRAMSER
DRILLER: AARON E.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						YEL BRN	SILT, SAND + GRAVEL						
	2						↓						
S-1 0830		2/2			MED STIFF	YEL BRN	SILT w/SOME GRAVEL TR SAND CLAY	SM	MOIST	0		0	
	4	9/12	1.8/2.0				↓	↓					
	6												
S-2 0846		6/9			STIFF	V GREY	SILT w/CLAY TR f-g SAND	SM	DRY	0		0	
	8	12/30	2.0/2.0				↓		MOTTLED YEL BRN				
									COLLECTED S33SB001010168'				
	10												
S-3 0900		12/12			STIFF	LT	GREENISH GREY AS ABOVE	SM	SLIGHTLY MORE f-g SAND	0		0	
	12	14/14	1.8/2.0				w/ SAND STRINGERS	(SP)	DRY, SLIGHTLY MOTTLED YEL BRN				
						↓	↓	↓	↓				
	14												
S-4 0916		9/12		▽	STIFF	GREY	AS ABOVE	SM	MOIST TO WET	0		0	
	16	12/15	24/2.0				TR GRAVEL		WATER DRAINING FROM SAND STRINGERS COLLECTED				
	18							↓	S33SB001020116-16'				
S-5 0915		5/7			MED	LT GREY	SILT w/f-g SAND TR CLAY	SM/	WET, MOTTLED	0		0	
	20	20/24	2.0/2.0		STIFF		TR GRAVEL	SP	LT BRN + BLK				
					↓			↓					
	22			▽									
S-6 0925		4/4			LOOSE		f-g SAND w/ SILT + GRA	SP	SPOON SATURATED				
	24	5/6	1.0/2.0										
								↓					

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm):

Remarks: COLLECTED S33SB001010101 FOR CHEM ANALYSIS (RAINY NO PID USED) BEGIN COLLECTING SPLIT SPOONS @ 2'-4' 2" SPLIT SPOONS BELOW 20' BGS

Converted to Well: Yes X (TEMP) No ____ Well I.D. #: S33TW001

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: SEVEN SITES INV
PROJECT NUMBER: 0525
DRILLING COMPANY: CHESAPEAKE
DRILLING RIG: ATV B-47
BORING NUMBER: S33TW001
DATE: 2-7-02
GEOLOGIST: FRED W. RAMSER
DRILLER: AARON E.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	26												
S-7 0948		3/4			LOOSE/ MED DENSE	DK GREY	f-g SAND	SP	WET				
	28	6/12	2.0/2.0										
									PLACE SCREEN				
							DRILLER OVER		@ 18-28				
							DRILLED TO 30'		BEGIN TO INSTALL				
									PVC @ 0956				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm):

Remarks:

Converted to Well: Yes X No Well I.D. #: S33TW001

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: THDIV
PROJECT NUMBER: 0525
DRILLING COMPANY: CHESAPEAK GEOSYSTEMS
DRILLING RIG: ATV MOBIL B-57
BORING NUMBER: S33TW002
DATE: 2-8-02
GEOLOGIST: FRED W RAMSER
DRILLER: AARON E.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	2												
S-1 0910		4 5			MED STIFF	YEL BRN	SILT W/SOME F-g SAND TR GRAVEL	Sm	MOIST	0		0	
	4	4 4	1.0 2.0										
S-2 0915	6	9 12			DENSE	LT GREY	f-g SAND + SILT (6-8')	SP/SM	MOIST COLLECTED (6-8')	0		0	
		15 18	2.0 2.0				(S-2 = 6-8')		(S33SB002 0101 6-8')				
	8												
S-3 0920		12 15			DENSE	LT GREY	f-g SAND + SILT FR CLAY TR GRAV	SP/SM	MOIST	0		0	
	10	18 14	1.8 2.0				GRAVEL CONTACTS		SLIGHTLY MOTTLED				
		~~18~~ 14					DRY S-3 (10-12')						
S-4	12												
							CUTTINGS MOIST						
	14						NOT WET						
S-4 0930		5								0.2		0	
	16	5 9	2.0		MED DENSE	GREY	f-g SAND + SILT + CLAY	SM	MOTTLE YEL BRN				
		17 21	1.8 2.0						W BLK STRINGERS COLLECTED				
	18								S33SB002 0201 (14-16')				
S-5 0940		12 20			DENSE	YEL BRN	f-g SAND + SILT	SM/SP	MOTTLED ORG	0		0	
	20	30 35	1.8 2.0	▽	VERY DENSE		GRAVEL + f-g SAND + SILT	GP/SP	BLK STAINED GREY GRAVEL CONTACTS				
									MOIST TO WET				
	22			▽									
S-6 0950		6 9			MED DENSE	MED BRN TO GREY	f-g SAND + SILT	SP/SM	WET MOTTLED ORANGE	0.2		0	
	24	12 15	2.0 2.0										
	25												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm):

Remarks: TEMPORARY WELL

Converted to Well: Yes Y No _____ Well I.D. #: S33TW002

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: IRDIV STUMPNECK
PROJECT NUMBER: 0525
DRILLING COMPANY: CHESAPEAK
DRILLING RIG: B-57
BORING NUMBER: S33TW002
DATE: 2-8-02
GEOLOGIST: FRED WRAMSER
DRILLER: AARON E.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	26												
S-7 1004		5 9			MED. DENSE	GREY	F-g SAND + SILT	SP/SM	WET MOTTLED ORANGE				
	28	12 15	20 2.0				↓						
									OVER DRILLED				
									TO 30' BGS				
				TD = 30'					PLACE SCREEN				
									18-28				
									SAND				
									15-30				
									BENTONITE				
									13-15				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): ____

Remarks: ____

Converted to Well: Yes X No ____ Well I.D. #: S33TW002

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: SEVEN SITES INV. IHDIV
PROJECT NUMBER: 0525
DRILLING COMPANY: CHESAPEAK GEOSYSTEMS
DRILLING RIG: MOBIL B-47 ATV
BORING NUMBER: S33TW003
DATE: 2-6-02
GEOLOGIST: FRED W RAMSER
DRILLER: AARON F.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
							CLAY + SILT + GRAVEL						
	2						↓						
S-1 1045		18/27			MED STIFF	YEL BRN	CLAY + SILT w/ TR GRAVEL	CL		0		0	
	4	32/50/1	1.2/2.0		VERY DENSE	YEL BRN	GRAVEL w/ TR SAND SILT + CLAY		MOIST				
S-2 1100		8/8			DENSE	YEL BRN	f-g SAND + SILT	SP	MOTTLED GREY	0		0	
	6	10/13	1.0/2.0				TR GRA						
S-3 1108		5/9			STIFF	YEL BRN	SILT TR f-g SAND TR CLAY	SM	DRY MOTTLED GREY	0		0	
	8	12/18	1.8/2.0		↓	↓	↓	↓	↓				
S-4 1113		6/12			↓	↓	AS ABOVE LESS MOTTLED	↓	↓	0		0	
	10	15/20	0.6/2.0		↓	↓	↓	↓	↓				
1124 S-5		8/12	1		VERY STIFF	GREY	CLAY + SILT TR f-g SAND	SM	SLIGHT MOTTLING YEL BRN	0		0	
	12	22/20	2.0/2.0		↓	↓	↓	↓	↓				
S-6 1134		6/7			STIFF	↓	SILT + CLAY TR f-g SAND	↓	↓	6		0	
	14	13/19	1.5/2.0		↓	↓	↓	↓	↓				
S-7 1140		6/6			↓	GREY	SILT + CLAY TR f-g SAND		MOTTLED YEL BRN	0.2		0	
	16	16/17	1.6/2.0		↓	↓	TR GRAVEL		MOISTURE SURFACE OF GRAVEL				
S-8 1239		6/9			STIFF	GREY	SILT + CLAY + f-g SAND	SM	SLIGHT MOTTLING				
	18	12/20	1.5/2.0		↓	↓	TR GRAVEL	↓	MOIST				
S-9 1242		5/4			↓	↓	AS ABOVE	↓	MOTTLED YEL.				
	20	15/18	1.8/2.0		↓	↓	↓	↓	BRN				
S-10 1257		3/3			LOOSE/	GREY	f-g SAND & SILT TR	SM/SP	MOIST TO WET				
	22	6/8	2.0/2.0		SOFT		CLAY & GRAVEL		AT 21.5'				
S-11 1305		5/5			↓	DK OL	f-g SAND + CLAY + SILT		MOIST TO WET				
	24	10/10	2.0/2.0		↓	GRN	↓	↓	SAND STRINGERS DRAIN WATER				
S-12 1310	25	3/5					AS ABOVE						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: DOWN GRADIENT WELL NO CHEM. ANALYSIS SAMPLE

Drilling Area Background (ppm):

Converted to Well: Yes X No ____ Well I.D. #: S33TW003

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: SEVEN SITES INV, IH DIV
PROJECT NUMBER: 0525
DRILLING COMPANY: CHESAPEAK
DRILLING RIG:
BORING NUMBER: S33TW003
DATE: 2-6-02
GEOLOGIST: FRED WRAMSER
DRILLER: AARON E.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	26	5/9	2.0/2.0		DENSE	DK OLIVE GREEN	F-g SAND + SILT	SP	WET				
S-13 1330		4/5					CLAY + SILT	CL		0.2		0	
	28	9/12	2.0/2.0			MAROON	CLAYEY F-g SAND TR GRA	SP	WET				
S-14 1335		12/9					NO RECOVERY			0.3		0	
	30	9/14	2.0/2.0			YEL BRN	SAND GRAVEL IN SHOE		WET				
S-15 1345		6/15				LT BRN	M-g SAND TR SILT	SP	SATURATED				
	32	21/35	2.0/2.0				↓		WATER IN HOLE				
									MEASURED H_2O				
									IN HOLE TO 17'				
									BGS.				
									PLACE SCREEN				
									20-30				
									SAND 30-18				
									BENTONITE 14-18'				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: HSA TO 30'
SAMPLED TO 32

Drilling Area Background (ppm):

Converted to Well: Yes X No Well I.D. #: S33TW003

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: SEVEN SITES WV
PROJECT NUMBER: 0525
DRILLING COMPANY: CHESAPEAK - GEOSYSTEMS
DRILLING RIG: B-57 ATV
BORING NUMBER: S34TW001
DATE: 2-1-02
GEOLOGIST: FRED WRAMSER
DRILLER: AARON EICHELBERGER

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sample BZ	Borehole**	Driller BZ**
						DK BRN			ROOT MATL.				
	2					YEL BRN	f-g SAND TR SILT						
S-1 0735		4/4			MED DENSE	YEL BRN	f-g SAND TR SILT	SP	MOIST	0.1		0	
	4	7/6	2.0/2.0				↓		MOIST				
S-2 0738		6/4		▽			AS ABOVE	SP	WET @ 5'	0.1		0	
	6	4/2	1.5/2.0										
S-3 0742		3/5			↓		AS ABOVE	↓					
	8	32/14	1.5/2.0		DENSE		GRAVEL & SAND	GP		0.2		0	
S-4 0750		9/12											
	10	16/12	1.9/2.0		STIFF	GREY	CLAY + SILT	ML	MOTTLED YEL	0.3		0	
S-5 0800		6/9					CLAY W/SOME SILT						
	12	12/14	1.8/2.0						APPEARS DRY				
	14						TD @ 10'		SCREEN 4'-9'				
									SAND 2'-10'				
									BENT. 0'-2'				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): ____

Remarks: ____

Converted to Well: Yes X No ____ Well I.D. #: S34TW001

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: SEVEN SITES INV
PROJECT NUMBER: 0525
DRILLING COMPANY: CHESAPEAK GEOSYSTEMS
DRILLING RIG: B-57
BORING NUMBER: S34TW002
DATE: 2-1-02
GEOLOGIST: FRED W RAMSIER
DRILLER: AARON EIGLEBERGER

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						DK BRN	SAND + SILT						
	2												
S-1 0900		2/2				MED BRN	CLAYEY F-g SAND & SILT	SP	MOTTLED WET	0		0	
	4	4/3	1.2/2.0				↓						
S-2 0905		2/3			LOOSE	GREENISH GRAY	CLAYEY f-g SAND	SP	SATURATED	0.2		0	
	6	3/4	1.2/2.0				↓						
S-3 0910		6/6			MED DENSE		AS ABOVE			0.2		0	
	8	9/12	1.8/2.0				↓						
S-4 0915		5/7					↓						
	10	9/10	/2.0		VERY STIFF	GREY	CLAY MOTTLED YEL BRN	ML	APPEARS DRY	0.3		0	
	12												
									SCREEN 4-9				
									SAND 2-10				
									BENTONITE 0-2'				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: 1ST SPOON COLLECTED @ 2'-4'

Drilling Area Background (ppm): ____

Converted to Well: Yes ✓ No ____ Well I.D. #: S34TW002

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: SEVEN SITES SSP
PROJECT NUMBER: 0525
DRILLING COMPANY: CHESAPEAK GEOSYSTEMS
DRILLING RIG: MOBIL B-57
BORING NUMBER: S34TW003
DATE: 1-31-02
GEOLOGIST: FRED WRAMSER
DRILLER: ARON EICHELBERGER

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sample BZ	Borehole**	Driller BZ**
						RIC BRN	SILT + SAND TR CLAY		TR ROOT MATL.				
	2					YEL BRN	f-g SAND TR SILT	SP					
S-1 1536		3/3			LOOSE		↓		MOIST	0.0		0	
	4	4/5	20/2.0			YEL BRN	m-g SAND	SP					
S-2 1539		4/4							MOIST TOWRT	0.2		0	
	6	7/10	18/2.0	▽					WET				
S-3 1545		7/7			MED DENSE		m-g-c-g SAND		SATURATED	0.2		0	
	8	9/13	1.5/2.0				GRAVEL @ 6.5'-6.8'						
S-4 1551		7/12			VERY DENSE	BRN	GRAVEL + SAND	GW		0.3		0	
	10	50/3"	1.0/1.3 / 3.0										
							AS ABOVE		AUGER TO 12'	0.0		0	
	12						PER CUTTINGS		PAST GRAVEL				
S-5 1600		14/8		?	DENSE		NO RECOVERY	?	GRAVEL IN	0.0		0	
	14	10/12	0.2/2.0					?	TIP OF SPOON				
									SCREEN 4'-14'				
									SAND 3-15'				
									BENT - 0-3				
										*			

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): ___

Remarks: 1ST SPOON TAKEN @ 2'-4' *NO PID MEASURED
TEMP WELL

Converted to Well: Yes X No ___ Well I.D. #: S34TW003

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: IHDIV STUMPNECK
PROJECT NUMBER: 0525
DRILLING COMPANY: CHESAPEAK GEOSYSTEMS
DRILLING RIG: B-57 ATV
BORING NUMBER: S37TW001
DATE: 2-5-02
GEOLOGIST: FRED WRAMSER
DRILLER: A. EIGLBERGER

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						DK BRN	SAND + SILT + GRA						
	2												
S-1 0830		6/6			MED	MED BRN	C-G SAND	SP	COLLECTED	0		0	
	4	9/12	2.0/2.0		DENSE		MOIST		S37SB001010I 2-4'				
S-2 0845		14/36			DENSE		AS ABOVE			0		0	
	6	39/42	2.0/2.0	▽					WET @ 5.5'				
S-3 0900		12/16			DENSE		AS ABOVE		COLLECTED S37SB001020I (4'-6')				
	8	18/14	1.6/2.0				TR GRAVEL			0		0	
S-4 0905		1/1						↓					
	10	1/1	1.2/2.0			DK BRN	CLAY AT 9.5' BLK	OL					
									PLACE SCREEN @ 5'-10'				
									SAND 3'-10'				
									BENT. 0-3'				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): ____

Remarks: S-1 3" SPLITSPOON

Converted to Well: Yes X No ____ Well I.D. #: S37TW001

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: INDIAN HEAD
PROJECT NUMBER: 0525
DRILLING COMPANY: CHESAPEAK GEOSYSTEMS
DRILLING RIG: B-57 ATV
BORING NUMBER: S37TW002
DATE: 2-5-02
GEOLOGIST: FRED WILLIAMS
DRILLER: AARON E.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						DK BRN	SAND & GRAVEL						
	2												
S-1 1115		6/12			DENSE	BRN	GRAVEL + SAND	GW	VARIEGATED COLLECTED	0		0	
	4	16/18	1.0/2.0						S37SB002010				
S-2 1130		50/2"					REFUSAL		GRAVEL IN SHOE				
	6			▽			AUGER REFUSAL		BLK SAND +				
							MOVE HOLE ~100'		SILT TR GRAVEL				
	8						TO THE WEST		SEVERAL ATTEMPT				
									HSA = 12'				
	10								PLUS 10' = 22'				
									SCREEN 5-10				
									SAND 3-10				
									BENTONITE 0-3				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): ____

Remarks: S-1 - 3" SPLIT SPOON
+ S-2 3" SPLIT SPOON

Converted to Well: Yes X No ____ Well I.D. #: S37TW002

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: IHDIV STUMPNECK
PROJECT NUMBER: 0525
DRILLING COMPANY: CHESAPEAKE GEOSYSTEMS
DRILLING RIG: MOBIL B-57 ATV
BORING NUMBER: S37TW003
DATE: 2-5-02
GEOLOGIST: FRED W. RAMSER
DRILLER: AARON E.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	0			G.S.									
						MED BRN	SAND + SILT			0		0	
	2						↓						
S-1 1000		8/10			DENSE	MED BRN	M-g SAND TRGRA.	SP	COLLECTED S37SB0030101	0		0	
	4	12/14	1.0/2.0				↓						
S-2 1015		16/19			VERY		AS ABOVE						
	6	25/31	1.0/2.0	▽	DENSE				COLLECTED S37SB0030201	0		0	
S-3 1030		7/8			DENSE		AS ABOVE						
	8	9/12	0.4/2.0					↓					
S-4 1040		1/2			SOFT	DK GRN	SANDY CLAY	SM/CL		0		0	
	10	1/2	1.8/2.0										
									SCREEN 5-10				
									SAND 3-10				
									BENT. 0'-3'				

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: S-1 + S-2 3" SPLIT SPOONS
S-2 + S-4 2" SPLIT SPOONS

Drilling Area Background (ppm): [ ]

Converted to Well: Yes X No ___ Well I.D. #: S37TW003

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: SEVEN SITES INV
PROJECT NUMBER: 0525
DRILLING COMPANY: CHESAPEAK * GEOSYSTEMS
DRILLING RIG: HAND AUGER
BORING NUMBER: S51SB001
DATE: 2-11-02
GEOLOGIST: FWRAMSER
DRILLER: ARRON E.

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
	1					BRN	SILT + CLAY						
1754	2						↓		COLLECTED				
1830	3					BRN	GRAVEL		S51SB001010101 @ 1.5-2'	0.5		0	
							AUGER REFUSAL @ 2'		S51SB001020101				
							SEVERAL ATTEMPS		@ 2'-3'	0.5		0	
							ARE MADE AT						
							DIFFERENT LOCATIONS						
							THIS GRAVEL EXTENTS						
							LATERALY FROM THE						
							GRATE BY AT LEAST						
							2' FEET						

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): ____

Remarks: HAND AUGER

Converted to Well: Yes ____ No X Well I.D. #: ____

APPENDIX C

SAMPLE LOG SHEETS AND CHAIN OF CUSTODY FORMS

C.1 Groundwater
C.2 Surface Water
C.3 Sediment
C.4 Soil
C.5 Chain of Custody Forms

C.1 GROUNDWATER

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: INDIAN HEAD, MD
Project No.: N0525

Sample ID No.: S33TW001 0001
Sample Location: S33TW001
Sampled By: KEITH SIMPSON
C.O.C. No.: MK/STL 009

[] Domestic Well Data
[X] Monitoring Well Data TW
[] Other Well Type:
[] QA Sample Type:

Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

Date: 2-8-02	Color	pH	S.C.	Temp.	Turbidity	DO	ORP	~~TDS~~
Time: 0835	Visual	Standard	mS/cm	°C	NTU	mg/l	mV	NA
Method: BLADDER PUMP	CLEAR	5,580,093		10.0	9.2	0.07	191	—

PURGE DATA:

Date: 2-8-02	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	TDS
Method: BLADDER PUMP								
Monitor Reading (ppm): —								
Well Casing Diameter & Material Type: 2" PVC TW								
Total Well Depth (TD): 29.40	T OF PVC							
Static Water Level (WL): 10.22	"							
One Casing Volume (gal/ft): 3.1								
Start Purge (hrs): 0719								
End Purge (hrs): 0835								
Total Purge Time (min): 77								
Total Vol. Purged (gal): 2.3								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
TAL METALS	HNO_3	2 - 500 ML PE	✓
DISS. TAL METALS	4°C	2 - 500 ML PE	✓
EXPLOSIVES	4°C	5 - QTS	✓
— NO NITROCELLULOSE —			

OBSERVATIONS / NOTES:

RISER STICK-UP = 1.10' ABOVE GS

Circle if Applicable:		Signature(s):
MS/MSD	Duplicate ID No.:	
—	—	

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT SITE NAME: NSWC INDIAN HEAD
PROJECT NUMBER: N7129 CTO 0245
WELL ID.: S33TW001
DATE: 2-8-07

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	~~TDS~~ NA ( )	Notes:
0718	10.22	0	115								START PURGE
0730	11.05	↓	↓	5.25	0.049	81	0.23	8.70	220		CLOUDY, NO ODOR
0740	11.07			5.40	0.046	66	0.	9.3	218		
0750	11.10			5.53	0.044	50	0.13	9.9	198		CLEARING
0800	11.12			5.54	0.043	39	0.11	9.9	197		
0810	11.16			5.54	0.043	28	0.10	9.9	197		
0820	11.21			5.59	0.043	19	0.09	10.0	195		
0830	11.22	↓		5.56	0.043	13	0.07	10.0	192		
0835	11.23	2.3	↓	5.58	0.043	9.2	0.07	10.0	191		END PURGE

SIGNATURE(S):

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: INDIAN HEAD, MD
Project No.:

[] Domestic Well Data
[X] Monitoring Well Data
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 533TW002 0001
Sample Location: 533TW002
Sampled By: KEITH SIMPSON
C.O.C. No.: NA
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

Date: 2.12.02 / Time: 0925 / Method: BLADDER PUMP	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	ORP mV	~~TDS~~ NA
	CLEAR	5.50	0.040	10.3	15	0.12	251	

PURGE DATA:

Date: 2.12.02	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	TDS
Method: BLADDER PUMP								
Monitor Reading (ppm): —								
Well Casing Diameter & Material Type: 2" PVC TW								
Total Well Depth (TD): 29.60 TOC PVC								
Static Water Level (WL): 10.05 "								
One Casing Volume (gal/l): 3.2								
Start Purge (hrs): 0805								
End Purge (hrs): 0925								
Total Purge Time (min): 80								
Total Vol. Purged (gal/l): 2.6								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
TAL METALS	HNO_3	2 500 ML PE	✓
DISS. TAL METALS	4°C	2 500 ML PE	✓
EXPLOSIVES	4°C	6 QT GLASS	✓

OBSERVATIONS / NOTES:

PUMP SET ≈ 4' OFF BTM. LATE 2.11.02

RISER STICK-UP = 1.30' ABOVE GS

Circle if Applicable:

MS/MSD —

Duplicate ID No.: —

Signature(s):

KS SL

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT SITE NAME: NSWC INDIAN HEAD
PROJECT NUMBER: N7129 CTO 0245

WELL ID.: 533TW002
DATE: 2-12-02

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	~~TDS~~ NA ( )	Notes:
0805	10.05	0	125							START	PURGE
0815	10.70	↓	↓	5.27	0.065	16	2.13	9.4	268	CLEAR,	NO ODOR
0825	10.90			5.50	0.054	23	0.17	10.1	253		
0835	10.98			5.52	0.046	35	0.15	10.3	251		
0845	11.16			5.50	0.044	25	0.32	10.3	254		
0855	11.13			5.48	0.042	22	0.08	10.3	247		
0905	11.10			5.49	0.042	20	0.07	10.3	248		
0915	11.14	↓		5.50	0.041	18	0.19	10.3	252		
0925	11.15	2.6	↓	5.50	0.040	15	0.12	10.3	251	END	PURGE

SIGNATURE(S): [signature]

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: INDIAN HEAD, MD
Project No.: N 0525

[] Domestic Well Data
[X] Monitoring Well Data 2" TW
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: S33TW003000 1
Sample Location: S33TW003
Sampled By: K. SIMPSON
C.O.C. No.: SFL/MR 008
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

Date: 2.7.02	Color	pH	S.C.	Temp.	Turbidity	DO	ORP	~~TDS~~
Time: 1450	Visual	Standard	mS/cm	°C	NTU	mg/l	mV	NA
Method: BLADDER	TAN	5.84	0.046	12.7	>999	1.17	123	—

PURGE DATA:

Date: 2.7.02	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	TDS
Method: BLADDER PUMP								
Monitor Reading (ppm): —								
Well Casing Diameter & Material Type: 2" PVC TW								
Total Well Depth (TD): 30.00	TOF PVC							
Static Water Level (WL): 9.35	"							
One Casing Volume (gal/l): 3.4								
Start Purge (hrs): 1310								
End Purge (hrs): 1450								
Total Purge Time (min): 100								
Total Vol. Purged (gal/l): 2.9								

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
TAL METALS	1:1 HNO3	500 ML PE (2)	✓
DISS. TAL METALS	4°C	500 ML PE (2)	✓
EXPLOSIVES	4°C	—	
↳ NO NITROCELLULOSE	4°C	5 QTs (5)	✓

OBSERVATIONS / NOTES:

RISER STICK-UP = 0.8' ABOVE GS

HIGH TSS PUMPED 30 MIN, 1ST TO CLEAR UP

Circle if Applicable:		Signature(s):
MS/MSD	Duplicate ID No.:	
—	—	

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT SITE NAME: NSWC INDIAN HEAD
PROJECT NUMBER: N7129 CTO 0245

WELL ID.: 533 TW 003
DATE: 2.7.02

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	~~TDS~~ NA ( )	Notes:
1310	9.35	0	110			>999				START	PURGE
1315	10.09									LT. TAN	NO ODOR
1320	10.31										
1340	10.40			5.92	0.058	>999	0.03	12.6	121		
1350	10.28			5.90	0.052	>999	0.02	12.5	102		
1400	10.19			5.89	0.050	>999	0.28	12.6	104		
1410	10.13			5.88	0.048	>999	0.02	12.6	101		
1420	10.12			5.87	0.047	>999	0.38	12.7	108		
1430	10.15			5.86	0.046	>999	1.00	12.7	115		
1440	10.18			5.85	0.046	>999	1.16	12.7	120		
1445	10.16			5.84	0.046	>999	1.16	12.7	122		
1450	10.14	2.9		5.84	0.046	>999	1.17	12.7	123	END	PURGE

SIGNATURE(S):

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: INDIAN HEAD, MD
Project No.: N0525 SITE 34

[] Domestic Well Data
[X] Monitoring Well Data TW
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: S34TW001 0001
Sample Location: S34TW001
Sampled By: R. SIMPSON
C.O.C. No.: MK008
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

	Color	pH	S.C.	Temp.	Turbidity	DO	ORP	~~TDS~~
	Visual	Standard	mS/cm	°C	NTU	mg/l	mV	NA
Date: 2.7.02								
Time: 0910								
Method: PERISTALTIC	CLEAR	4.64	0.382	9.6	5.0	0.06	274	—

PURGE DATA:

	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	TDS
Date: 2.7.02								
Method: PERISTALTIC								
Monitor Reading (ppm): —								
Well Casing Diameter & Material Type: 1" PVC TW	→12.35							
Total Well Depth (TD): ~~7.4~~	T.OF PVC							
Static Water Level (WL): 7.41	T.OF PVC							
One Casing Volume (gal/L): 0.4								
Start Purge (hrs): 0800								
End Purge (hrs): 0910								
Total Purge Time (min): 70								
Total Vol. Purged (gal/L): 2.4	+ DEV. VOL.							

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
BERYLLIUM & COPPER	HNO_3	500 ML PE	—
			✓
DISS. BERYLLIUM & COPPER	4°C	500 ML PE	

OBSERVATIONS / NOTES:

RISER STICK-UP ≈ 2.50± ABOVE GS
1ST 5 MIN PUMPED @ ≥500 ML/MIN TO DEV./CLEAN OUT LINE
1" TW = 0.082 GAL/FT

Circle if Applicable:

MS/MSD — Duplicate ID No.:

Signature(s):

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT SITE NAME: NSWC INDIAN HEAD
PROJECT NUMBER: N7129 CTO 0245
WELL ID.: 534TW001
DATE: 2.7.02

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	~~TDS~~ NA ( )	Notes:
0800	7.41	0	130							START	PURGE
0810	7.80	↓	↓	4.42	0.614	320	2.27	9.8	282	LT TAN, NO ODOR	
0820	7.77	↓	↓	4.49	0.451	34	0.27	9.8	285	CLEARING	
0830	7.77	↓	↓	4.53	0.429	32	0.31	9.8	283		
0840	7.77	↓	↓	4.56	0.410	30	0.35	9.7	282		
0850	↓	↓	↓	4.58	0.399	19	0.12	9.6	290		
0900	↓	↓	↓	4.60	0.388	11	0.08	9.6	278		
0905	↓	↓	↓	4.63	0.383	7.2	0.08	9.6	275		
0910	↓	2.4	↓	4.64	0.382	5.0	0.06	9.6	274	END	PURGE

SIGNATURE(S):

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: INDIAN HEAD, MD
Project No.: 0525 SITE 34

[] Domestic Well Data
[X] Monitoring Well Data TW
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: 534TW002000/
Sample Location: 534TW002
Sampled By: K. SIMPSON
C.O.C. No.: MK007
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

Date: 2.4.02	Color	pH	S.C.	Temp.	Turbidity	DO	ORP	TDS
Time: 1710	Visual	Standard	mS/cm	°C	NTU	mg/l	mV	NA
Method: PERISTALTIC	CLEAR	6.31	1.29	9.0	1.1	0.03	4	

PURGE DATA:

Date: 2.4.02	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	TDS
Method: PERISTALTIC								
Monitor Reading (ppm): —								
Well Casing Diameter & Material Type: 1" PVC TW								
Total Well Depth (TD): 7.50	TOF PVC							
Static Water Level (WL): 3.93	TOF PVC							
One Casing Volume (gal/l): 0.3								
Start Purge (hrs): 1620								
End Purge (hrs): 1710								
Total Purge Time (min): 50	4 DEV.							
Total Vol. Purged (gal/l): 1.3	"							

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
BERYLLIUM & COPPER	HNO_3	500 ML PE	✓
DISS. BERYLLIUM & COPPER	4°C	500 ML PE	✓

OBSERVATIONS / NOTES:

RISER STICK-UP = 2.50 ABOVE GS

1ST 7 MIN PUMPED @ 500 ML/MIN TO DEV/CLEAN OUT WELL

Circle if Applicable:

MS/MSD —

Duplicate ID No.: —

Signature(s):

KJS

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT SITE NAME: NSWC INDIAN HEAD
PROJECT NUMBER: N7129 CTO 0245

WELL ID.: S34TW002
DATE: 2.4.02

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	TDS ( )	Notes:
1620	5.14	0	100	6.21	1.22	7.4	0.11	9.11	14	START	PURGE
1630	↓	↓	↓	6.27	1.26	5.8	0.08	9.0	10	CLEAR,	NO ODOR
1640	↓	↓	↓	6.27	1.26	4.3	0.07	9.1	11	↓	↓
1650	5.12	↓	↓	6.28	1.27	2.5	0.04	9.0	8	↓	↓
1700	5.09	↓	↓	6.30	1.28	1.8	0.04	9.0	7	↓	↓
1705	5.05	↓	↓	6.31	1.28	1.3	0.05	8.9	5	↓	↓
1710	5.03	1.3	↓	6.31	1.28	1.1	0.03	9.0	4	END	PURGE

SIGNATURE(S):

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: INDIAN HEAD, MD
Project No.: SITE 34

[] Domestic Well Data
[X] Monitoring Well Data TW
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: S34TW003 0001
Sample Location: S34TW03
Sampled By: KEITH SIMPSON
C.O.C. No.: MK007
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

Date: 2.4.02 / Time: 1540 / Method: PERISTALTIC	Color Visual	pH Standard	S.C. mS/cm	Temp. °C	Turbidity NTU	DO mg/l	ORP mV	TDS
	CLEAR	4.74	0.326	10.3	14	0.25	260	NA

PURGE DATA:

Date: 2.4.02	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	TDS
Method: PERISTALTIC								
Monitor Reading (ppm): —								
Well Casing Diameter & Material Type: 1" PVC TW								
Total Well Depth (TD): 17.3	T OF PVC	14.8 BGS						
Static Water Level (WL): 8.19	T OF PVC							
One Casing Volume (gal): 0.8								
Start Purge (hrs): 1430								
End Purge (hrs): 1540								
Total Purge Time (min): 70								
Total Vol. Purged (gal): 2.6	+DEV.							

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
BERYLLIUM & COPPER TOTAL	HNO_3	500 ML PE	✓
BERYLLIUM & COPPER DISS.	4°C	500 ML PE	✓

OBSERVATIONS / NOTES:

1" TW = 0.082 GAL/FT
DEVELOPED & PURGED SAME DAY
1ST 5 MIN. PUMPED @ 500 ML/MIN TO DEV./CLEAN WELL
RISER STICK-UP = 2.5' ABOVE GS

Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s): KTS

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT SITE NAME: NSWC INDIAN HEAD
PROJECT NUMBER: N7129 CTO 0245 SITE 34

WELL ID.: S34TW003
DATE: 2.4.02

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	~~TDS~~ NA ( )	Notes:
1430	8.19	0	140	4.75	0.358	190	0.02	10.4	248	START PURGE	
1440	8.33			4.67	0.362	55	0.02	10.3	263	LT TAN, NO ODOR	
1450	8.34			4.57	0.360	46	0.57	10.1	274	CLEARING	
1500	↓			4.59	0.351	32	0.23	10.2	275		
1510				4.59	0.348	25	0.18	10.2	275		
1520				4.63	0.340	20	0.19	10.1	273		
1530				4.70	0.331	17	0.22	10.2	270		
1535				4.73	0.327	15	0.28	10.2	267		
1540	↓		↓	4.74	0.326	14	0.25	10.3	266	END PURGE	

SIGNATURE(S): [signature]

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: INDIAN HEAD SITE 37
Project No.: N 0525

Sample ID No.: S37TW001 0001
Sample Location: S37TW001
Sampled By: R. SIMPSON
C.O.C. No.: MK007/ST2007
Type of Sample:
[X] Low Concentration
[] High Concentration

[] Domestic Well Data
[X] Monitoring Well Data TW
[] Other Well Type:
[] QA Sample Type:

SAMPLING DATA:

Date: 2.5.02	Color	pH	S.C.	Temp.	Turbidity	DO	ORP	TDS
Time: 1440	Visual	Standard	mS/cm	°C	NTU	mg/l	mV	NA
Method: PERISTALTIC	CLEAR	6.58	1.63	7.5	3.9	0.07	-42	—

PURGE DATA:

Date: 2.5.02	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	TDS
Method: PERISTALTIC								
Monitor Reading (ppm): —								
Well Casing Diameter & Material Type: 1" PVC								
Total Well Depth (TD): 8.20	T.O.C. PVC →		12.40					
Static Water Level (WL): 6.47	T.O.C. PVC		AFTER DEV.					
One Casing Volume (gal/L): 0.5								
Start Purge (hrs): 1350								
End Purge (hrs): 1440								
Total Purge Time (min): 50								
Total Vol. Purged (gal/L): 1.7	+ DEV.							

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOC	HCL	2 VIALS	✓
SVOC	4°C	1 QT	✓
PEST/PCB	4°C	2 QTS	✓
TAL METALS	HNO3	2 500 ML PE	✓
DIS. TAL METALS	4°C	1 300 ML PE	✓
EXPLOSIVES	4°C	4 QTS	✓
NITROCELLULOSE	4°C	1 QT	✓
NITROGUANIDINE	4°C	2 QTS	✓
~~NITRO~~			
		2X VOL FOR DUP	

OBSERVATIONS / NOTES:

PUMPED @ ≥500 ML/MIN TO DEV./CLEAN 1ST 5 MIN.
STICK-UP = 2.5' ABOVE GS

Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	S37TW DUP 001

Signature(s):

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT SITE NAME: NSWC INDIAN HEAD
PROJECT NUMBER: N7129 CTO 0245

WELL ID.: 537TW001
DATE: ~~5-25~~ 2-5-02

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal.)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	TDS NA ( )	Notes:
1350	RD ~~8.20~~ 6.47	0	125							START	PURGE
1400	7.09	↓	↓	6.54	1.62	167	0.61	7.0	-15	CLEAR,	NO ODOR
1410	7.05			6.57	1.63	13	0.13	7.4	-35		
1420	7.08			6.57	1.63	8.7	0.12	7.5	-34		
1430	7.12	↓		6.58	1.64	5.1	0.11	7.5	-39		
1440	7.15	1.7	↓	6.58	1.63	3.9	0.07	7.5	-42	END PURGE	

SIGNATURE(S):

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: INDIAN HEAD, MD
Project No.: N 0525

Sample ID No.: S37TW002 0001
Sample Location: S37TW002
Sampled By: R. SIMPSON
C.O.C. No.: ST2008/~~MK008~~
Type of Sample:
[X] Low Concentration
[] High Concentration

[] Domestic Well Data
[X] Monitoring Well Data TW
[] Other Well Type:
[] QA Sample Type:

SAMPLING DATA:

Date: 2.6.02	Color	pH	S.C.	Temp.	Turbidity	DO	ORP	~~TDS~~
Time: 1700	Visual	Standard	mS/cm	°C	NTU	mg/l	mV	NA
Method: PERISTALTIC	CLEAR	6.43	2.85	8.2	2.2	0.04	-5	—

PURGE DATA:

Date: 2.6.02	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	TDS
Method: PERISTALTIC								
Monitor Reading (ppm): —								
Well Casing Diameter & Material Type: 1" PVC TW								
Total Well Depth (TD): 12.35	TOP PVC							
Static Water Level (WL): 5.04	11							
One Casing Volume (gal/L):								
Start Purge (hrs): 1540								
End Purge (hrs): 1700								
Total Purge Time (min): 80	+ DEV.							
Total Vol. Purged (gal/L): 2.8	11							

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOC	HCl	2 VIALS	✓
SVOC	4°C	1 QT	✓
PEST/PCB	4°C	2 QTS	✓
TAL METALS	HNO_3	2 500 ML PE	✓
DISS. TAL METALS	4°C	2 500 ML PE	✓
EXPLOSIVES	4°C	2 QTS	✓

OBSERVATIONS / NOTES:

DEV. 1ST FOR 7 MIN. PUMPED @ ≥ 500 ML MIN. ON/OFF

END SAMPLING @ 1830

Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT SITE NAME: NSWC INDIAN HEAD
PROJECT NUMBER: N7129 CTO 0245

WELL ID.: S37TW002 0001
DATE: 2-6-02

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	~~TDS~~ NA ( )	Notes:
1540	5.04	0	130							START	PURGE
1545	5.17	↓	↓	5.39	3.83	25	5.58	9.0	108	CLEAR,	NO ODOR
1555	5.17			5.73	3.51	21	0.87	8.8	77		
1605	5.18			5.94	3.37	16	0.14	8.6	57		
1615	5.20			6.07	3.28	12	0.11	8.5	39		
1625	5.19			6.22	3.10	11	0.11	8.4	22		
1635	5.19			6.34	2.94	5.2	0.12	8.2	4		
1645	5.19			6.37	2.92	3.8	0.07	8.2	-1		
1650	5.20			6.39	2.88	3.3	0.05	8.2	-2		
1655	5.21	↓		6.42	2.86	3.0	0.04	8.2	-3		
1700	5.21	2.8	↓	6.43	2.85	2.2	0.04	8.2	-5	END	PURGE

SIGNATURE(S):

Tetra Tech NUS, Inc.

GROUNDWATER SAMPLE LOG SHEET

Project Site Name: INDIAN HEAD, MD
Project No.: N 0525

[] Domestic Well Data
[X] Monitoring Well Data TW
[] Other Well Type:
[] QA Sample Type:

Sample ID No.: S37TW003 0001
Sample Location: S37TW003
Sampled By: KEITH SIMPSON
C.O.C. No.: MK008/STL008
Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

Date: 2.6.02	Color	pH	S.C.	Temp.	Turbidity	DO	ORP	~~TDS~~
Time: 0925	Visual	Standard	mS/cm	°C	NTU	mg/l	mV	NA
Method: PERISTALTIC	CLEAR	6.36	4.84	7.6	1.5	0.04	-30	—

PURGE DATA:

Date: 2.6.02	Volume	pH	S.C.	Temp. (C)	Turbidity	DO	Salinity	TDS
Method: PERISTALTIC								
Monitor Reading (ppm): —								
Well Casing Diameter & Material Type: 1" PVC TW								
Total Well Depth (TD): 12.25	TOF	PVC						
Static Water Level (WL): 6.51	TOF	PVC						
One Casing Volume (gal/L): 0.5								
Start Purge (hrs): 0810								
End Purge (hrs): 0925								
Total Purge Time (min): 75	+ DEV.							
Total Vol. Purged (gal/L): 2.7	11							

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	MS/MSD	Collected
VOC	HCL	2 VIALS	6	—
SVOC	4°C	1 QT GLASS	3	—
PEST/PCBs	4°C	2 QT GLASS	6	—
TAL METALS	HNO_3	2 500 ML PE	6	—
DISS. TAL METALS	4°C	2 500 ML PE	6	—
EXPLOSIVES	4°C	7 QTs	21	✓
		3X VOL. FOR MS/MSD		

OBSERVATIONS / NOTES:

DEV. 1ST FOR 10 MIN. PUMPED @ ≥500 ML MIN, ON/OFF

END SAMPLING @ 1330

TW 2.5' RISER

Circle if Applicable:

MS/MSD: YES

Duplicate ID No.:

Signature(s):

KS/SL

Tetra Tech NUS, Inc.

LOW FLOW PURGE DATA SHEET

PROJECT SITE NAME: NSWC INDIAN HEAD
PROJECT NUMBER: N7129 CTO 0245

WELL ID.: 537TW003
DATE: 2.6.02

Time (Hrs.)	Water Level (Ft. below TOC)	Volume (gal/L)	Flowrate (mL/min)	pH (S.U.)	Cond. (mS/cm)	Turb. (NTU)	DO (mg/L)	Temp. (Celsius)	ORP (mV)	~~TDS~~ NA ( )	Notes:
0910	6.51	0	135							START	PURGE
0830	6.69	↓	↓	6.34	5.05	40	1.46	7.3	1	CLEAR,	NO ODOR
0840	↓			6.34	5.10	18	0.08	7.4	-11		
0850	↓			6.34	5.07	9.4	0.06	7.5	-17		
0900	6.69			6.35	5.01	6.2	0.08	7.5	-21		
0910	6.69			6.36	4.91	3.4	0.05	7.6	-25		
0915	↓			6.36	4.86	2.2	0.08	7.6	-26		
0920	↓	↓		6.36	4.85	1.7	0.03	7.6	-29		
0925	↓	2.7	↓	6.36	4.84	1.5	0.04	7.6	-30	END PURGE	
										CELL FROZEN @	
										TIME OF 1ST	
										READING (0920	

SIGNATURE(S): K-1 Sli

C.2 SURFACE WATER

Tetra Tech NUS, Inc. **SURFACE WATER SAMPLE LOG SHEET**

Project Site Name: 7 SITES INDIAN HEAD
Project No.: 0525

Sample ID No.: S37SW00100001
Sample Location: S37SW/SD01
Sampled By: R. SIMPSON
C.O.C. No.: MC006/STL006

[] Stream
[] Spring
[] Pond
[] Lake
[X] Other: RIVER/CREEK
[] QA Sample Type:

Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

Date: 1.31.02	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	Other
Time: 1630								
Depth: 0-6"								
Method: DIRECT FILL	CLEAR	7.08	6.56	9.6	2.7	5.91	0.34	—

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
TCL VOC	HCL	2 VIALS	MK
TCL SVOC	4°C	1 QT	↓
TAL METALS	HNO3	2 500 ML PE	
PEST/PCBs	4°C	2 QT	
EXPLOSIVES	4°C	7 QT	STL

OBSERVATIONS / NOTES:

SAME AS SW/SD02

45' W OF UTILITY POLE #3255

MAP:

SEE FIG 4-5
+ 02 SED LOG SHEET

Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	FD013102 02

Signature(s):

Tetra Tech NUS, Inc.

SURFACE WATER SAMPLE LOG SHEET

Project Site Name: 7 SITES INDIAN HEAD
Project No.: 0525

Sample ID No.: 537SW002 0001
Sample Location: 537SW002
Sampled By: K. SIMPSON
C.O.C. No.: MC006/ST2006

- [ ] Stream
- [ ] Spring
- [ ] Pond
- [ ] Lake
- [x] Other: RIVER/CREEK
- [ ] QA Sample Type:

Type of Sample:
- [x] Low Concentration
- [ ] High Concentration

SAMPLING DATA:

Date: 1-31-02 / Time: 1510 / Depth: 0-6" / Method: DIRECT FILL	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	Other
	CLEAR	6.99	6.34	10.0	2.9	6.38	0.33	NA

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
TCL VOC	HCL	2 VIALS	MK
TCL SVOC	4°C	1 QT	↓
TAL METALS	HNO_3	2 500 ML PE	↓
PEST/PCBs	4°C	2 QT	↓
EXPLOSIVES	4°C	1 QT	STL

OBSERVATIONS / NOTES:

SAMPLES COLLECTED
≈ 30' N OF GABION ~~BASKETS~~
≈ 4' FROM WATERS EDGE

MAP:

SEE FIG 4-5
+ SED. LOG SHEET

Circle if Applicable:

MS/MSD	Duplicate ID No.:
YES	—

Signature(s):

Tetra Tech NUS, Inc. **SURFACE WATER SAMPLE LOG SHEET**

Project Site Name: INDIAN HEAD MD, 7 SITES
Project No.: N052

Sample ID No.: S375W003 0001
Sample Location: S375W003
Sampled By: R. SIMPSON
C.O.C. No.: MK007/SC007

[] Stream
[] Spring
[] Pond
[] Lake
[] Other:
[] QA Sample Type:

Type of Sample:
[X] Low Concentration
[] High Concentration

SAMPLING DATA:

Date: 2.5.02 / Time: 1030 / Depth: 0 TO 4" / Method: DIRECT FILL	Color (Visual)	pH (S.U.)	S.C. (mS/cm)	Temp. (°C)	Turbidity (NTU)	DO (mg/l)	Salinity (%)	Other
	CLEAR *	6.36	0.940	0.8	12	1.38		—

SAMPLE COLLECTION INFORMATION:

Analysis	Preservative	Container Requirements	Collected
VOC	HCL	2 VIALS	✓
SVOC	4°C	1 QT GLASS	✓
PEST/PCB	4°C	2 QT GLASS	✓
TAL METALS BE, CU	HNO_3	1 500 ML PE	✓
EXPLOSIVES	4°C	1 QT GLASS	✓

OBSERVATIONS / NOTES:

LOW FLOW ≈ 1 GPM

* TRACE FINES STIRRED-UP DURING SAMPLING. SMALL PONDED AREA

1/4" OF ICE ON SURFACE

MAP:

SEE SED. LOG FORM

Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

RS/SL

C.3 SEDIMENT

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Project Site Name: SEVEN SITES INDIAN HEAD NSWC
Project No.: SITE SCREENING INV. 0525

Sample ID No.: S37SD001 0001
Sample Location: S37 SW/SD01
Sampled By: R SIMPSON
C.O.C. No.: MC006/ST006

- [ ] Surface Soil
- [ ] Subsurface Soil
- [X] Sediment
- [ ] Other:
- [ ] QA Sample Type:

Type of Sample:
- [X] Low Concentration
- [ ] High Concentration

GRAB SAMPLE DATA:

Date: 1-31-02	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 1650	0-6"	BRN	WET, F-C. SAND TR F. GRAVEL
Method: PLASTIC TROWEL			
Monitor Reading (ppm): —			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	ENCORE X3	—	
TCL SVOA	4OZ WMG	—	
TAL METALS	4OZ WMG X 1	✓	
TCL PEST/PCBS / TCL SVOA	8OZ WMG X 1	✓	
EXPLOSIVES/8332/NITROG	8OZ WMG X 1	✓	
NITROCELLULOSE	4OZ WMG X 1	✓	
Be + Cu	4OZ WMG	—	

OBSERVATIONS / NOTES:

MAP:

SEE FIG. 4-5 & 02 LOG SHEET

Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	FD 01310201

Signature(s):

RS/SL

LOCATION S37 SW/SD 02

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Project Site Name: SEVEN SITES INDIAN HEAD NSWC
Project No.: SITE SCREENING INV. 0525

Sample ID No.: S37SD002 0001
Sample Location: S37SD02
Sampled By: K. SIMPSON
C.O.C. No.: MC006/SL2006

- [ ] Surface Soil
- [ ] Subsurface Soil
- [X] Sediment
- [ ] Other:
- [ ] QA Sample Type:

Type of Sample:
- [X] Low Concentration
- [ ] High Concentration

GRAB SAMPLE DATA:

Date: 1.31.02	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 1605	0-6"	BRN	WET SAND SOME F. GRAVEL (F TO C SAND)
Method: PLASTIC TROWEL			
Monitor Reading (ppm): —			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	ENCORE X 5	✓	
TCL SVOA	4OZ WMG X 1	—	
TAL METALS 8	½OZ WMG X 1	✓	
TCL PEST/PCBS / TCL SVOA	8OZ WMG X 1	✓	
EXPLOSIVES/8332/NITROG	8OZ WMG X 1	✓	
NITROCELLULOSE 8	½OZ WMG X 1	✓	
Be + Cu	4OZ WMG X 1	—	
	X VOC FOR MS/MSD		
	TOTAL		

OBSERVATIONS / NOTES:

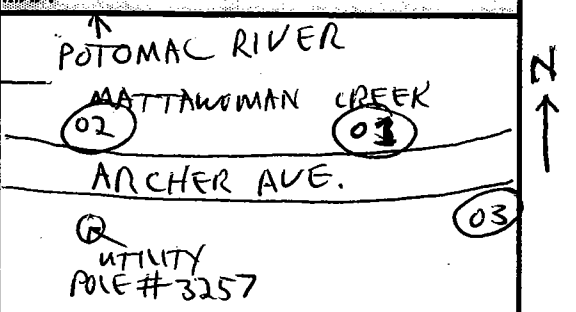
LOW TIDE @ 1526

FLOW ←

COLLECTED CLOSE TO WATER EDGE

SEE FIG. 4-5

MAP:



Circle If Applicable:

MS/MSD: YES

Duplicate ID No.: —

Signature(s):

K. Simpson

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Project Site Name: SEVEN SITES INDIAN HEAD NSWC SITE SCREENING INV.
Project No.: 0525

Sample ID No.: S37SD003 0001
Sample Location: S37SD003
Sampled By: K. SIMPSON
C.O.C. No.: MK007/STL007

- [ ] Surface Soil
- [ ] Subsurface Soil
- [X] Sediment
- [ ] Other:
- [ ] QA Sample Type:

Type of Sample:
- [X] Low Concentration
- [ ] High Concentration

GRAB SAMPLE DATA:

Date: 2.5.02	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 1050	0 - 6"	DK BRN BLK	SILT + SAND WET PLANT MATL.
Method: PLASTIC TRAVEL			
Monitor Reading (ppm): —			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	ENCORE X3		
~~TCL SVOA~~	~~4OZ WMG~~		
TAL METALS + BE, CN	4OZ WMG		
TCL PEST/PCBS / TCL SVOA	8OZ WMG		
EXPLOSIVES/8332/NITROG	8OZ WMG		
NITROCELLULOSE	4OZ WMG		
~~Be + CN~~	~~4OZ WMG~~		

OBSERVATIONS / NOTES:

MAP:

SEE FIG. 4-5
MOVED 50 YD ± SOUTH OF LOCATION ON FIG.

NO WATER @ FIG. LOCATION

Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

K. Simpson

C.4 SOIL

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Project Site Name: SEVEN SITES INDIAN HEAD NSWC
Project No.: SITE SCREENING INV. 0525

Sample ID No.: S33SB0010101
Sample Location: S33SB001
Sampled By: FWR
C.O.C. No.: MK/STL 008

- [ ] Surface Soil
- [x] Subsurface Soil
- [ ] Sediment
- [ ] Other:
- [ ] QA Sample Type:

Type of Sample:
- [x] Low Concentration
- [ ] High Concentration

GRAB SAMPLE DATA:

Date: 2-7-02	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 0846			
Method: SPLIT SPOON	6'-8'	GREY	SILT W/CLAY TR SAND
Monitor Reading (ppm): —			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

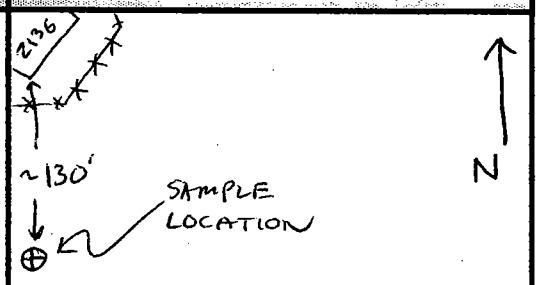
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	ENCORE X3		
TCL SVOA	4OZ WMG		
TAL METALS	4OZ WMG	✓	
TCL PEST/PCBS / TCL SVOA	8OZ WMG		
EXPLOSIVES/8332/NITROG	8OZ WMG	✓	
NITROCELLULOSE	4OZ WMG		
Be + Cu	4OZ WMG		

OBSERVATIONS / NOTES:

THIS SAMPLE WAS COLLECTED FROM S33TW001 LOCATION.

MAP:



Circle If Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Fred W Ramsey

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Project Site Name: SEVEN SITES INDIAN HEAD NSWC
Project No.: SITE SCREENING INV. 0525

Sample ID No.: S33SB00102O1
Sample Location: S33SB001
Sampled By: FUR
C.O.C. No.: MK/STL008

[] Surface Soil
[X] Subsurface Soil
[] Sediment
[] Other:
[] QA Sample Type:

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

Date: 2-7-02	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 0910			
Method: SPLIT SPOON	14'-16'	GREY	SILT W/CLAY TR SAND
Monitor Reading (ppm):			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

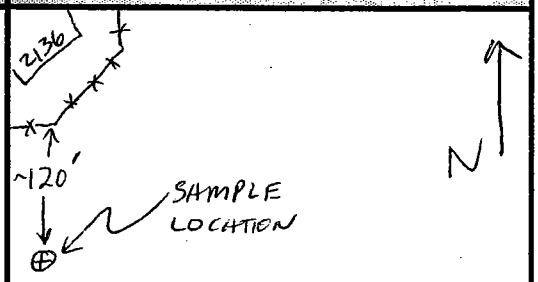
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	ENCORE X3	—	
TCL SVOA	4OZ WMG	—	
TAL METALS	4OZ WMG	✓	
TCL PEST/PCBS / TCL SVOA	8OZ WMG	—	
EXPLOSIVES/8332/NITROG	8OZ WMG	✓	
NITROCELLULOSE	4OZ WMG	—	
Be + Cu	4OZ WMG	—	

OBSERVATIONS / NOTES:

THIS SAMPLE WAS COLLECTED FROM S33TW001 LOCATION.

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Fred Ramsey

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Project Site Name: SEVEN SITES INDIAN HEAD NSWC
Project No.: SITE SCREENING INV. 0525

Sample ID No.: S33SB0020101
Sample Location: S33SB002
Sampled By: FWR
C.O.C. No.: STL/MK 009

- [ ] Surface Soil
- [x] Subsurface Soil
- [ ] Sediment
- [ ] Other:
- [ ] QA Sample Type:

Type of Sample:
- [x] Low Concentration
- [ ] High Concentration

GRAB SAMPLE DATA:

Date: 2-8-02	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 0915	6-8'	LT. GREY	f-g SAND AND SILT
Method: SPLIT SPOON			
Monitor Reading (ppm): —			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

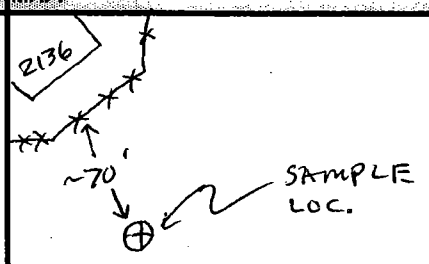
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	ENCORE X3	—	
TCL SVOA	4OZ WMG	—	
TAL METALS	4OZ WMG	✓	
TCL PEST/PCBS / TCL SVOA	8OZ WMG	—	
EXPLOSIVES/8332/NITROG	8OZ WMG	✓	
NITROCELLULOSE	4OZ WMG	—	
Be + Cu	4OZ WMG	—	

OBSERVATIONS / NOTES:

SAMPLE COLLECTED FROM S33TW002 LOCATION.

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Fred W Ramsey

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page ___ of ___

Project Site Name: SEVEN SITES INDIAN HEAD NSWC
Project No.: SITE SCREENING INV. 0525

Sample ID No.: S335B0020201
Sample Location: S335B002
Sampled By: FHR
C.O.C. No.: MK/STL 009

- [ ] Surface Soil
- [X] Subsurface Soil
- [ ] Sediment
- [ ] Other:
- [ ] QA Sample Type:

Type of Sample:
- [X] Low Concentration
- [ ] High Concentration

GRAB SAMPLE DATA:

Date: 2-8-02	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 0930			
Method: SPLIT SPOON	14'-16'	GREY	MOIST SAND + SILT + CLAY
Monitor Reading (ppm): —			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

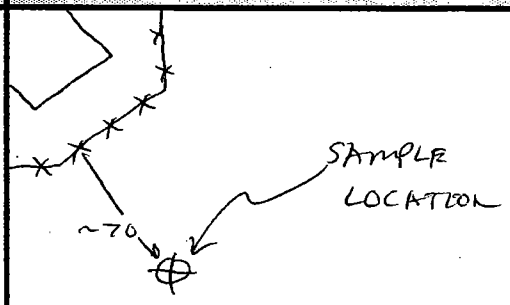
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	ENCORE X3	—	
TCL SVOA	4OZ WMG	—	
TAL METALS	4OZ WMG	✓	
TCL PEST/PCBS / TCL SVOA	8OZ WMG	—	
EXPLOSIVES/8332/NITROG	8OZ WMG	✓	
NITROCELLULOSE	4OZ WMG	—	
Be + Cu	4OZ WMG	—	

OBSERVATIONS / NOTES:

SAMPLE COLLECTED FROM S33TW002 LOCATION

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Fred M Ramsey

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: SEVEN SITES INDIAN HEAD NSWC
Project No.: SITE SCREENING INV. 0525

Sample ID No.: S33SB0030101
Sample Location: S33SB003
Sampled By: FLR
C.O.C. No.: NA

- [ ] Surface Soil
- [X] Subsurface Soil
- [ ] Sediment
- [ ] Other:
- [ ] QA Sample Type:

Type of Sample:
- [X] Low Concentration
- [ ] High Concentration

GRAB SAMPLE DATA:

Date: 2-12-02	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 1225			
Method: BACK HOE	3-5'	YEL BRN	SILT + F-g SAND + GRAVEL
Monitor Reading (ppm): —			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

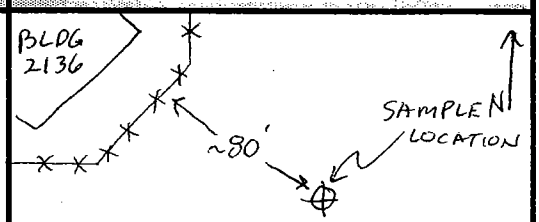
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	ENCORE X3		
TCL SVOA	4OZ WMG		
TAL METALS	4OZ WMG	✓	
TCL PEST/PCBS / TCL SVOA	8OZ WMG		
EXPLOSIVES/8332/NITROG	8OZ WMG	✓	
NITROCELLULOSE	4OZ WMG		
Be + Cu	4OZ WMG		

OBSERVATIONS / NOTES:

THIS SAMPLE WAS COLLECTED FROM TEST PIT #3.

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Fred McKamey

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Project Site Name: SEVEN SITES INDIAN HEAD NSWC
Project No.: SITE SCREENING INV. 0525

Sample ID No.: S33SB0030201
Sample Location: S33SB003
Sampled By: FUR
C.O.C. No.: NA

[] Surface Soil
[X] Subsurface Soil
[] Sediment
[] Other:
[] QA Sample Type:

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

Date: 2-12-02	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 1245	8'-10'	YEL/GRN BRN/GREY	CLAY, SILT + SAND
Method: BACK HOE			
Monitor Reading (ppm): —			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				FUR

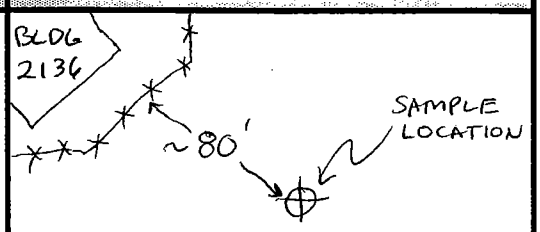
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	ENCORE X3		
TCL SVOA	4OZ WMG		
TAL METALS	4OZ WMG	✓	
TCL PEST/PCBS / TCL SVOA	8OZ WMG		
EXPLOSIVES/8332/NITROG	8OZ WMG	✓	
NITROCELLULOSE	4OZ WMG		
Be + Cu	4OZ WMG		

OBSERVATIONS / NOTES:

THIS SAMPLE WAS COLLECTED FROM TEST PIT #3.

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	S33SBDUP0101

Signature(s):

Fred M Ramer

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: SEVEN SITES INDIANHEAD NSWC SITE SCREENING INV.
Project No.: 0525

Sample ID No.: S34SB0010101
Sample Location: S34SB001
Sampled By: FUR
C.O.C. No.: MC004/STL004

- [] Surface Soil
- [] Subsurface Soil
- [] Sediment
- [] Other:
- [] QA Sample Type:

Type of Sample:
- [X] Low Concentration
- [] High Concentration

GRAB SAMPLE DATA:

Date: 1-30-02	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 1400	4'-4.5'	YEL BRN	MOIST SAND + SILT TR GRAVEL
Method: DIRECT FILL			
Monitor Reading (ppm):			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

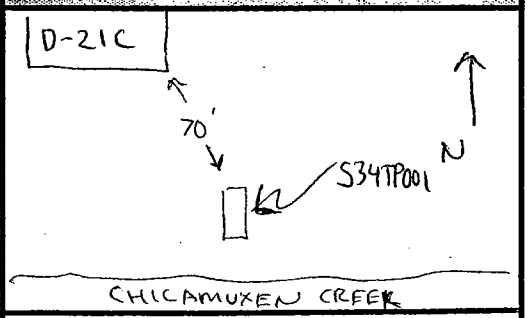
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	ENCORE X3		
TCL SVOA	4OZ WMG		
TAL METALS	4OZ WMG		
TCL PEST/PCBS / TCL SVOA	8OZ WMG		
EXPLOSIVES/8332/NITROG	8OZ WMG	✓	
NITROCELLULOSE	4OZ WMG	✓	
Be + Cu	4OZ WMG	✓	

OBSERVATIONS / NOTES:

COLLECTED SAMPLE FROM S34TP001

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	S34SBDUP0101

Signature(s):

Fred Ramsey

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of___

Project Site Name: SEVEN SITES INDIAN HEAD NSWC
Project No.: SITE SCREENING INV. 0525

Sample ID No.: S34SB0010201
Sample Location: S34SB001
Sampled By: FLR
C.O.C. No.: MC004/ST004

[] Surface Soil
[] Subsurface Soil
[] Sediment
[] Other:
[] QA Sample Type:

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

Date: 1-30-02	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 1445	7'-8'	YEL BRN	SAND, SILT + CLAY
Method: DIRECT FILL			
Monitor Reading (ppm): —			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

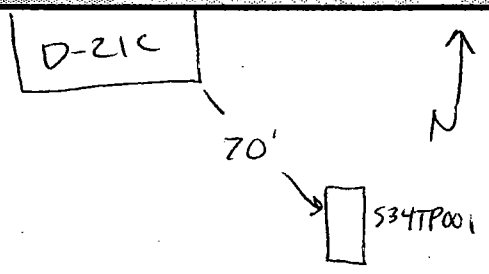
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	ENCORE X3		
TCL SVOA	4OZ WMG		
TAL METALS	4OZ WMG		
TCL PEST/PCBS / TCL SVOA	8OZ WMG		
EXPLOSIVES/8332/NITROG	8OZ WMG		
NITROCELLULOSE	4OZ WMG		
Be + Cu	4OZ WMG		

OBSERVATIONS / NOTES:

THIS SAMPLE IS PLACED ON HOLD PENDING RESULTS OF SHALLOW SAMPLE (4-4.5') COLLECTED FROM THE SAME TEST PIT S34TP001.

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Fred Wanner

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: SEVEN SITES INDIAN HEAD NSWC
Project No.: SITE SCREENING INV. 0525

Sample ID No.: S37SB001010101
Sample Location: S37SB001
Sampled By: FWR
C.O.C. No.: MK/STL007

- [ ] Surface Soil
- [X] Subsurface Soil
- [ ] Sediment
- [ ] Other:
- [ ] QA Sample Type:

Type of Sample:
- [X] Low Concentration
- [ ] High Concentration

GRAB SAMPLE DATA:

Date: 2-5-02	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 0830	2'-4'	BRN	SAND MOIST
Method: SPLIT SPOON			
Monitor Reading (ppm): —			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

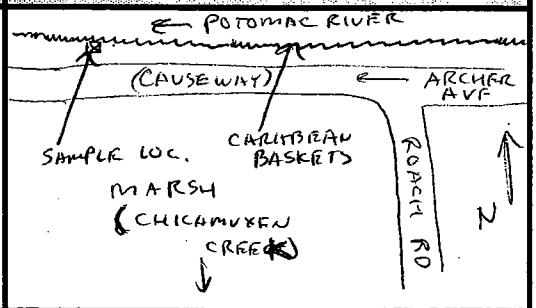
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	ENCORE X3	✓	
TCL SVOA	4OZ WMG	—	
TAL METALS	4OZ WMG	✓	
TCL PEST/PCBS / TCL SVOA	8OZ WMG	✓	
EXPLOSIVES/8332/NITROG	8OZ WMG	✓	
NITROCELLULOSE	4OZ WMG	✓	
Be + Cu	4OZ WMG	—	

OBSERVATIONS / NOTES:

THIS SAMPLE COLLECTED FROM S37TW001 BORING.

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Fred W Kramer

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of___

Project Site Name: SEVEN SITES INDIAN HEAD NSWC
Project No.: SITE SCREENING INV. 0525

Sample ID No.: S37SB0010201
Sample Location: S37SB001
Sampled By: FWR
C.O.C. No.: MK/STL007

- [] Surface Soil
- [X] Subsurface Soil
- [] Sediment
- [] Other:
- [] QA Sample Type:

Type of Sample:
- [X] Low Concentration
- [] High Concentration

GRAB SAMPLE DATA:

Date: 2-5-02	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 0845	4-6'	BRN	SAND MOIST TO WET
Method: SPLIT SPOON			
Monitor Reading (ppm): —			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

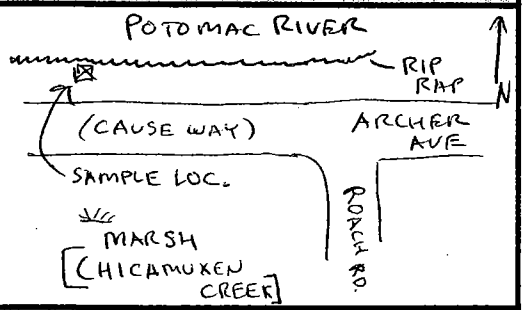
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	ENCORE X3	✓	
TCL SVOA	4OZ WMG	—	
TAL METALS	4OZ WMG	✓	
TCL PEST/PCBS / TCL SVOA	8OZ WMG	✓	
EXPLOSIVES/8332/NITROG	8OZ WMG	✓	
NITROCELLULOSE	4OZ WMG	✓	
Be + Cu	4OZ WMG	—	

OBSERVATIONS / NOTES:

SAMPLE COLLECTED FROM S37TW001

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Fred W Ramsey

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: SEVEN SITES INDIAN HEAD NSWC SITE SCREENING INV.
Project No.: 0525

Sample ID No.: S37SB0020101
Sample Location: S37SB002
Sampled By: FWR
C.O.C. No.: MK/STL 007

[] Surface Soil
[X] Subsurface Soil
[] Sediment
[] Other:
[] QA Sample Type:

Type of Sample:
[X] Low Concentration
[] High Concentration

GRAB SAMPLE DATA:

Date: 2-5-02	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 1115			
Method: SPLIT SPOON	2'-4'	BRN	SAND & GRA MOIST
Monitor Reading (ppm): -			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

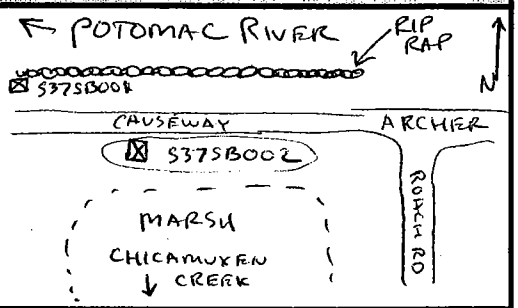
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	ENCORE X 3	✓	
TCL SVOA	4OZ WMG	—	
TAL METALS	4OZ WMG	✓	
TCL PEST/PCBS / TCL SVOA	8OZ WMG	✓	
EXPLOSIVES/8332/NITROG	8OZ WMG	✓	
NITROCELLULOSE	4OZ WMG	✓	
Be + Cu	4OZ WMG	—	

OBSERVATIONS / NOTES:

SAMPLE COLLECTED @ S37TW002 BORING.

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Fred G. Ramer

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: SEVEN SITES INDIAN HEAD NSWC
Project No.: SITE SCREENING INV. 0525

Sample ID No.: S37SB0030101
Sample Location: S37SB003
Sampled By: FUR
C.O.C. No.: MK/STL007

- [ ] Surface Soil
- [X] Subsurface Soil
- [ ] Sediment
- [ ] Other:
- [ ] QA Sample Type:

Type of Sample:
- [X] Low Concentration
- [ ] High Concentration

GRAB SAMPLE DATA:

Date: 2-5-02	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 1000			
Method: SPLIT SPOON	2'-4'	BRN	MOIST SAND TR GRAVEL
Monitor Reading (ppm): —			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

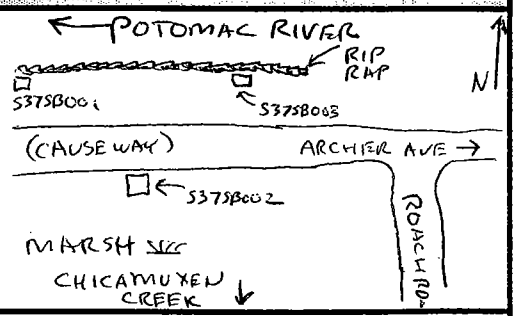
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	ENCORE X3	✓	
TCL SVOA	4OZ WMG	—	
TAL METALS	4OZ WMG	✓	
TCL PEST/PCBS / TCL SVOA	8OZ WMG	✓	
EXPLOSIVES/8332/NITROG	8OZ WMG	✓	
NITROCELLULOSE	4OZ WMG	✓	
Be + Cu	4OZ WMG	—	

OBSERVATIONS / NOTES:

SAMPLE COLLECTED FROM S37TW003 BORING

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Fred M Ramsey

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: SEVEN SITES INDIAN HEAD NSWC
Project No.: SITE SCREENING INV. 0525

Sample ID No.: S37SB0030201
Sample Location: S37SB003
Sampled By: FWR
C.O.C. No.: MK/STL007

- [] Surface Soil
- [X] Subsurface Soil
- [] Sediment
- [] Other:
- [] QA Sample Type:

Type of Sample:
- [X] Low Concentration
- [] High Concentration

GRAB SAMPLE DATA:

Date: 2-5-02	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 1015	4'-6'		
Method: SPLIT SPOON	~~2'-4' PWR~~	BRN	SAND TR GRAVEL MOIST
Monitor Reading (ppm): —			

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

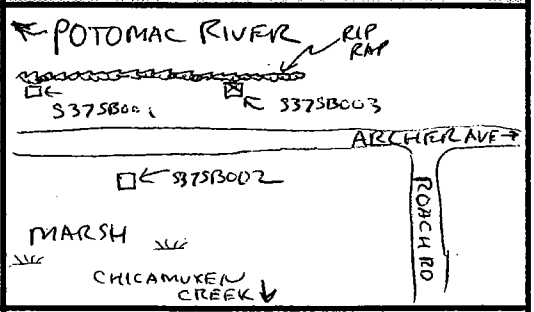
SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	ENCORE X3	✓	
TCL SVOA	4OZ WMG	—	
TAL METALS	4OZ WMG	✓	
TCL PEST/PCBS / TCL SVOA	8OZ WMG	✓	
EXPLOSIVES/8332/NITROG	8OZ WMG	✓	
NITROCELLULOSE	4OZ WMG	✓	
Be + Cu	4OZ WMG	—	

OBSERVATIONS / NOTES:

SAMPLE COLLECTED FROM S37TW003 BORING.

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Fred W Ramsey

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page ___ of ___

Project Site Name: SEVEN SITES INDIAN HEAD NSWC
Project No.: SITE SCREENING INV. 0525

Sample ID No.: S51SB0010101
Sample Location: S51SB001
Sampled By: PUR
C.O.C. No.: NA

- [ ] Surface Soil
- [X] Subsurface Soil
- [ ] Sediment
- [ ] Other:
- [ ] QA Sample Type:

Type of Sample:
- [X] Low Concentration
- [ ] High Concentration

GRAB SAMPLE DATA:

Date: 2-11-02 / Time: 1754 / Method: HAND AUGER / Monitor Reading (ppm): —	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
	1.5'-2'	BRN	SILT + CLAY MOIST

COMPOSITE SAMPLE DATA:

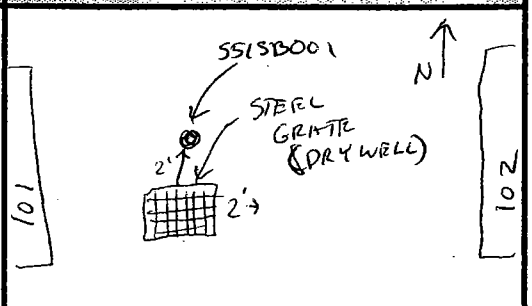
Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	~~ENCORE x3~~ 1x4oz	✓	
TCL SVOA	4oz WMG	—	
TAL METALS	4oz WMG	—	
TCL PEST/PCBS / TCL SVOA	8oz WMG	—	
EXPLOSIVES/8332/NITROG	8oz WMG	—	
NITROCELLULOSE	4oz WMG	—	
Be + Cu	4oz WMG	—	

OBSERVATIONS / NOTES:

MAP:



Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	—

Signature(s):

Fred McLaney

Tetra Tech NUS, Inc.

SOIL & SEDIMENT SAMPLE LOG SHEET

Page___ of ___

Project Site Name: SEVEN SITES INDIAN HEAD NSWC
Project No.: SITE SCREENING INV. 0525

Sample ID No.: SS1SB001Q201
Sample Location: SS1SB001
Sampled By: FUR
C.O.C. No.: NA

- [ ] Surface Soil
- [X] Subsurface Soil
- [ ] Sediment
- [ ] Other:
- [ ] QA Sample Type:

Type of Sample:
- [X] Low Concentration
- [ ] High Concentration

GRAB SAMPLE DATA:

Date: 2-11-02	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Time: 1830			
Method: HAND AUGER			
Monitor Reading (ppm): —	2-3'	BRN	SILT + CLAY WET

COMPOSITE SAMPLE DATA:

Date:	Time	Depth	Color	Description (Sand, Silt, Clay, Moisture, etc.)
Method:				
Monitor Readings (Range in ppm):				

SAMPLE COLLECTION INFORMATION:

Analysis	Container Requirements	Collected	Other
TCL VOA	~~ENCORE X3~~ 1X4oz	✓	
TCL SVOA	4oz WMG	—	
TAL METALS	4oz WMG	—	
TCL PEST/PCBS / TCL SVOA	8oz WMG	—	
EXPLOSIVES/8332/NITROG	8oz WMG	—	
NITROCELLULOSE	4oz WMG	—	
Be + Cu	4oz WMG	—	

OBSERVATIONS / NOTES:

MAP:

Circle if Applicable:

MS/MSD	Duplicate ID No.:
—	SS1SBDUP0101

Signature(s):

C.5 CHAIN OF CUSTODY FORMS

TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER MC006 | PAGE ___ OF ___

PROJECT NO: 0525	SITE NAME: INDIAN HEAD STUMP NECK	PROJECT MANAGER AND PHONE NUMBER: GEORGE LATULIPPE	LABORATORY NAME AND CONTACT: MITKEM CORP BEN DODGE
SAMPLERS (SIGNATURE): Fred W Ramser		FIELD OPERATIONS LEADER AND PHONE NUMBER: FRED W RAMSER	ADDRESS: 175 METRO CTR BLVD
		CARRIER/WAYBILL NUMBER: FED EX # 828074027919	CITY, STATE: WARWICK RI 02886

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

						CONTAINER TYPE PLASTIC (P) or GLASS (G)							
						PRESERVATIVE USED: HCL-AQ 4°C	4°C	HNO3 AQ	4°C				
DATE YEAR 2002	TIME	SAMPLE ID	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS	TYPE OF ANALYSIS: TCL VOA + ~~ETHYL ETHER FW~~	TCL SVOA	TAL METALS	TCL PEST/PCBS	~~EXPLOSIVES FW~~	~~+ NITROCELLULOSE~~	~~NITROGUANIDINE~~	COMMENTS
1/31	0800	S37TB013102	AQ	G	2	✓							
1/31	1510	S37SW0020001	AQ	G	21	✓	✓	✓	✓				RUN MS/MSD
1/31	1605	S37SD0020001	SO	G	7	✓	✓	✓	✓				RUN MS/MSD
1/31	1630	S37SW0010001	AQ	G	7	✓	✓	✓	✓				
1/31	1650	S37SD0010001	SO	G	5	✓	✓	✓	✓				
1/31	0000	FD01310201	SO	G	5	✓	✓	✓	✓				
1/31	0000	FD01310202	AQ	G	7	✓	✓	✓	✓				

RELINQUISHED BY	DATE	TIME	RECEIVED BY	DATE	TIME
1. RELINQUISHED BY Fred W Ramser	1/31/02	1900	1. RECEIVED BY FED EX		
2. RELINQUISHED BY			2. RECEIVED BY		
3. RELINQUISHED BY			3. RECEIVED BY		

COMMENTS

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FORM NO. TtNUS-001

TETRA TECH NUS, INC. | CHAIN OF CUSTODY | NUMBER STL006 | PAGE ___ OF ___

PROJECT NO: 0525	SITE NAME: INDIAN HEAD STUMPNECK	PROJECT MANAGER AND PHONE NUMBER GEORGE LATULIPPE	LABORATORY NAME AND CONTACT: STL KNOXVILLE JAMIE MCKINNEY
SAMPLERS (SIGNATURE) Fred W Ramsey		FIELD OPERATIONS LEADER AND PHONE NUMBER FRED W. RAMSEY	ADDRESS 5815 MIDDLEBROOK PIKE
		CARRIER/WAYBILL NUMBER FED EX 828074027908	CITY, STATE KNOXVILLE TN 37921

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE YEAR 2002	TIME	SAMPLE ID	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS	CONTAINER TYPE PLASTIC (P) or GLASS (G)	PRESERVATIVE USED	TYPE OF ANALYSIS: EXPLOSIVES	NITROCELLULOSE	NITROGUANIDINE	NITROGLYCERINE					COMMENTS
1/31	1510	S37SW0020001	AQ	G	21			✓	✓	✓	✓					RUN MS/MSD
1/31	1605	S37SD0020001	SO	G	2			✓	✓	✓	✓					RUN MS/MSD
1/31	1630	S37SW0010001	AQ	G	7			✓	✓	✓	✓					~~RUN FR~~
1/31	1650	S37SD0010001	SO	G	2			✓	✓	✓	✓					
1/31	0000	FD01310201	SO	G	2			✓	✓	✓	✓					
1/31	0000	FD01310202	AQ	G	7			✓	✓	✓	✓					

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY Fred W Ramsey	1/31/02	1900	1. RECEIVED BY		
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

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FORM NO. TtNUS-001

TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER mc 004 | PAGE ___ OF ___

PROJECT NO:	SITE NAME:	PROJECT MANAGER AND PHONE NUMBER	LABORATORY NAME AND CONTACT:
0525	INDIAN HEAD	GEORGE LATULIPPE	MITKEM CORP
SAMPLERS (SIGNATURE)		**FIELD OPERATIONS LEADER AND PHONE NUMBER**	**ADDRESS**
Fred W Ramser		FRED W RAMSER	175 METRO CTR BLVD
		CARRIER/WAYBILL NUMBER	**CITY, STATE**
		FED Ex 828074027882	WARWICK RI 02886

STANDARD TAT ☐
RUSH TAT ☐
☐ 24 hr. ☒ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE YEAR 2002	TIME	SAMPLE ID	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS	CONTAINER TYPE PLASTIC (P) or GLASS (G)	PRESERVATIVE USED	TYPE OF ANALYSIS Cu + Beryl.							COMMENTS
						G	4°C								
1/30	1400	S34SB0010101	SO	G	1			✓							
1/30	1445	S34SB0010201	SO	G	1			✓							*HOLD, DO NOT ANALYZE
1/30	0000	S34SBDUP0101	SO	G	1			✓							

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY Fred W Ramser	1/30/02	1900	1. RECEIVED BY FEDEX		
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS * DO NOT ANALYZE UNTIL NOTIFIED BY TtNUS

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FORM NO. TtNUS-001

TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER STL004 | PAGE ___ OF ___

PROJECT NO:	SITE NAME:	PROJECT MANAGER AND PHONE NUMBER	LABORATORY NAME AND CONTACT:
0525	INDIAN HEAD	GEORGE LATULIPPE	STL KNOXVILLE JAMIE McKINNEY
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER AND PHONE NUMBER	ADDRESS
Fred W Ramser		FRED W RAMSER	
		CARRIER/WAYBILL NUMBER	CITY, STATE
		FED EX 828074027893	

STANDARD TAT ☐
RUSH TAT ☐
☐ 24 hr. ☒ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE YEAR 2002	TIME	SAMPLE ID	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS	CONTAINER TYPE PLASTIC (P) or GLASS (G)	PRESERVATIVE USED	TYPE OF ANALYSIS: EXPLOSIVES	NITROCELL.	NITROGUAN.	NITROGLY.					COMMENTS
									4°C	4°C	4°C	4°C				
1/30	1400	S34SB0010101	SO	G	1			✓	✓	✓	✓					
1/30	1445	S34SB0010201	SO	G	1			✓	✓	✓	✓					HOLD, DO NOT ANALYZE UNTIL NOTIFIED *
1/30	0000	S34SBDUP0101	SO	G	1			✓	✓	✓	✓					

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY Fred W Ramser	1-30-02	1900	1. RECEIVED BY FEDEX		
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS
* HOLD, DO NOT ANALYZE UNTIL NOTIFIED BY TtNUS

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FORM NO. TtNUS-001

TETRA TECH NUS, INC. | CHAIN OF CUSTODY | NUMBER MK007 | PAGE ___ OF ___

PROJECT NO: 0525	SITE NAME: THDIV STUMPNECK	PROJECT MANAGER AND PHONE NUMBER: GEORGE LATULIPPE	LABORATORY NAME AND CONTACT: MITKEM CORP
SAMPLERS (SIGNATURE): F W Ramser		FIELD OPERATIONS LEADER AND PHONE NUMBER: FRED W. RAMSER	ADDRESS: 175 METRO CENTER BLVD
		CARRIER/WAYBILL NUMBER: FEDEX 828074027920	CITY, STATE: WARWICK, RI 02886

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE (YEAR 2002)	TIME	SAMPLE ID	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS	CONTAINER TYPE PLASTIC (P) or GLASS (G)	PRESERVATIVE USED	TYPE OF ANALYSIS: Be+Cu (TOTAL)	Be+Cu (DISSOLVED)*	TCL VOA	TCL S-VOA, PEST/PCBs	TAL METALS TOT + DISS*				COMMENTS
						P	HNO3 4°C									
						P	4°C									
						G (EnCore)	4°									
						G	4°									
						G	4°									
2-4	1540	S34TW0030001	AQ	G	2			✓	✓							
2-4	1710	S34TW0020001	AQ	G	2			✓	✓							
2-5	0800	S34TB020502-1	AQ	G	2					✓						
2-5	0830	S37SB0010101	SO	G	5					✓	✓	✓				
2-5	0845	S37SB0010201	SO	G	5					✓	✓	✓				
2-5	1000	S37SB0030101	SO	G	5					✓	✓	✓				
2-5	1015	S37SB0030201	SO	G	5					✓	✓	✓				
2-5	1115	S37SB0020101	SO	G	5					✓	✓	✓				
2-5	1600	S37RB020502-1	AQ	G	7					✓	✓	✓				SPLIT SPOON
2-5	1030	S37SW0030001	AQ	G	6					✓	✓	✓				TAL METALS TOTAL ONLY
2-5	1050	S37SD0030001	SO	G	5					✓	✓	✓				
2-5	1440	S37TW0010001	AQ	G	9					✓	✓	✓				
2-5	0000	S37TWDUP001	AQ	G	9					✓	✓	✓				

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY: F W Ramser	2-5-02	1900	1. RECEIVED BY: FEDEX		
2. RELINQUISHED BY			2. RECEIVED BY		
3. RELINQUISHED BY			3. RECEIVED BY		

COMMENTS: * TO BE FILTERED BY LAB

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TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER STL007 | PAGE ___ OF ___

PROJECT NO:	SITE NAME:	PROJECT MANAGER AND PHONE NUMBER	LABORATORY NAME AND CONTACT:
0525	IHDIV/STUMPNECK	GEORGE LATULIPPE	STL KNOXVILLE
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER AND PHONE NUMBER	ADDRESS
Fred W Ramser		FRED W RAMSER	5815 MIDDLEBROOK PIKE
		CARRIER/WAYBILL NUMBER FEDEX	CITY, STATE
		828074027930	KNOXVILLE, TN 37921

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE YEAR 2002	TIME	SAMPLE ID	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS	CONTAINER TYPE PLASTIC (P) or GLASS (G)								
						PRESERVATIVE USED								
						TYPE OF ANALYSIS	EXPLOSIVES	NITROCELLULOSE 4°C	NITROGUANIDINE 4°C	NITROGLYCERINE 4°C				COMMENTS
2-5	0830	S37SB0010101	SO	G	2		✓	✓	✓	✓				
2-5	0845	S37SB0010201	SO	G	2		✓	✓	✓	✓				
2-5	1000	S37SB0030101	SO	G	2		✓	✓	✓	✓				
2-5	1015	S37SB0030201	SO	G	2		✓	✓	✓	✓				
2-5	1115	S37SB0020101	SO	G	2		✓	✓	✓	✓				
2-5	1600	S37RB020502-1	AQ	G	7		✓	✓	✓	✓				SPLIT SPOON
2-5	1030	S37SW0030001	AQ	G	7		✓	✓	✓	✓				
2-5	1050	S37SD0030001	SO	G	2		✓	✓	✓	✓				
2-5	1440	S37TW0010001	AQ	G	7		✓	✓	✓	✓				
2-5	0000	S37TWDUP001	AQ	G	7		✓	✓	✓	✓				

1. RELINQUISHED BY	DATE	TIME	1. RECEIVED BY	DATE	TIME
F Ramser	2-5-02	1900	FED EX		
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

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FORM NO. TtNUS-001

TETRA TECH NUS, INC. | CHAIN OF CUSTODY | NUMBER MK 008 | PAGE ___ OF ___

PROJECT NO:	SITE NAME:	PROJECT MANAGER AND PHONE NUMBER	LABORATORY NAME AND CONTACT:
0525	IHDIV STUMPNECK	GEORGE LATULIPPE	MITKEM CORP BEN DODGE
SAMPLERS (SIGNATURE)		**FIELD OPERATIONS LEADER AND PHONE NUMBER**	**ADDRESS**
Fred W Ramser		FRED W. RAMSER	175 METRO CTR BLVD
		CARRIER/WAYBILL NUMBER	**CITY, STATE**
		FED EX AB 828074027941	WARWICK RI 02886

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE (YEAR 2002)	TIME	SAMPLE ID	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS	CONTAINER TYPE PLASTIC (P) or GLASS (G)	PRESERVATIVE USED	TYPE OF ANALYSIS: TCL VOA	TCL S-VOA	TAL METALS* (DISS)	TAL METALS (TOT)	TCL PEST/PCB	Be + Cu (TOT)	Be + Cu (DISS)*	COMMENTS
2/6	0800	S37TB020602-1	AQ	G	2			✓							
2/6	0925	S37TW0030001	AQ	G	27			✓	✓	✓	✓	✓			RUN MS/MSD
2/6	1700	S37TW0020001	AQ	G	9			✓	✓	✓	✓	✓			
2/7	0846	S33SB0010101	SO	G	1					✓					
2/7	0910	S33SB0010201	SO	G	1					✓					
2/7	0910	S34TW0010001	AQ	G	2							✓	✓		
2/7	1400	S33RB020702-1	AQ	G	2					✓					
2/7	1450	S33TW0030001	AQ	G	24				✓	✓					

1. RELINQUISHED BY	DATE	TIME	1. RECEIVED BY	DATE	TIME
Fred W Ramser	2-7-02	1900			
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS * TO BE FILTERED BY LABORATORY PRIOR TO ANALYSIS.

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FORM NO. TtNUS-001

TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER STL008 | PAGE ___ OF ___

PROJECT NO:	SITE NAME:	PROJECT MANAGER AND PHONE NUMBER	LABORATORY NAME AND CONTACT:
0525	IHDIV STUMPNECK	GEORGE LATULIPPE	STL KNOXVILLE JAMIE McKINNEY
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER AND PHONE NUMBER	ADDRESS
S.W. Ramser		FRED W RAMSER	5815 MIDDLEBROOK PIKE
		CARRIER/WAYBILL NUMBER	CITY, STATE
		FED Ex # 828074027952	KNOXVILLE, TN 37921

STANDARD TAT ☒
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE YEAR 2002	TIME	SAMPLE ID	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS	CONTAINER TYPE PLASTIC (P) or GLASS (G)	PRESERVATIVE USED	TYPE OF ANALYSIS: EXPLOSIVES	NITROCELLULOSE	NITROGUANIDINE	NITROGLYCERINE					COMMENTS
2/6	0925	S37TW0030001	AQ	G	21			✓	✓	✓	✓					RUN MS/MSD
2/6	1700	S37TW0020001	AQ	G	7			✓	✓	✓	✓					
2/7	0846	S33SB0010101	SO	G	1			✓		✓	✓					
2/7	0910	S33SB0010201	SO	G	1			✓		✓	✓					
2/7	1450	S33TW0030001	AQ	G	5			✓		✓	✓					
2/7	1400	S33RB020702-1	AQ	G	6			✓		✓	✓					
		~~S34TW0010001~~ PUR														

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY S.W. Ramser	2/7/02	1900	1. RECEIVED BY FED EX		
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

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TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER MK 009 | PAGE 1 OF 1

PROJECT NO:	SITE NAME:	PROJECT MANAGER AND PHONE NUMBER	LABORATORY NAME AND CONTACT:
0525	IHDIV STUMPNECK	GEORGE LATULIPPE	BEN DODGE MITKEM CORP
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER AND PHONE NUMBER	ADDRESS
T. Latulippe		FRED W RAMSER	175 METRO CTR BLVD
		CARRIER/WAYBILL NUMBER	CITY, STATE
		1 FED EX AB# 828074027963	WARWICK RI 02886

STANDARD TAT ☐
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE (YEAR 2002)	TIME	SAMPLE ID	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS	CONTAINER TYPE PLASTIC (P) or GLASS (G)	PRESERVATIVE USED	TYPE OF ANALYSIS: TAL METALS (TOT)	TAL METALS (DISS)	COMMENTS
2/8	0835	S33TW001 0001	AQ	G	4			2	2	
↓	0915	S33SB002 0101	S	G	1			✓	—	
↓	0930	S33SB002 0201	S	G	1			✓	—	

INDIAN HEAD STUMP NECK SITE 33

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY T. Latulippe	2.8.02	1330	1. RECEIVED BY FEDEX		
2. RELINQUISHED BY			2. RECEIVED BY		
3. RELINQUISHED BY			3. RECEIVED BY		

COMMENTS

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TETRA TECH NUS, INC. | CHAIN OF CUSTODY | NUMBER STL009 | PAGE 1 OF 1

PROJECT NO: 0525	SITE NAME: IH DIV STUMP NECK	PROJECT MANAGER AND PHONE NUMBER: GEORGE LATULIPPE	LABORATORY NAME AND CONTACT: STL KNOXVILLE JAMIE McKIN
SAMPLERS (SIGNATURE): K J S Lamp		FIELD OPERATIONS LEADER AND PHONE NUMBER: FRED WRAMSER	ADDRESS: 5815 MIDDLEBROOK PIKE
		CARRIER/WAYBILL NUMBER: FED EX 828074027974 PAR	CITY, STATE: KNOXVILLE, TN 37921

STANDARD TAT ☐
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE YEAR 2002	TIME	SAMPLE ID (INDIAN HEAD STUMP NECK SITE 33)	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS	CONTAINER TYPE PLASTIC (P) or GLASS (G)	PRESERVATIVE USED	TYPE OF ANALYSIS: EXPLOSIVES	NITROGUANIDINE	NITROGLYCERINE	COMMENTS
2/8	0835	S33TW001 0001	AQ	G	6			2	2	2	
↓	0915	S33SB002 0101	S	G	1			✓	✓	✓	
↓	0930	S33SB002 0201	S	G	1			✓	✓	✓	

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY: K J S Lamp	2-8-02	1230	1. RECEIVED BY: FEDEX		
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

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FORM NO. TtNUS-001

TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER | PAGE ___ OF ___

PROJECT NO:	SITE NAME:	PROJECT MANAGER AND PHONE NUMBER	LABORATORY NAME AND CONTACT:
0525	IHDIV STUMP NECK	GEORGE LATULIPPE	MITKEM CORP BEN DODGE
SAMPLERS (SIGNATURE)		FIELD OPERATIONS LEADER AND PHONE NUMBER	ADDRESS
		FRED WRAMSER	175 METRO CTR BLVD
		CARRIER/WAYBILL NUMBER	CITY, STATE
		FED Ex 830334177288	WARWICK RI 02886

STANDARD TAT ☑
RUSH TAT ☐
☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE (YEAR 2002)	TIME	SAMPLE ID	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS	CONTAINER TYPE PLASTIC (P) or GLASS (G)	PRESERVATIVE USED	TYPE OF ANALYSIS: TCL VOA	TAL METAL (TOT)	TAL METAL (DISS)*							COMMENTS
						G	HCL										
						P	4°C										
						P	HNO3										
2/11	1300	S51TB021102-1	AQ	G	2			✓	—								
2/11	1754	S51SB0010101	SO	G	1			✓	—								
2/11	1830	S51SB0010201	SO	G	1			✓	—								
2/11	0000	S51SBDUP0101	SO	G	1			✓	—								
2/12	0925	S33TW002 0001	AQ	G	4			—	2	2							
2/12	1225	S33SB0030101	SO	G	1				✓								
2/12	1245	S33SB0030201	SO	G	1				✓								
2/12	0000	S33SBDUP0101	SO	G	1				✓								

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY	2-12-02	1800	1. RECEIVED BY FEDEX		
2. RELINQUISHED BY			2. RECEIVED BY		
3. RELINQUISHED BY			3. RECEIVED BY		

COMMENTS * TO BE FILTERED BY LABORATORY

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3/99
FORM NO. TtNUS-001

TETRA TECH NUS, INC. CHAIN OF CUSTODY | NUMBER | PAGE ___ OF ___

PROJECT NO: 0525	SITE NAME: THDN/STUMPNECK	PROJECT MANAGER AND PHONE NUMBER: GEORGE LATULIPPE	LABORATORY NAME AND CONTACT: STL KNOXVILLE JAMIE MCKINNEY
SAMPLERS (SIGNATURE): [signature]		FIELD OPERATIONS LEADER AND PHONE NUMBER: FRED W. RAMSEY	ADDRESS: 5815 MIDDLEBROOK PIKE
		CARRIER/WAYBILL NUMBER: FEDEX 830334177299	CITY, STATE: KNOXVILLE, TN 37921

STANDARD TAT ☒
RUSH TAT ☐ ☐ 24 hr. ☐ 48 hr. ☐ 72 hr. ☐ 7 day ☐ 14 day

DATE (YEAR 2002)	TIME	SAMPLE ID	MATRIX	GRAB (G) COMP (C)	No. OF CONTAINERS	CONTAINER TYPE PLASTIC (P) or GLASS (G)	PRESERVATIVE USED	TYPE OF ANALYSIS: EXPLOSIVES	NITROGUANIDINE	NITROGLYCERINE						COMMENTS
						G	4°C	G	G	G						
2/12	0925	S33TW002 0001	AQ	G	6	2	2	2								
2/12	1225	S33SB003 0101	SO	G	1	✓	✓	✓								
2/12	1245	S33SB003 0201	SO	G	1	✓	✓	✓								
2/12	0000	S33SB DUP0101	SO	G	1	✓	✓	✓								

	DATE	TIME		DATE	TIME
1. RELINQUISHED BY [signature]	2-12-02	1900	1. RECEIVED BY FEDEX		
2. RELINQUISHED BY	DATE	TIME	2. RECEIVED BY	DATE	TIME
3. RELINQUISHED BY	DATE	TIME	3. RECEIVED BY	DATE	TIME

COMMENTS

DISTRIBUTION: WHITE (ACCOMPANIES SAMPLE) YELLOW (FIELD COPY) PINK (FILE COPY)

3/99
FORM NO. TtNUS-001

APPENDIX D

GEOPHYSICAL REPORT

Earth Resources Technology, Inc.

February 6, 2002

Fred Ramser
Tetra Tech NUS, Inc.
661 Anderson Drive
Pittsburgh, PA 15220-2745

Re: Results of Geophysical Surveys
Indian Head Division – Naval Surface Warfare Center
Indian Head, MD 20640-5035

Dear Fred:

Earth Resources Technology, Inc. (ERT) performed electromagnetic (EM), magnetic, and GPR surveys at the above referenced site on Tuesday, January 22, 2002, through Thursday, January 24, 2002. These surveys were conducted at four separate sites to determine the locations of specific features and targets. EM surveys were conducted at sites 34 and 36. The EM survey at site 34 was conducted to determine the location of beryllium-copper alloy tools. The EM survey at site 36 was conducted to determine the extent of a closed landfill. A magnetic survey was conducted at site 33 to determine the location of buried scrap metal. A GPR survey was conducted at site 51/52 to determine the location and depths of steam lines entering dry wells.

1.0 Principle And Instrumentation

The Geonics EM31 was used for the electromagnetic survey. The EM31 measures the changes in the ground conductivity using a patented electromagnetic inductive technique that makes the measurements without electrodes or ground contact. The unit of conductivity used is millisiemens per meter (mS/m). Conductivity changes are used to infer the geological variations, or groundwater contamination. The EM31 has two analog meters, which display the quadrature-phase (conductivity) and inphase components, respectively. Inphase measurements are the ratio of the induced secondary magnetic field to the primary magnetic field in parts per thousand (ppt). The inphase component is especially useful for searching for buried metal drums, pipes, and other ferrous and non-ferrous metallic debris. The effective depth of exploration of the equipment is about twenty (20) feet.

A Geometrics Portable Cesium Magnetometer, Model G-858, was used for the magnetic survey. Using self-oscillating split-beam Cesium Vapor (non-radioactive CS-133), this magnetometer measures the earth's total geomagnetic field at a particular location in units of nanoTeslas (nT) with an accuracy of ±1.0 nT. It collects a maximum of 10 magnetic readings per second. The total field consists of three components: the main field, the external field, and local variations. The main field and external field remain fixed over the period of time of a field investigation. Local variations are attributable to anomalies near the surface such as buried metal objects or above ground objects containing ferrous metallic substance. The effective penetration depth of the instrument is 50 feet. The horizontal detection range of the magnetometer varies with targets but is generally larger than that of the EM31.

The pulseEKKO 1000 radar from Sensors & Software, Inc. was used to conduct the GPR survey. During the survey, the device radiates a 450 MHz electromagnetic wave from a transmitter antenna into the earth

and receives at a receiving antenna the reflection of the wave from subsurface interfaces at which changes in the electrical properties (dielectric permittivity and electrical conductivity) of the subsurface materials occur. Dielectric permittivity controls wave speed; and conductivity determines the signal attenuation. Radar reflections occur when the radio waves encounter a change in the velocity or attenuation. The bigger the change in properties the more signal reflected. These properties are sometimes controlled by water in the material, hence by the porosity and quantity of dissolved solids in the water. Metallic objects usually exhibit strong subsurface reflection character due to their high electrical impedance, or contrast, versus surrounding soil or fill. Depth of penetration of the radar signal is inversely proportional to the conductivity of the soil. As a result, electrically resistive earth materials such as coarse-grained, unsaturated sediments allow a deeper radar penetration than the conductive finer-grained soils such as clay and silt. Similarly, reinforced concrete and shallow groundwater are conductive and thus attenuate the radar signals.

2.0 Field Design and Operation

2.1 Site 33 – Scrap Metal Area:

The goal of the survey was to locate areas within a pre-determined site that may contain buried ferrous metal. The suspect area for site 33 is located near Buildings 2116 and 2136 in the southern portion of the Stump Neck Annex. The area was for the most part wooded and sloped to the west. As shown in Figure 1, the magnetic survey was conducted along a grid that was based on a Cartesian coordinate system with fiducial marks every 10 feet. The grid was 100 feet by 200 feet. For example, the origin of the coordinate system on the grid is located outside the fence in the northwest corner of the designated site and has the coordinates {100, 100}. The grid lines decreased from 100 in an easterly direction and increased from 100 in a southerly direction. During the data collection, the G-858 Magnetometer collected data continuously along each north-to-south transect line. Survey lines were spaced five feet apart.

2.2 Site 34 – Beryllium-Copper Alloy Tool Area:

The goal of the survey was to locate areas within a pre-determined site that may contain buried beryllium-copper alloy tools. The suspect area for site 34 is located near Building D-21C on Stump Neck Annex. The area for the most part was open except for the eastern and southern edges of the grid, which were heavily wooded. As shown in Figure 2, the EM survey was conducted along a grid that was based on a Cartesian coordinate system with fiducial marks every 10 feet. The grid was 80 feet by 190 feet. For example, the origin of the coordinate system on the grid is located 40 feet west of the building for the designated site and has the coordinates {100, 100}. The grid lines increase from 100 in an easterly direction and increased from 100 in a southerly direction. During the data collection, the EM31 was set in a manual mode with readings collected at 5-feet centers along each survey line in both quadrature-phase and inphase. Prior to the survey, scrap metal on the surface was gathered and placed into a pile to minimize interference and erroneous anomalies.

2.3 Site 36 – Closed Landfill Area

The goal of the survey was to define the extent of a closed landfill. The suspect area for site 36 is located near along Roach Road on Stump Neck Annex. The area for the most part was covered with thick brush and woods that bordered a swamp. As shown in Figure 3, the EM survey was conducted along 15 transects that were spaced 30 feet apart. During the data collection, the EM31 was set in a manual mode

with readings collected at 10-feet centers along each survey line in both quadrature-phase and inphase.

2.4 Site 51/52 Dry Well and Steam Line Area

The goal of the survey was to determine the location of steam lines that lead from two buildings to two dry wells. The suspect area for site 51/52 is located between Buildings 101 and 102 in the restricted area of the base near Thames and Evans road. The area was open for the most part except for some surface objects, which can be seen on Figure 4. The GPR data were collected along 8 N-S lines and 10 E-W lines (Figure 4). The collection of the GPR data was performed by pulling the antenna along each grid line while the positions of each radar reading were recorded with an odometer attached to a survey wheel. The odometer was set up such that one radar reading would be acquired every 0.05 m (0.164 ft). Because the subject property is underlain by the artificial fill or clay/silt/sand, the average velocity of the radar is estimated around 0.1 m (0.328 ft) per nanosecond (ns). The time range was thus selected as 70 ns and would allow a penetration depth of about 10 feet. The GPR data were recorded digitally in a portable computer for instant display and subsequent processing.

3.0 Results and Interpretations

3.1 Site 33 – Scrap Ferrous Metal Area:

Figure 5 presents the contour map of magnetic readings measured in nanoTeslas (nT). The approach to interpreting the magnetic data is to distinguish the local variations from the main and external fields. The main field is created by the earth's magnetic field; while the external field is created by the sun and/or moon. To interpret the data, magnetic readings collected based on the survey grid were used to construct a magnetic contour map. The average of the readings (background), or those readings with little fluctuation usually represent the main field. In contrast, the local anomalies often occur as closed or elongated contours that have readings either above or below the background. The closed or elongated contours with readings above the background are considered as the magnetic highs; while the contours with readings below the background are considered as magnetic lows.

Magnetic anomalies occur in several areas (A, B, C, D, E, F, and G) as shown in Figure 5. The magnitudes of some of these anomalies are not particularly high (or low), suggesting that they are most likely created by small ferrous objects buried in the subsurface (such as anomalies D and E on Figure 5). The two anomalies along the southwest edge of the map (A and B) are rather large anomalies. Anomaly B is accounted for by surface metal. However, there is no evidence for surface metal near anomaly A. Therefore this is an area of concern for buried ferrous metal. There are five other anomalies (C and G) marked on Figure 1 that are most likely caused by large concrete blocks on the ground. The linear anomaly (F) along the northwest edge of the site is most likely associated with the fence.

3.2 Site 34 – Beryllium-Copper Alloy Tool Area:

In Figure 6 and Figure 7, the EM anomalies are shown with the highest readings in orange and the lowest readings in blue. Background readings fall between the orange and blue colors. Note that the low or high conductivity/inphase values are not absolute, but relative, reflecting a deviation from the background values. The positive or negative values reflect the change of the dipole orientation of the local electromagnetic field. Both the high and low deviations are used to locate buried materials.

There are several large anomalies in the grid area that are associated with known surface features. The anomaly that extends from 140 easting to 190 easting (A) along the north edge of Figures 6 and 7 is associated with the building on the property. The anomaly that extends from 220 easting to 240 easting and 120 southing to 140 southing (B) of Figures 6 and 7 is associated with a large scrap metal pile on the ground surface. There are several anomalous low readings that show up on Figures 6 and 7 that cannot be accounted for by surface features and therefore are areas of concern for buried tools. The anomaly that is centered around 210 (easting), 155 (southing) (C) shows up as anomalous lows on both Figures 2 and 3. The anomaly that is centered around 262 (easting), 102 (southing) (D) shows up as an anomalous low on Figure 7. The closed contours on Figure 6 labeled E an F are also anomalous areas of concern for buried tools.

3.3 Site 36 – Closed Landfill Area

In Figure 8 and Figure 9, the EM anomalies are shown with the highest readings in orange and the lowest readings in blue. The location of readings is shown as black dots on Figure 4. Background readings fall between the orange and blue colors. Note that the low or high conductivity/inphase values are not absolute, but relative, reflecting a deviation from the background values. The positive or negative values reflect the change of the dipole orientation of the local electromagnetic field. Both the high and low deviations are used to locate buried materials.

Figure 8 presents the in-phase data showing the occurrence of ferrous or non-ferrous debris on or below the ground surface. Figure 9 presents the quadrature conductivity data. Both figures indicate a similar pattern with isolated or scattered anomalies in the west half of the survey and linear continuous anomaly along the east boundary of the survey area. Some of the isolated anomalies in the east half are associated with surface metallic debris. However, no surface debris was observed along the east boundary. The linear anomaly is likely created by subsurface ferrous or non-ferrous debris. In summary, the entire survey area may contain landfill material with the concentrated volume of material along the east boundary.

3.4 Site 51/52 Dry Well and Steam Line Area

Figures 10 and 11 present GPR profiles that were acquired during the geophysical survey. Along these GPR profiles, the horizontal axis represents the horizontal distance in feet; while the left vertical axis represents the two-way travel time in ns and the right vertical axis the depth in feet (converted using the assumed velocity of 0.328 ft/ns). A GPR profile is made of individual traces that have peaks and valleys. The peaks of radar signals represent different interfaces in the subsurface encountered by the penetrating signals. Connecting and coloring the peaks and valleys of successive traces creates a GPR profile. As shown in the profiles, the red reflections represent the peaks of individual traces with the highest amplitudes; while the blue reflections are the valleys of individual traces with the lowest amplitudes. The red color is replaced by dark gray of varying degrees for the lower peak amplitudes; and the blue by white for varying degrees of higher valley amplitudes. The red and blue reflections, as discussed in Section 1.0, are created by interfaces with higher dielectric contrasts.

The location of the GPR profiles are shown in Figure 4 and labeled as A-A' and B-B'. On profile A-A' (Figure 10) the first pipe which is at a distance of 5 feet and a depth of 1 foot represents a utility line. The second and third pipes at distances of 16 feet and 24 feet respectively and depths of 1.5 represent the lines entering the first dry well (defined as the western most well). The saturated reflection at the distance of 26-30 feet represents the concrete/steel pad near the second dry well (defined as the eastern most well). The fourth pipe at a distance of 34 feet and depth of 1.5 feet represents a line entering the second dry

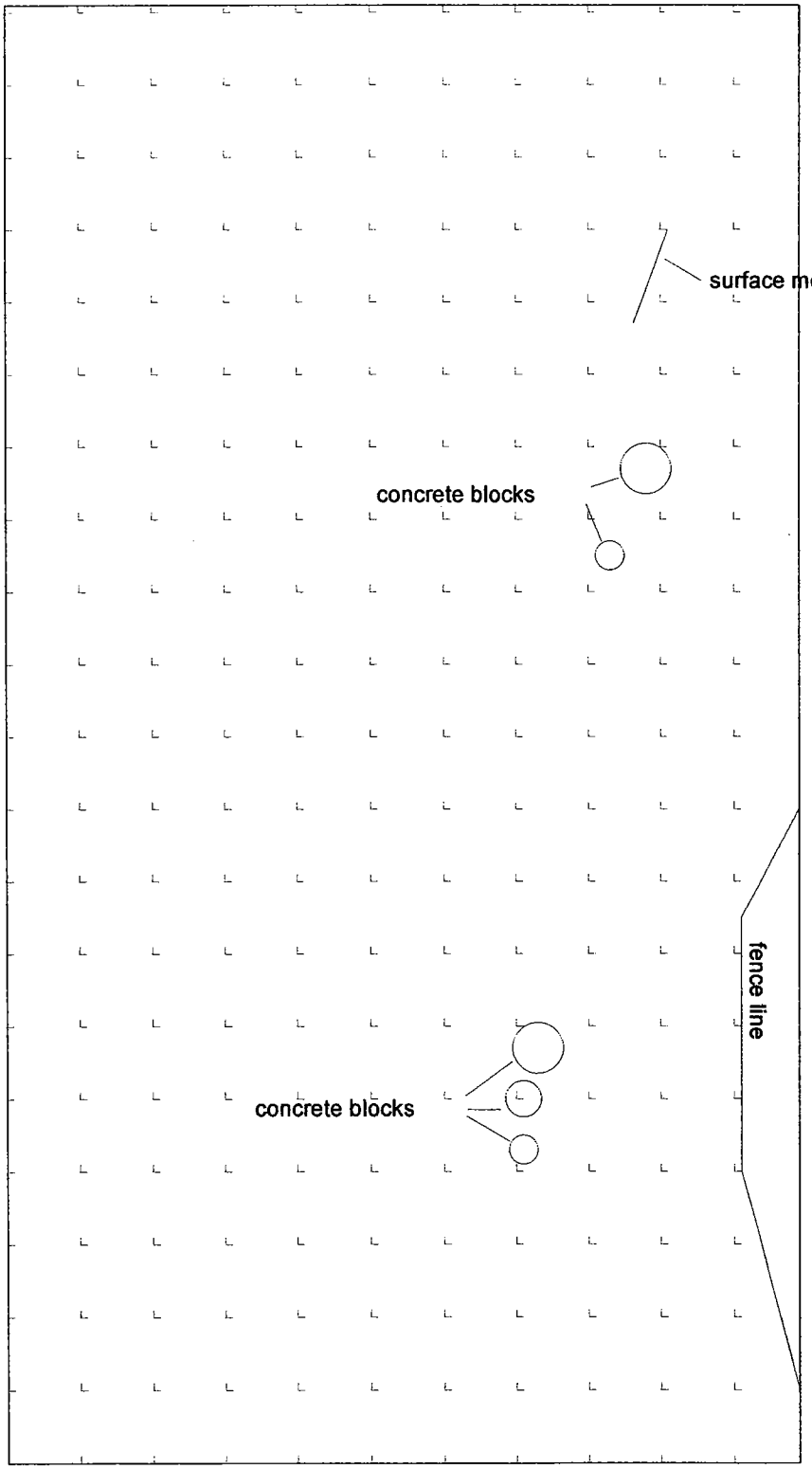
well. On profile B-B' (Figure 11) there are several hyperbolic reflections that represent pipes. The reflection labeled 1 at a distance of 10 feet and a depth of 1.5 feet represents a utility line. The second labeled reflection at a distance of 31 feet and a depth of 2.5 feet represents a utility line. The third labeled line at a distance of 38 feet and a depth of 1.5 feet represents a line entering the first dry well. The fourth labeled reflection at a distance of 42 feet and a depth of 2 feet represents a utility line. The saturated reflection at the distance of 45-47.5 feet represents the steel plates. The reflections at 57 feet to 66 feet represents an area that is generally disturbed. Figure 12 shows the locations of all the pipes (drawn in red) in the area of concern. The lines that are entering the dry wells at the depth of 1.5 feet are probably the steam lines.

4.0 CLOSING

The field procedures and interpretative methodologies used in this project are consistent with standard, recognized practices in similar geophysical investigations. The correlation of geophysical responses with probable subsurface features is based on the past results of similar surveys although it is possible that some variation could exist at this site. This warranty is in lieu of all other warranties either implied or expressed. **ERT** assumes no responsibility for interpretations made by others based on work performed by, or recommendations made by, **ERT.**

Sincerely,
Earth Resources Technology, Inc.

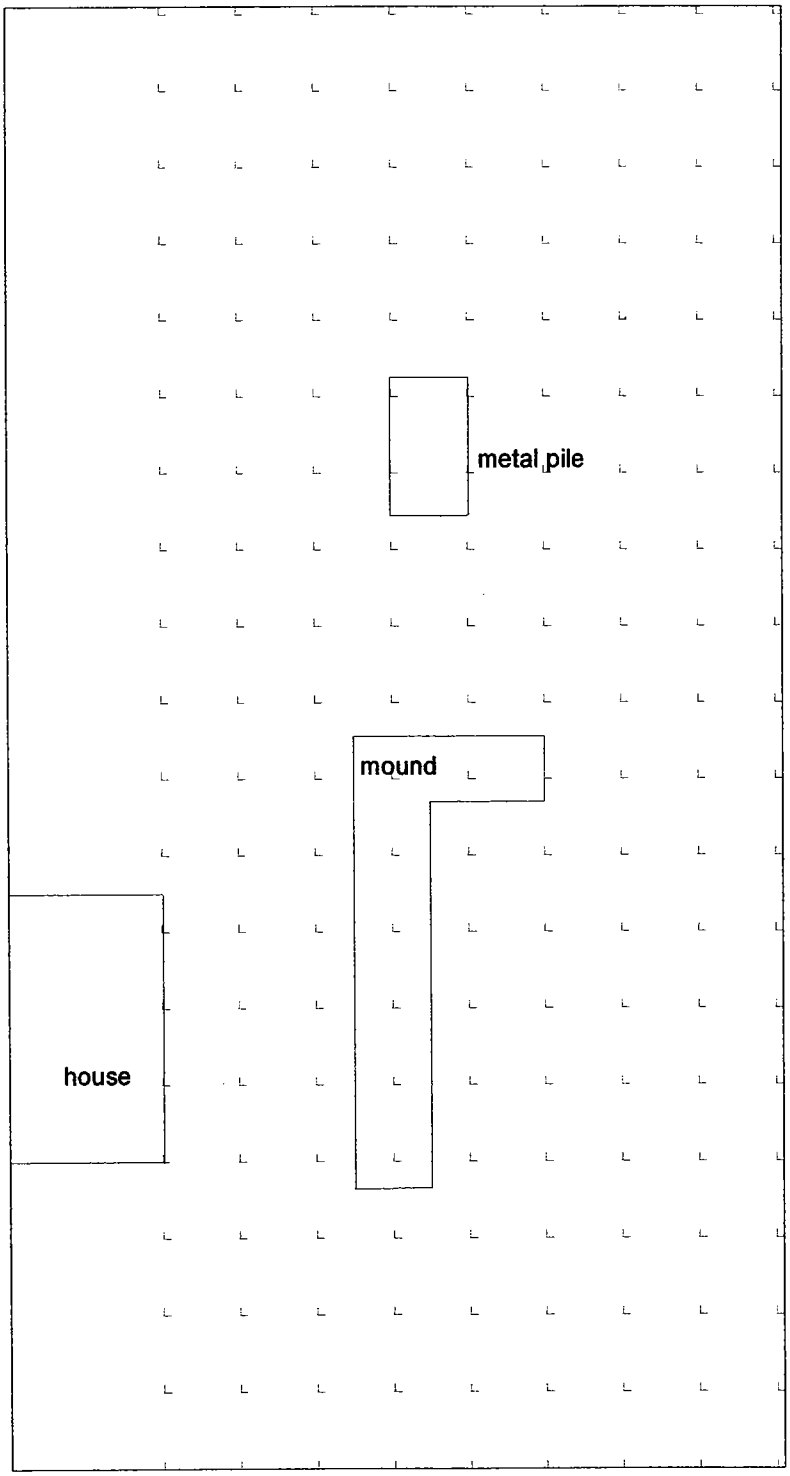
Michael E. Matthews
Staff Geophysicist



GRID LAYOUT MAP OF SITE 33 - SCRAP METAL AREA
INDIAN HEAD DIVISION
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MD 20640-5035

EARTH RESOURCES TECHNOLOGY

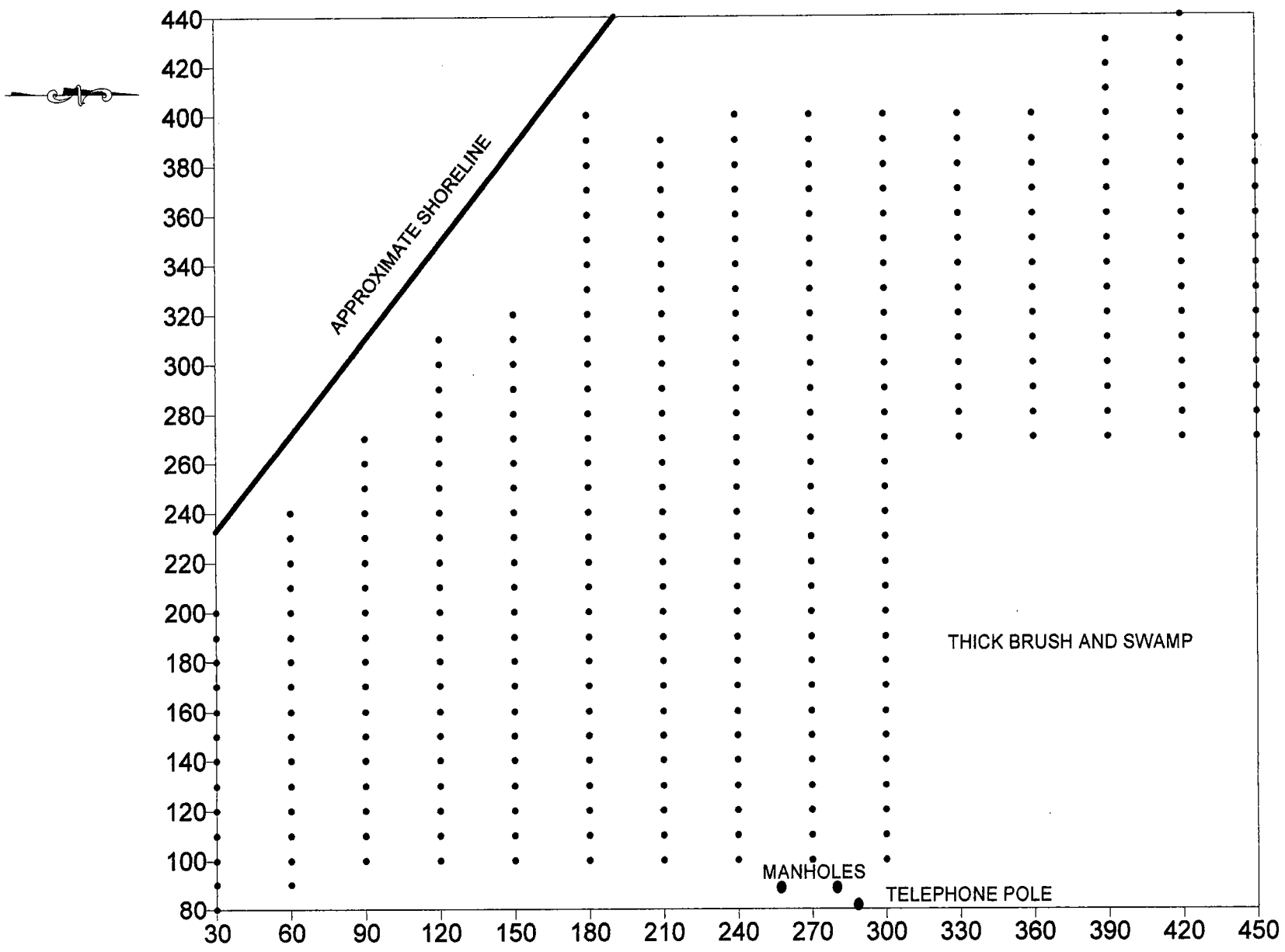
FIGURE 1 | SCALE 1" = 25' | FEBRUARY 6, 2002



GRID LAYOUT MAP OF SITE 34 - TOOL AREA
INDIAN HEAD DIVISION
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MD 20640-5035

EARTH RESOURCES TECHNOLOGY

FIGURE 2 | SCALE 1" = 25' | FEBRUARY 6, 2002



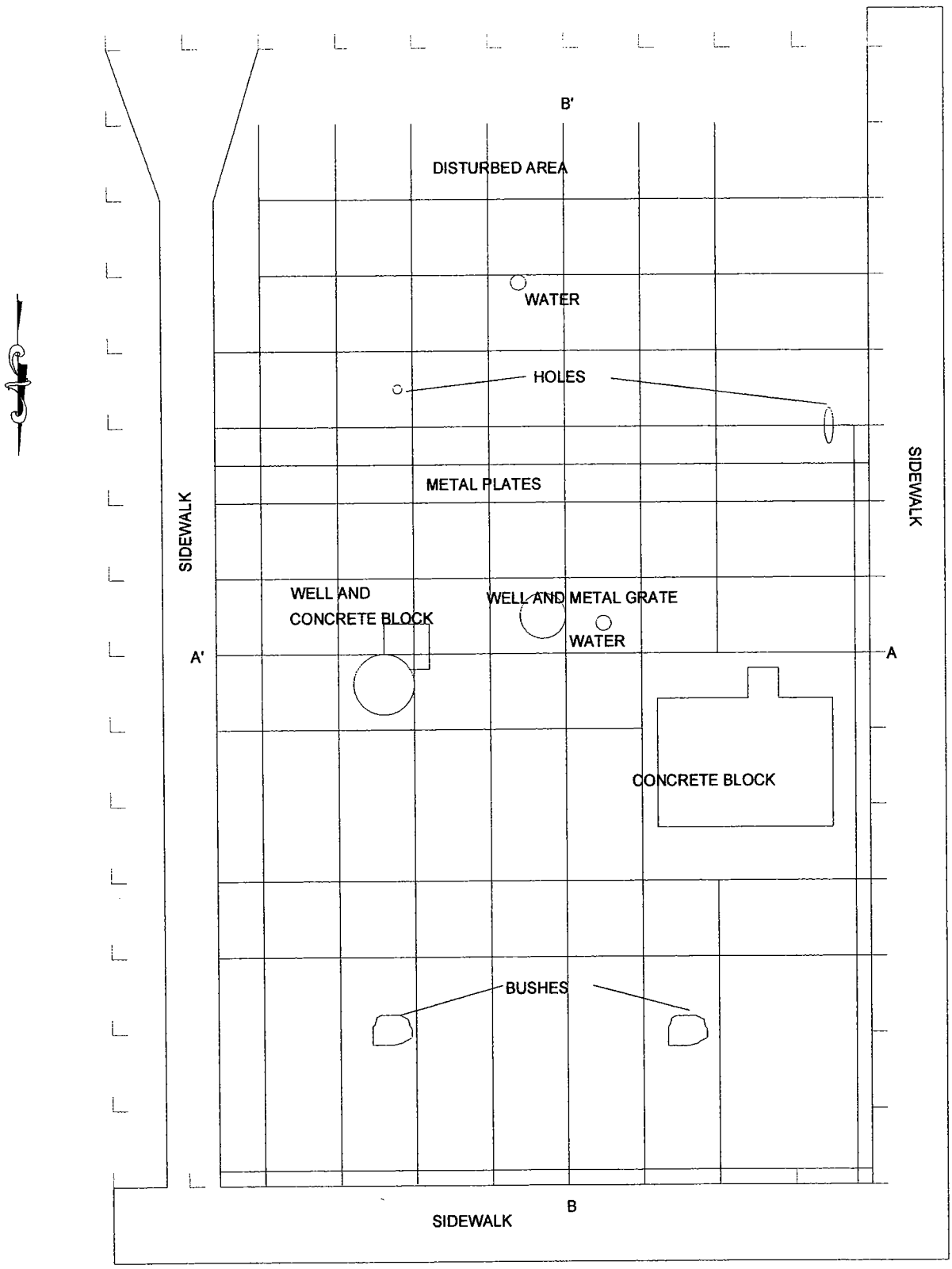
EARTH RESOURCES TECHNOLOGY

GRID LAYOUT MAP OF SITE 36 - LANDFILL
INDIAN HEAD DIVISION
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MD 20640-5035

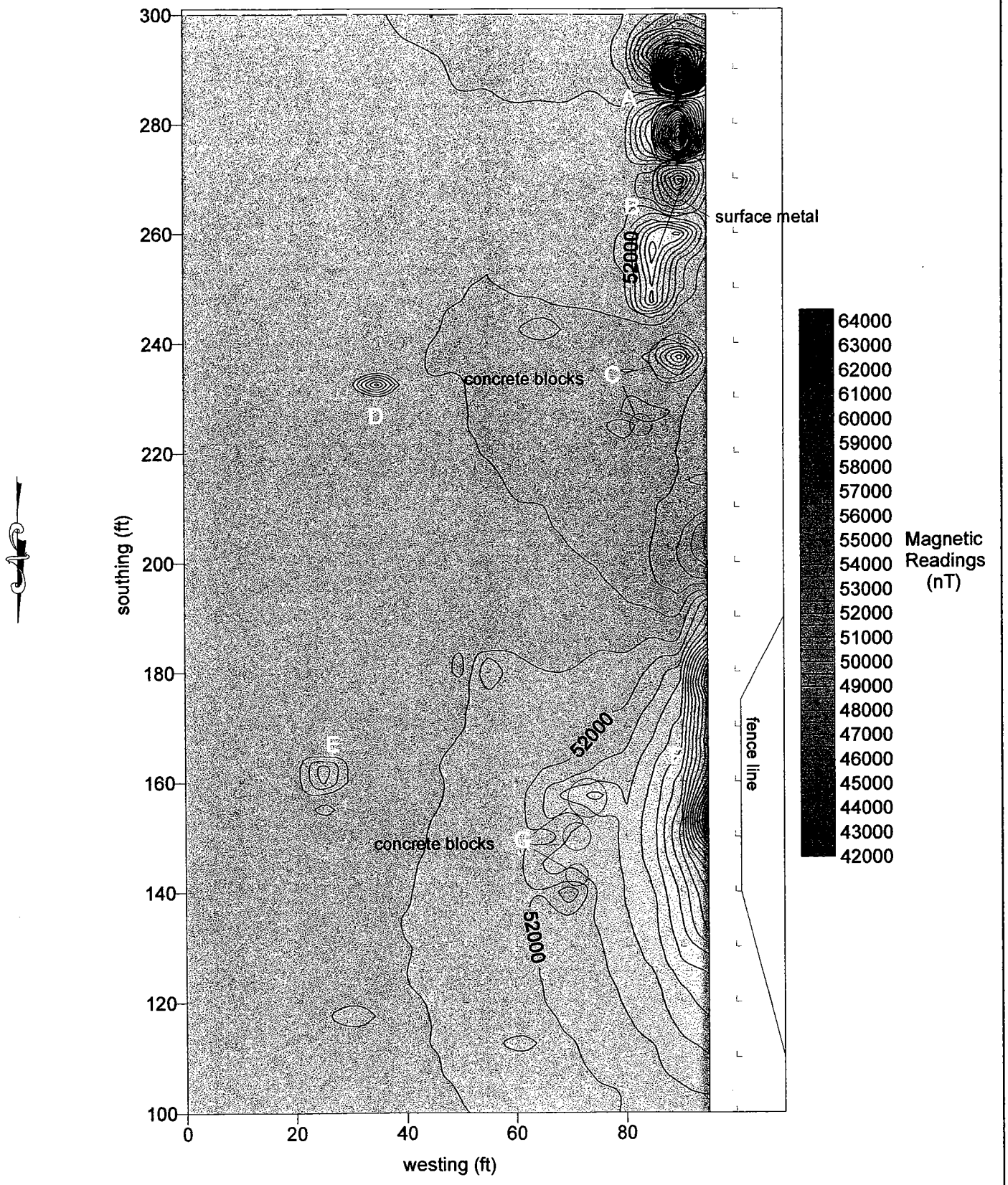
FIGURE 3

SCALE 1" = 60'

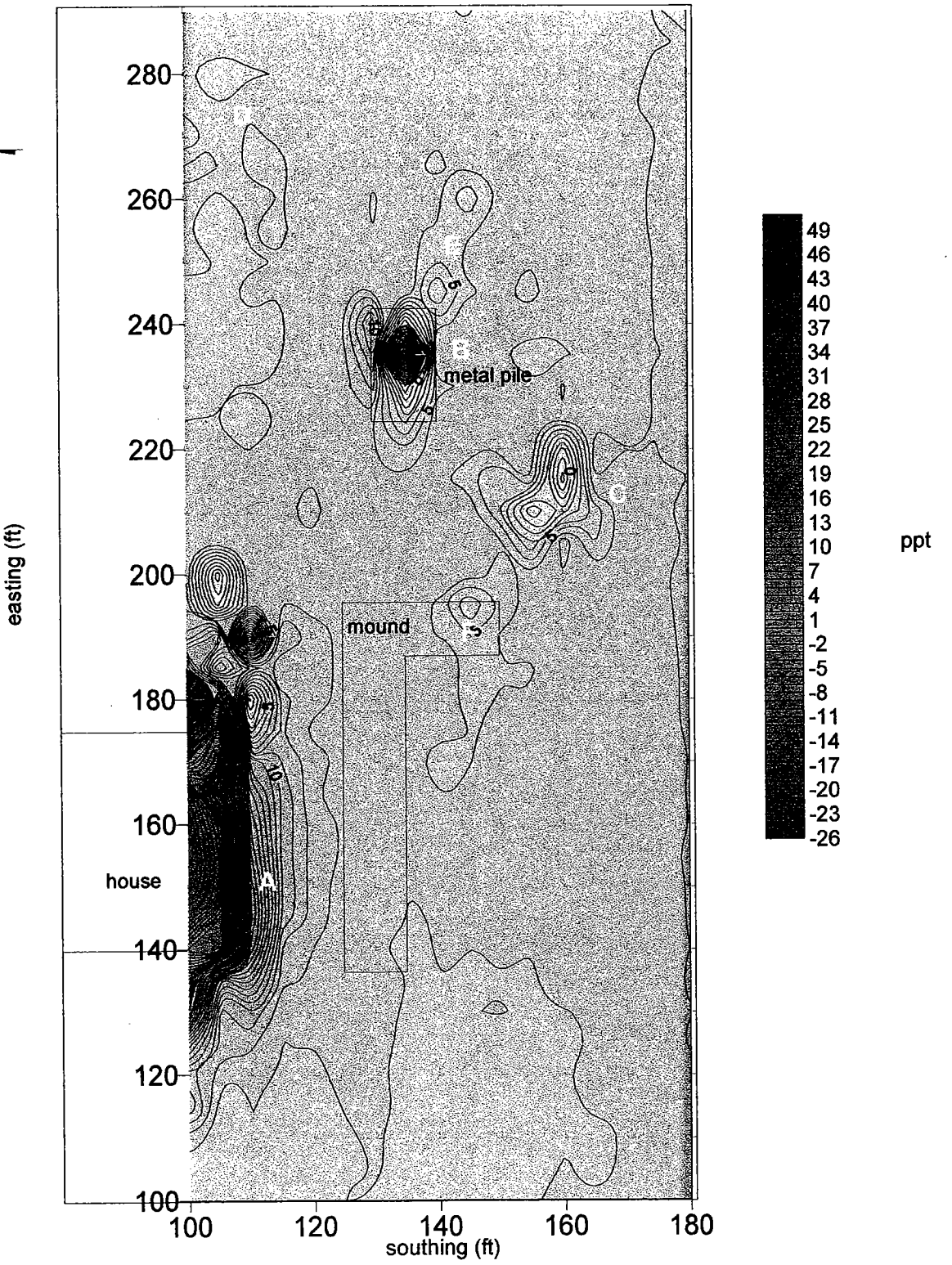
FEBRUARY 6, 2002



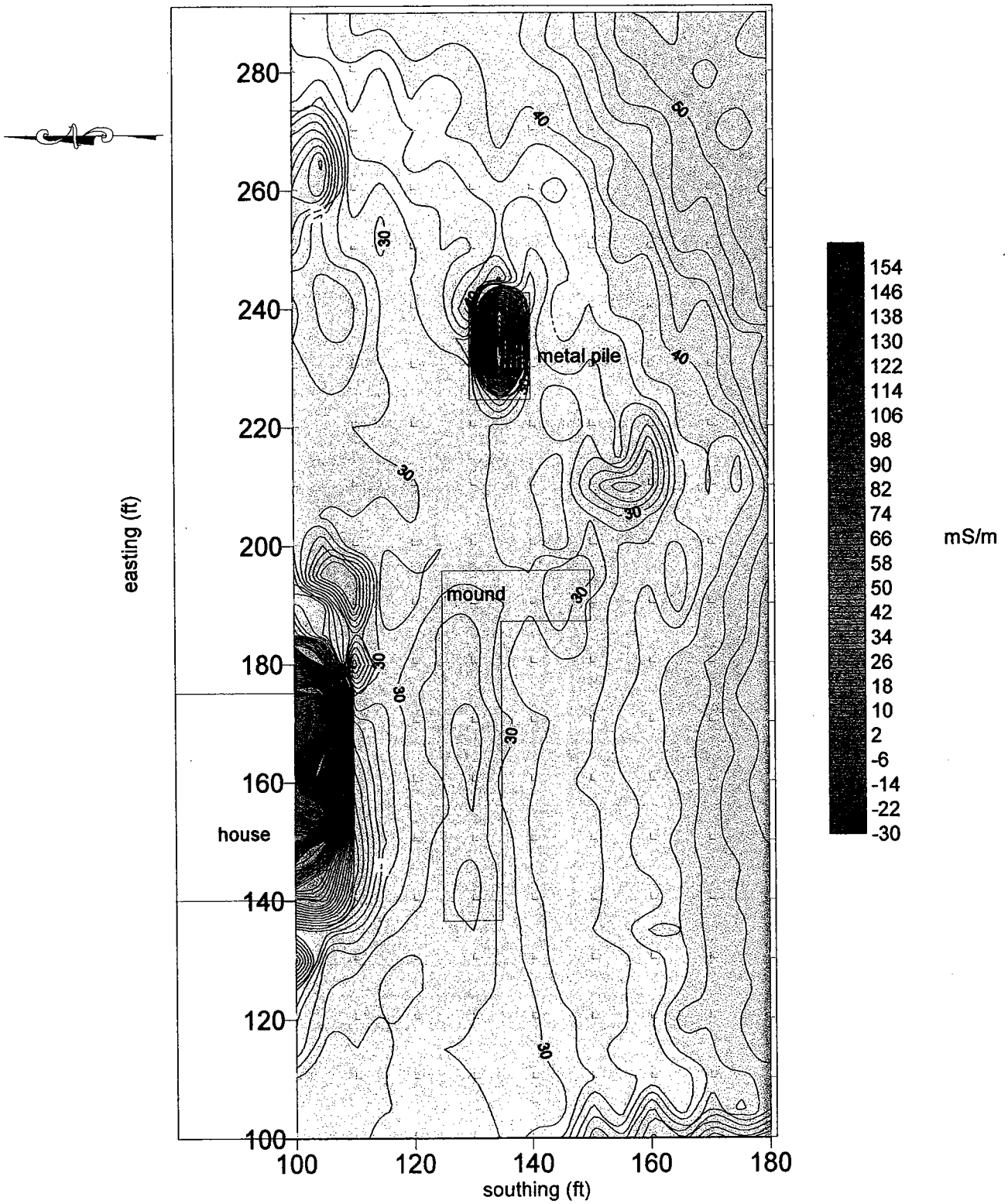
GPR SITE MAP OF SITE 51/52 - STEAM LINE SURVEY INDIAN HEAD DIVISION - NAVEL SURFACE WARFARE CENTER INDIAN HEAD, MD 20640-5035	EARTH RESOURCES TECHNOLOGY	
FIGURE 4	SCALE 1" = 10'	FEBRUARY 6, 2002



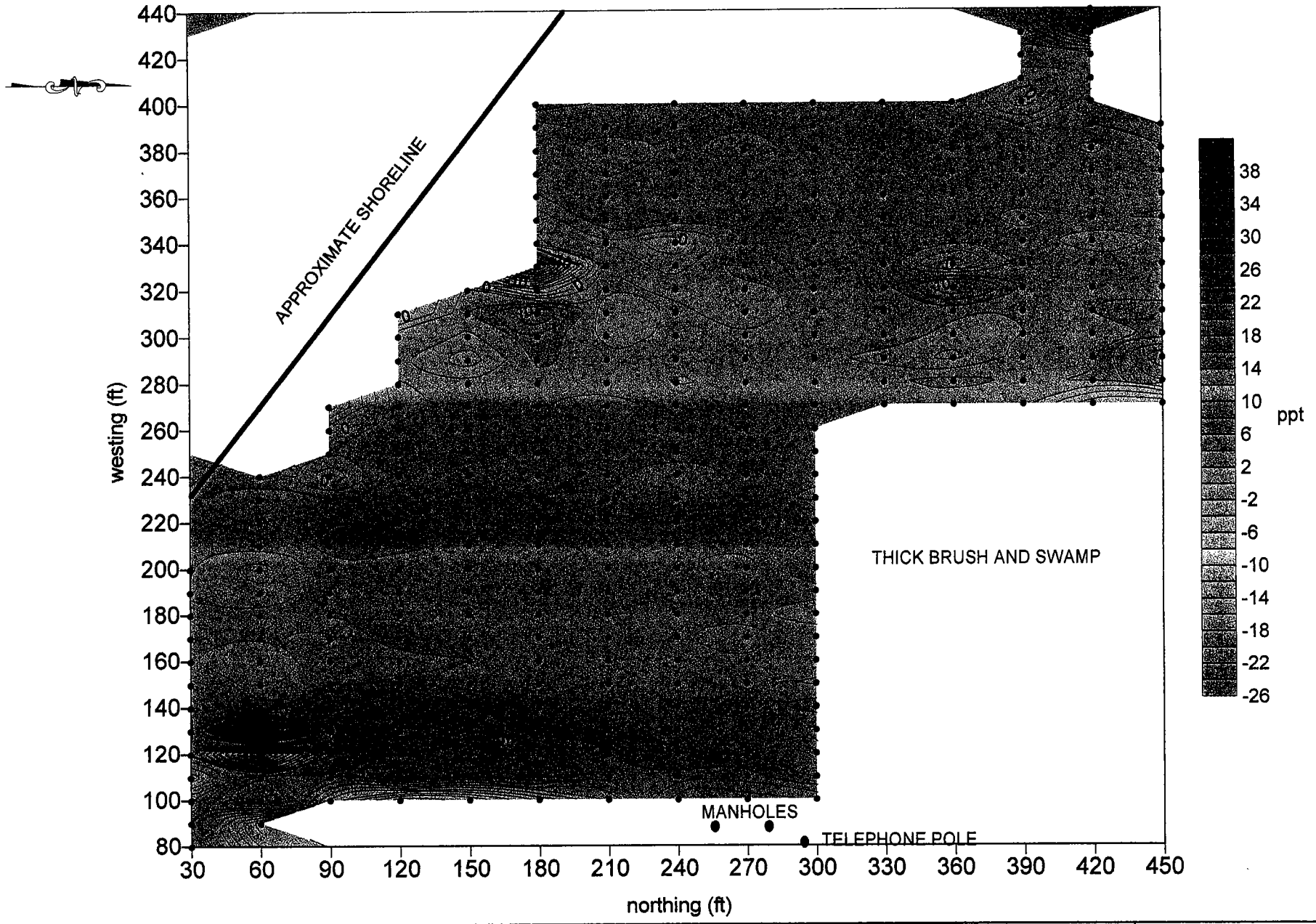
MAGNETIC CONTOUR MAP OF SITE 33 - SCRAP METAL AREA INDIAN HEAD DIVISION NAVAL SURFACE WARFARE CENTER INDIAN HEAD, MD 20640-5035	EARTH RESOURCES TECHNOLOGY	
FIGURE 5	SCALE 1" = 25'	FEBRUARY 6, 2002



IN-PHASE CONTOUR MAP OF SITE 34 - TOOL AREA INDIAN HEAD DIVISION NAVAL SURFACE WARFARE CENTER INDIAN HEAD, MD 20640-5035	EARTH RESOURCES TECHNOLOGY	
FIGURE 6	SCALE 1" = 25'	FEBRUARY 6, 2002



QUADRATURE CONDUCTIVITY CONTOUR MAP OF SITE 34 - TOOL AREA INDIAN HEAD DIVISION NAVAL SURFACE WARFARE CENTER INDIAN HEAD, MD 20640-5035	EARTH RESOURCES TECHNOLOGY	
FIGURE 7	SCALE 1" =25'	FEBRUARY 6, 2002



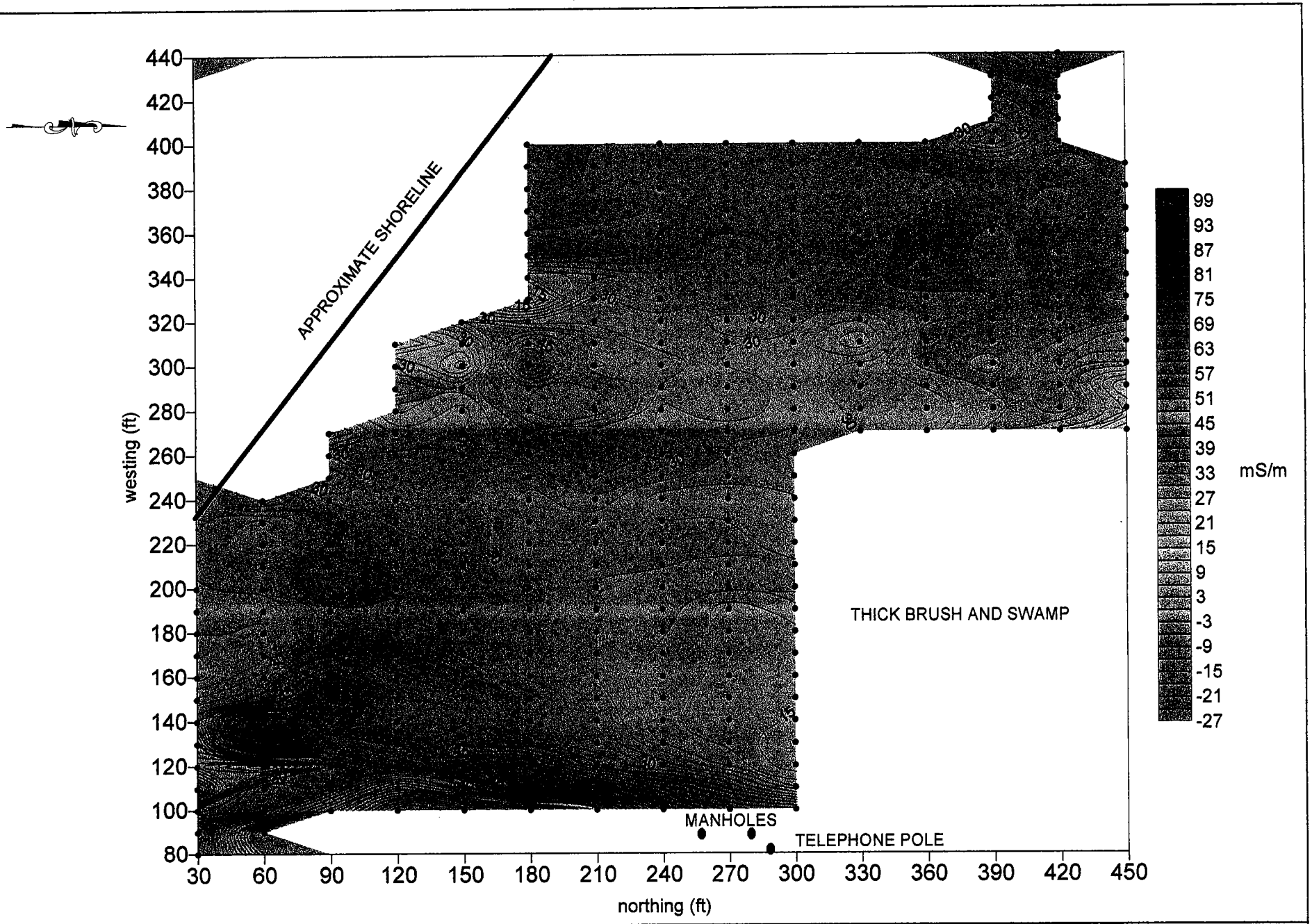
EARTH RESOURCES TECHNOLOGY

IN-PHASE CONTOUR MAP OF SITE 36 - LANDFILL
INDIAN HEAD DIVISION
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MD 20640-5035

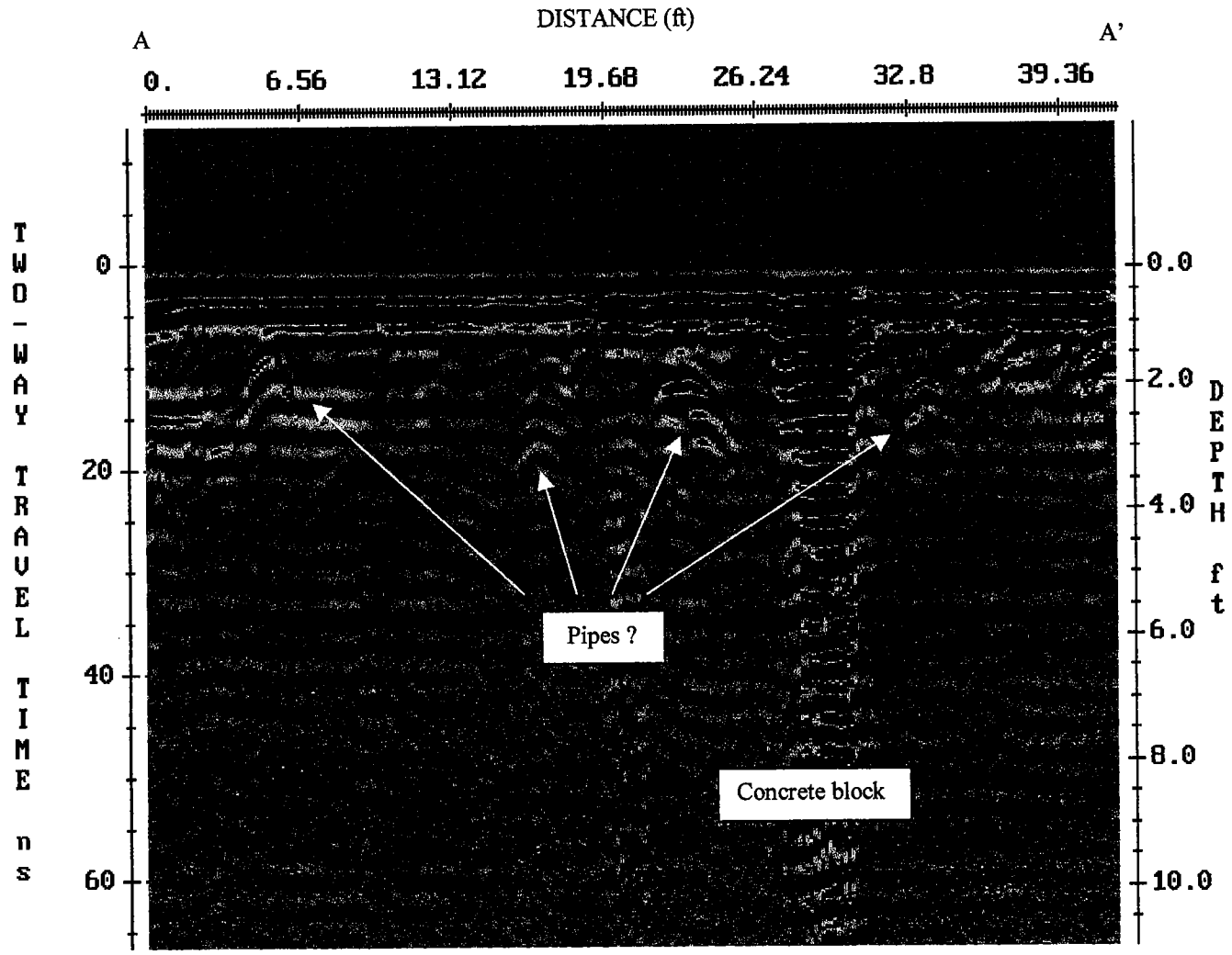
FIGURE 8

SCALE 1" = 60'

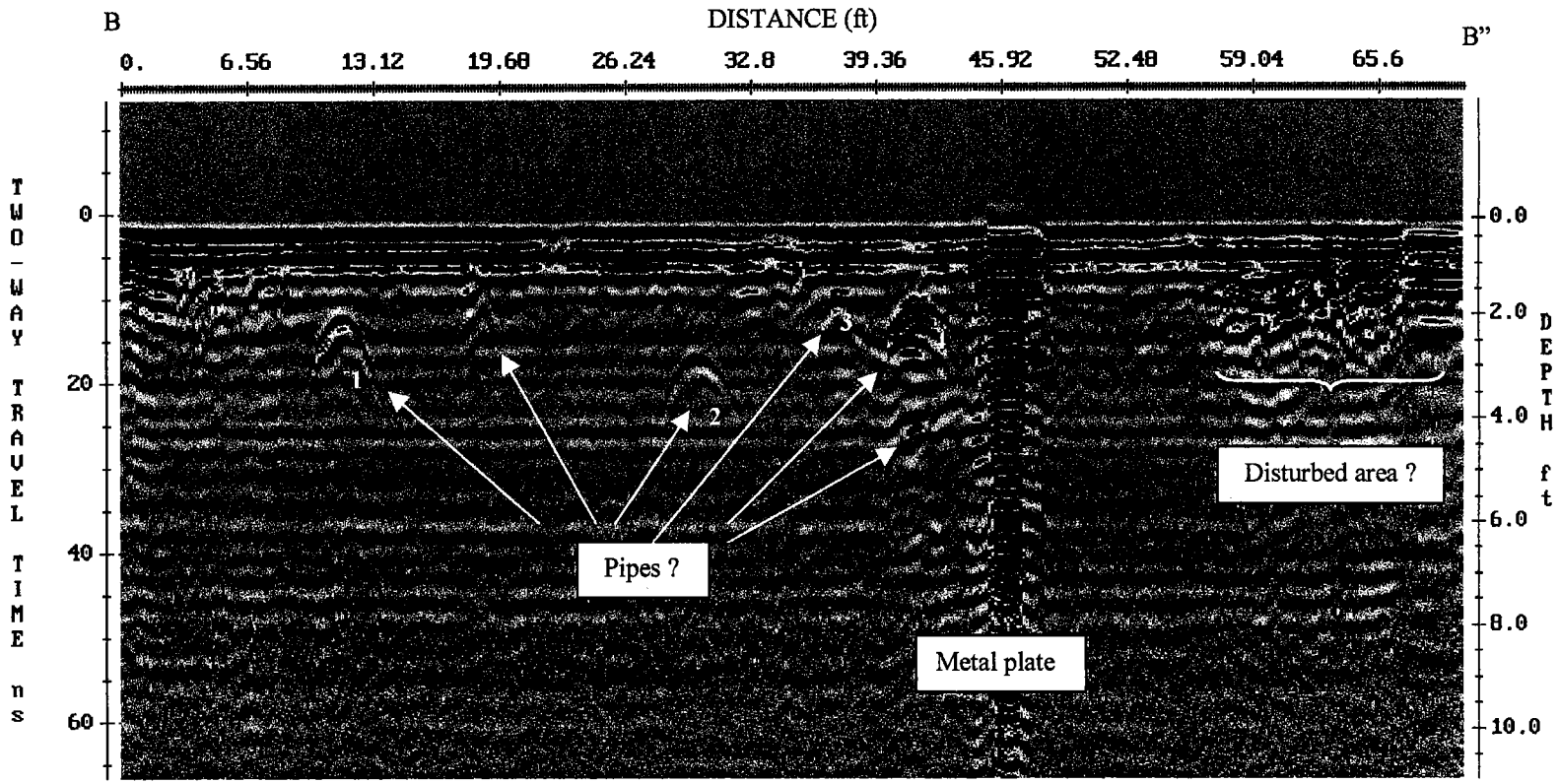
FEBRUARY 6, 2002



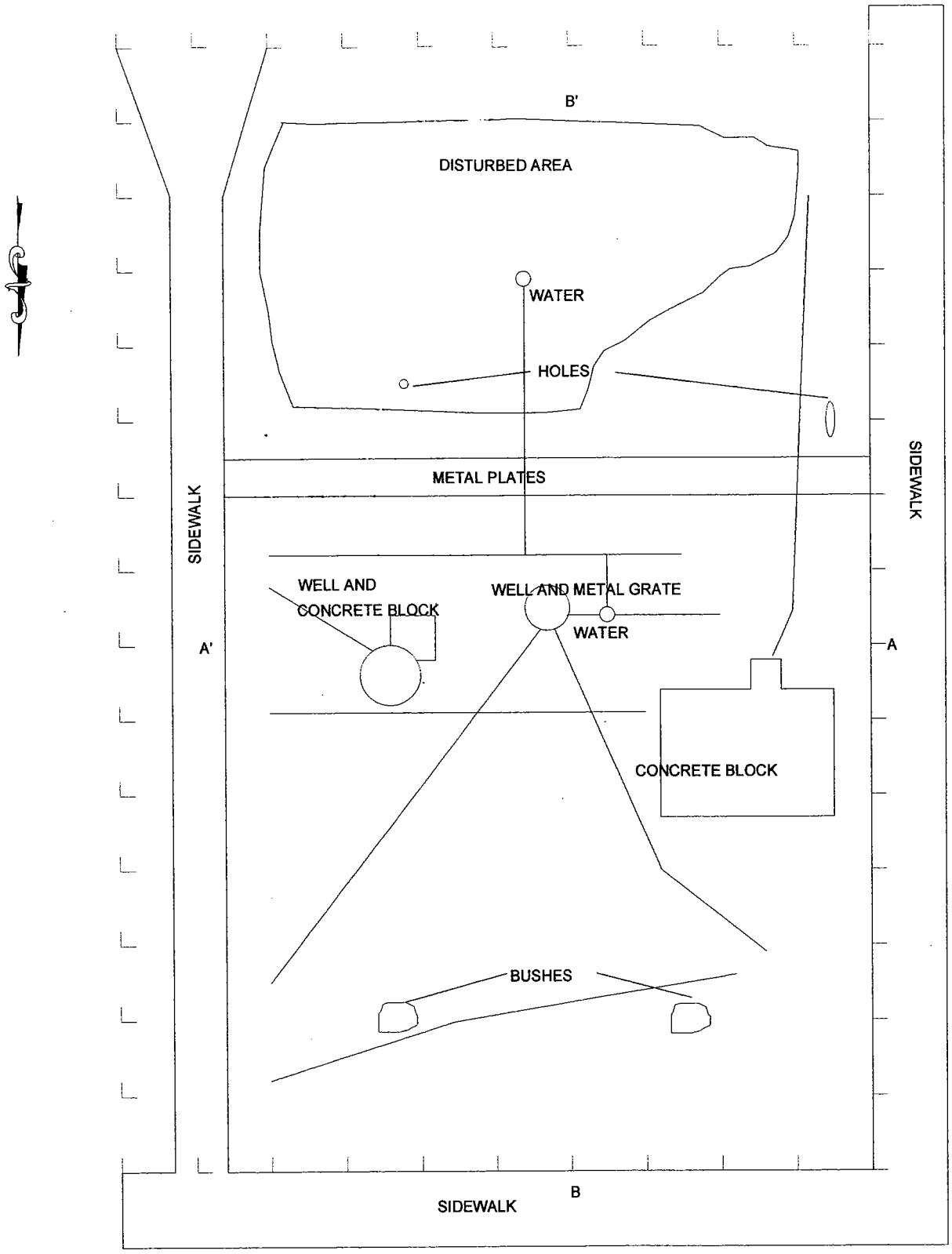
EARTH RESOURCES TECHNOLOGY	QUADRATURE CONDUCTIVITY CONTOUR MAP OF SITE 36 - LANDFILL INDIAN HEAD DIVISION NAVAL SURFACE WARFARE CENTER INDIAN HEAD, MD 20640-5035	FIGURE 9 SCALE 1" = 60' FEBRUARY 6, 2002



ERT EARTH RESOURCES TECHNOLOGY	GPR PROFILE A – A' SITE 51/52 – STEAM LINE SURVEY INDIAN HEAD DIVISION – NAVEL SURFACE WARFARE CENTER INDIAN HEAD, MD 20640-5035	FIGURE 10
SCALE AS SHOWN		February 6, 2002



ERT EARTH RESOURCES TECHNOLOGY	GPR PROFILE B– B' SITE 51/52 – STEAM LINE SURVEY INDIAN HEAD DIVISION – NAVEL SURFACE WARFARE CENTER INDIAN HEAD, MD 20640-5035	FIGURE 11
SCALE AS SHOWN		February 6, 2002



GPR PIPE MAP OF SITE 51/52 - STEAM LINE SURVEY INDIAN HEAD DIVISION - NAVAL SURFACE WARFARE CENTER INDIAN HEAD , MD 20640-5035	EARTH RESOURCES TECHNOLOGY	
FIGURE 12	SCALE 1" = 10'	FEBRUARY 6, 2002

APPENDIX E

GROUNDWATER LEVEL DATA

Tetra Tech NUS, Inc.

GROUNDWATER LEVEL MEASUREMENT SHEET

Project Name: Site Screening **Project No.:** 525
Location: IHDIV Stump Neck **Personnel:** KEITH SIMPSON
Weather Conditions: **Measuring Device:** M-SCOPE
Tidally Influenced: * Yes ✓ No ___ **Remarks:** S33 WELL NOT TIDALLY INFLUE

Well or Piezometer Number	Date	Time	Elevation of Reference Point (feet)*	Total Well Depth (feet)*	Water Level Indicator Reading (feet)*	Thickness of Free Product (feet)*	Groundwater Elevation (feet)*	Comments
S37TW01	2-12-02	1500	6.89	12.40	6.02	—	0.87	
S37TW02	↓	1503	6.24	12.35	4.99	—	1.25	
S37TW03	2-12-02	1505	6.98	12.25	5.94	—	1.04	
S34TW01	2-12-02	1519	7.20	12.35	7.35	—	-0.15	
S34TW02	↓	1518	5.30	7.50	3.87	—	1.43	
S34TW03	↓	1515	7.40	17.30	8.02	—	-0.62	
S33TW01	2-12-02	1550	82.11	29.40	10.97	—	71.14	
S33TW02	↓	1552	82.82	29.60	10.25	—	72.57	
S33TW03	↓	1545	79.50	30.00	9.25	—	70.25	

* All measurements to the nearest 0.01 foot

APPENDIX F

SURVEY DATA

TEMPOARY WELL SURVEY DATA
SITE SCREENING REPORT
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Well	Northing	Easting	Top of Casing elevation
S33TW001	320265.07	1252092.59	82.11
S33TW002	320293.41	1252107.64	82.82
S33TW003	320285.64	1252062.28	79.50
S34TW001	322639.58	1249271.79	7.20
S34TW002	322602.20	1249337.49	5.30
S34TW003	322676.97	1249318.22	7.40
S37TW001	323264.33	1249892.00	6.89
S37TW002	323217.47	1250053.61	6.24
S3/TW003	323314.95	1250151.60	6.98

Horizontal Datum - 1983 North American Datum
Vertical Datum - 1929 North American Geodetic Vertical Datum

APPENDIX G

DATA VALIDATION MEMORANDA

Tetra Tech NUS **INTERNAL CORRESPONDENCE**

TO: **MR. G. LATUILPPE** **DATE:** **APRIL 29, 2002**

FROM: **BERNARD F SPADA III** **COPIES:** **DV FILE**

SUBJECT: **ORGANIC DATA VALIDATION- VOA/SVOA/PEST/PCB**
CTO 325, NSWC INDIAN HEAD
SDG A0172

SAMPLES: 9/Aqueous

FD01310202	S34TB020502-1*	S37RB020502-1
S37SW0010001	S37SW0020001	S37SW0030001
S37TB013102*	S37TW0010001	S37TWDUP001

9/Soils

FD01310201	S37SB0010101	S37SB0010201
S37SB0020101	S37SB0030101	S37SB0030201
S37SD0010001	S37SD0020001	S37SD0030001

Overview

The sample set for CTO 325, NSWC Indian Head, SDG A0172 consists of four (4) environmental aqueous samples, eight (8) environmental soil samples, two (2) trip blanks, and three (3) field duplicates. The trip blanks denoted with an asterisk (*) were analyzed for volatile organic compounds (VOC) only by CLP Method OLC OLC02.1. All remaining samples were analyzed for volatile organic compounds (VOC), semiviolatile organic compounds (SVOC), pesticides (PEST), and polychlorinated biphenyls (PCB) by CLP Methods OLM04.1 (soils) and OLC02.1 (aqueous). Three duplicate pairs were included in this SDG: (FD01310202 / S37SW0010001), (FD01310201 / S37SD0010001), and (S37TWDUP001 / S37TW0010001).

The samples were collected by Tetra Tech NUS on January 31, February 4 and 5, 2002 and analyzed by Mitkem Corporation. All analyses were conducted in accordance with Naval Facilities Engineering Service Center (NFESC) Quality Assurance/Quality Control (QA/QC) criteria using CLP Methods OLM04.2 and OLC02.1 analytical and reporting protocols.

The data contained in this SDG were validated with regard to the following parameters: data completeness, holding times, GCMS tuning, initial/continuing calibrations, laboratory method blank results, surrogate spike recoveries, blank spike/blank spike duplicate results, internal standard recoveries, chromatographic resolution, compound identification, compound quantitation, field duplicate precision, and detection limits. Areas of concern are listed below.

Major

- Both of the volatile aqueous initial calibrations were below the 0.05 relative response factor (RRF) quality control criteria for acetone. All non-detected results for acetone were rejected (UR).

- All of the volatile aqueous continuing calibrations were below the 0.05 RRF quality control criteria for acetone. All non-detected results for acetone were rejected (UR).

- The volatile aqueous continuing calibration analyzed on February 11 at 01:11 was below the 0.05 RRF quality control criteria for 2-butanone. All associated results for 2-butanone were rejected (UR).

- The volatile aqueous continuing calibration analyzed on February 16 at 12:05 was below the 0.05 RRF quality control criteria for 2-butanone. All associated results for 2-butanone were rejected (UR).

- The volatile aqueous continuing calibration analyzed on February 20 at 09:38 was below the 0.05 RRF quality control criteria for 2-butanone. All associated results for 2-butanone were rejected (UR).

- Both of the semivolatile soil initial calibrations were below the 0.05 RRF quality control criteria for N-nitrosodiphenylamine. All non-detected results for N-nitrosodiphenylamine were rejected (UR).

- All of the semivolatile soil continuing calibrations were below the 0.05 RRF quality control criteria for N-nitrosodiphenylamine. All non-detected results for N-nitrosodiphenylamine were rejected (UR).

Minor

- Sample S37SD0030001 was <30% solids. All results for this sample were qualified as estimated (J, UJ).

The following compounds were detected in the semivolatile solid method blank:

Compound	Maximum Concentration	Blank Action Level
Bis(2-ethylhexyl)phthalate	33 ug/kg	330 ug/kg
Acetophenone	76 ug/kg	380 ug/kg

Sample aliquot, percent solids, and dilution factors were taken into consideration when applying the blank action levels. Positive results for bis(2-ethylhexyl)phthalate and acetophenone below the blank action level were qualified as non-detected (B).

- Internal standards 5 and 6 (chrysene-d12 and perylene-d12) were recovered below the 50% quality control criteria in sample S37SD0030001. All results associated with the aforementioned internal standards were qualified as estimated (UJ).

- Internal standard 6 (perylene-d12) was recovered below the 50% quality control criteria in the re-extraction of sample S37SB0020101. All results associated with the aforementioned internal standard were qualified as estimated (J, UJ).

- The semivolatile surrogate recoveries for 2-fluorobiphenyl and 2,4,6-tribromophenol were below the laboratory's quality control criteria (and <10%) in sample S37SB0020101. The sample was re-extracted outside of holding time and re-analyzed. The surrogate recoveries were compliant in the re-analysis. The re-analysis was qualified as estimated (J, UJ) for all results and used for validation.

Notes

The volatile continuing calibration analyzed on February 11 at 01:11 exceeded the 25 percent difference (%D) quality control criteria (but was < 50%) for acetone, 2-butanone, 4-methyl-2-pentanone, 2-hexanone, 1,2-dibromo-3-chloropropane, and ethyl ether. No action was taken because all associated results were non-detected.

The volatile continuing calibration analyzed on February 16 at 12:05 exceeded the 25 %D quality control criteria (but was < 50%) for acetone, 1,1-dichloroethane, 2-butanone, 1,2-dichloropropane, 4-methyl-2-pentanone, 2-hexanone, and 1,2,4-trichlorobenzene. No action was taken because all associated results were non-detected.

The semivolatile initial calibration analyzed on February 23 exceeded the 30% relative standard deviation (RSD) quality control criteria (but was <50%) for 2,4-dinitrophenol. No action was taken because all results for 2,4-dinitrophenol were non-detected.

The semivolatile continuing calibration analyzed on March 8 at 02:12 exceeded the 25 %D quality control criteria (but was <50%) for 2,4-dimethylphenol, 2,4,5-trichlorophenol, 4-nitrophenol, and pentachlorophenol. No action was taken because all associated results for the aforementioned compounds were non-detected.

The pesticide resolution check analyzed on January 28 at 15:00 was below the 90% resolution quality control criteria for methoxychlor on both columns and for 4,4-DDE on the DB-608 column. No action was taken because the resolution was shown to be acceptable, by analysis of a continuing calibration, before any environmental samples were analyzed.

Executive Summary

Laboratory Performance: Qualifications were made based on calibration non-compliances, internal standard non-compliances, %D between analytical columns for PEST/PCBs, method blank contamination, and surrogate non-compliance.

Other Factors Affecting Data Quality: None.

The data for these analyses were reviewed with reference to U.S. EPA National Functional Guidelines for Data Validation as modified by EPA Region III (9/94) and the NFESC guidelines entitled Navy IRCDQM (Sept. 1999). The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NFESC Guidelines and the Quality Assurance Project Plan (QAPP)."

Bernard F Spada III

Tetra Tech NUS
Bernard F Spada III
Chemist/Data Validator

Tetra Tech NUS
Joseph A. Samchuck
Quality Assurance Officer

Attachments:

Appendix A – Qualified Analytical Results
Appendix B – Results as Reported by the Laboratory
Appendix C – Support Documentation

Tetra Tech NUS **INTERNAL CORRESPONDENCE**

TO: **G. LATULIPPE** **DATE:** **APRIL 29, 2002**

FROM: **REBEKAH A. HAYNIE** **COPIES:** **DV FILE**

SUBJECT: **INORGANIC DATA VALIDATION – TAL METALS**
CTO 325-NSWC INDIAN HEAD
SAMPLE DELIVERY GROUP (SDG) – A0172

SAMPLES: 4/Sediment/

FD01310201	S37SD0010001	S37SD0020001
S37SD0030001		

5/Soil/

S37SB0010101	S37SB0010201	S37SB0020101
S37SB0030101	S37SB0030201	

9/Aqueous/

FD01310202	S34TW0020001	S34TW0030001
S37RB020502-1	S37SW0010001	S37SW0020001
S37SW0030001	S37TW0010001	S37TWDUP001

Overview

The sample set for CTO 325, NSWC Indian Head, SDG A0172, consists of four (4) sediment, five (5) soil, and eight (8) aqueous environmental samples and one (1) aqueous rinsate blank sample. Three field duplicate pairs, S37TWDUP001 / S37TW0010001, FD01310201 / S37SD0010001, and FD01310202 / S37SW0010001, are included in this SDG.

All sediment and soil samples were analyzed for target analyte list (TAL) metals. Two aqueous samples including S34TW0020001 and S34TW0030001 were analyzed for total and dissolved beryllium and copper only. Two aqueous samples including S37TW0010001 and S37TWDUP001 were analyzed for total and dissolved TAL metals. All other aqueous samples were analyzed for TAL metals only. The samples were collected by TetraTech NUS on February 4 and 5, 2002 and analyzed by Mitkem Corporation under Naval Facilities Engineering Service Center (NFESC) Quality Assurance/Quality Control (QA/QC) criteria. Analyses were conducted using EPA method ILM04.1.

All analyses, with the exclusion of mercury, were conducted using Inductively Coupled Plasma (ICP) methodologies. Mercury analyses were conducted using Cold Vapor Atomic Absorption (CVAA) methodologies.

Summary

All samples were successfully analyzed. The findings offered in this report are based upon a general review of all available data. The data review was based on data completeness, holding times, calibration data, laboratory blank results, ICP interference check sample (ICS) results, laboratory control spike (LCS) samples, matrix spike (MS) results, laboratory and field duplicate precision, and ICP serial dilutions.

Problems with respect to data quality are listed below.

Minor Problems

- The following contaminants were detected in the laboratory method / preparation blanks run on instrument identification Optima 1 at the following maximum concentrations:

Analyte	Maximum Concentration	Action Level
Aluminum	30.9 µg/L	154.5 µg/L 30.9 mg/kg
Barium[(1)]	4.615 µg/L	23.075 µg/L
Barium	1.8 µg/L	1.8 mg/kg
Chromium[(1)]	0.636 µg/L	3.18 µg/L
Chromium[(2)]	0.11 mg/kg	0.55 mg/kg
Cobalt	0.6 µg/L	3.0 µg/L 0.6 mg/kg
Copper[(1)]	4.541 µg/L	22.705 µg/L
Copper	3.2 µg/L	3.2 mg/kg
Iron[(1)]	98.944 µg/L	494.72 µg/L
Iron[(2)]	5.203 mg/kg	26.015 mg/kg
Magnesium	16.9 µg/L	84.5 µg/L
Magnesium[(2)]	3.701 mg/kg	18.505 mg/kg
Manganese[(1)]	2.22 µg/L	11.1 µg/L
Manganese[(2)]	0.549 mg/kg	2.745 mg/kg
Nickel	0.5 µg/L	2.5 µg/L 0.5 mg/kg
Potassium	101.7 µg/L	508.5 µg/L 101.7 mg/kg
Zinc[(1)]	5.088 µg/L	25.44 µg/L
Zinc[(2)]	2.077 mg/kg	10.385 mg/kg

Sediment samples affected: S37SD0010001, S37SD0020001, FD01310201
Aqueous samples affected: S37SW0010001, S37SW0020001, FD01310202

(1) Maximum concentration present in an aqueous preparation blank.
(2) Maximum concentration present in a sediment preparation blank.

An action level of 5X the maximum concentration was used to evaluate the sample data for blank contamination. Sample aliquot, percent solids, and dilution factors were taken into consideration when evaluating for blank contamination. Sample results for aluminum, chromium, cobalt, copper, iron, and nickel of the aqueous samples listed above and cobalt, copper, potassium, and zinc of the sediment samples listed above were qualified with a "B", as a result of blank contamination.

- The following contaminants were detected in the laboratory method / preparation blanks run on instrument identification Optima 2 at the following maximum concentrations:

Analyte	Maximum Concentration	Action Level
Antimony*	5.0 µg/L	25.0 µg/L 5.0 mg/kg
Barium(1)	2.608 µg/L	13.04 µg/L
Barium(2)	0.132 mg/kg	0.66 mg/kg
Chromium(1)	0.481 µg/L	2.405 µg/L
Chromium(2)	0.192 mg/kg	0.96 mg/kg
Cobalt	0.9 µg/L	4.5 µg/L 0.9 mg/kg
Copper	1.1 µg/L	5.5 µg/L 1.1 mg/kg
Magnesium	75.7 µg/L	378.5 µg/L 75.7 mg/kg
Manganese(1)	1.616 µg/L	8.08 µg/L
Manganese(2)	0.24 mg/kg	1.2 mg/kg
Nickel	1.0 µg/L	5.0 µg/L 1.0 mg/kg
Potassium(1)	137.71 µg/L	688.55 µg/L
Potassium(2)	19.582 mg/kg	97.91 mg/kg
Silver(1)	0.511 µg/L	2.555 µg/L
Sodium(1)	600.012 µg/L	3000.06 µg/L
Sodium(2)	109.759 mg/kg	548.795 mg/kg
Zinc	5.4 µg/L	27.0 µg/L 5.4 mg/kg

Solid samples affected: S37SD0030001, S37SB0010101, S37SB0010201, S37SB0030101, S37SB0030201, and S37SB0020101
Aqueous samples affected: S34TW0030001, S34TW0030001-F, S34TW0020001, S34TW0020001-F, S37SW0030001, S37TW0010001, S37TW0010001-F, S37TWDUP001, and S37TWDUP001-F

(1) Maximum concentration present in an aqueous preparation blank.
(2) Maximum concentration present in a sediment preparation blank.
*Antimony blank contamination affects all samples in the SDG

An action level of 5X the maximum concentration was used to evaluate the sample data for blank contamination. Sample aliquot, percent solids, and dilution factors were taken into consideration when evaluating for blank contamination. Sample results for antimony, beryllium, cobalt, nickel, silver, and zinc of the aqueous samples listed above and cobalt, potassium, and sodium of the solid samples listed above were qualified with a "B", as a result of blank contamination.

- Percent solids were < 30% in sediment sample S37SD0030001. All positive sample results were qualified as estimated, "J". Non-detected sample results were qualified as estimated, "UJ".

- Serial dilution non-compliance (percent difference (%D) > 10%) was noted for aluminum, barium, iron, and manganese, affecting the soil matrix. All positive results for these analytes were qualified as estimated, "J".

- Serial dilution non-compliance (%D > 10%) was noted for barium, magnesium, manganese, and potassium, affecting the aqueous matrix. All positive results for these analytes were qualified as estimated, "J". All non-detected results for magnesium, manganese, and potassium were qualified as estimated, "UJ".

- Laboratory duplicate imprecision (relative percent difference (RPD) > 35%) was noted for aluminum and manganese, affecting the soil matrix. All positive results were qualified as estimated, "J".

- LCS sample recovery non-compliance (percent recovery (%R) < 80%) was noted for aluminum, antimony, and iron, affecting the soil and sediment matrices. Positive results for aluminum and iron were qualified as estimated, "J". Due to conflicting non-compliances, a direction of bias could not be determined. Non-detected results reported for antimony were qualified as biased low, "UL", and estimated, "UJ", when a direction of bias could not be determined due to conflicting non-compliances.

- MS recovery non-compliance (%R < 75%) was noted for selenium, affecting the sediment matrix. Non-detected selenium results were qualified as biased low, "UL". In cases where directional bias could not be determined due to conflicting non-compliances, non-detected results were qualified as estimated, "UJ".

- The interfering analyte iron was present in sample S37SD0030001 at a concentration comparable to the level of iron in the Interference Check Sample (ICS) solution. Several analytes namely antimony, arsenic, barium, cadmium, chromium, cobalt, copper, lead, manganese, nickel, potassium, selenium, silver, sodium, thallium, vanadium, and zinc were present in the ICS solution at concentrations that exceeded the absolute value of the Instrument Detection Limit (IDL). Interference affects exist for antimony, arsenic, cadmium, silver, and thallium. The non-detected results reported for antimony, silver, and thallium were qualified as estimated, "UJ", due to conflicting non-compliances. Positive results reported for arsenic and cadmium were qualified as estimated, "J", due to conflicting non-compliances.

- Contract Required Detection Limit (CRDL) calibration standards non-compliance (%R > 110%) was noted for antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, manganese, nickel, selenium, silver, thallium, and vanadium, affecting all three sample matrices. Positive results less than two times the CRDL for antimony, arsenic, cadmium, cobalt, nickel, selenium, thallium, and vanadium of the aqueous matrix were qualified as biased high, "K". Positive results less than two times the CRDL for arsenic, beryllium, cadmium, chromium, cobalt, copper, nickel, silver, and vanadium of the soil and sediment matrices were qualified as biased high, "K", or estimated, "J", in cases where directional bias could not be determined due to conflicting non-compliances.

Notes

- LCS non-compliance (%R > 120%) was noted for mercury, affecting the soil and sediment matrices. Because all sample results for mercury were reported as non-detected by the laboratory, qualification was not necessary and sample results were considered acceptable.

- CRDL calibration standards noncompliance (%R > 110%) was noted for lead and zinc. Qualification of the sample results was not necessary, as results were greater than two times the CRDL.

Executive Summary

Laboratory Performance: Contamination of the laboratory method/preparation blanks was noted for all three sample matrices. Laboratory duplicate imprecision was noted for aluminum and manganese, affecting the soil and sediment matrices. CRDL calibration non-compliance was noted for many analytes, affecting all three sample matrices. The LCS sample recovery was low for aluminum, antimony, and iron, affecting the soil and sediment sample matrices.
Other Factors Affecting Data Quality: MS recovery non-compliance was noted for selenium, affecting the soil and sediment matrices. The interfering analyte iron was found in a sediment sample. Serial dilution non-compliance was noted for several analytes, affecting all three sample matrices. Percent solids of sediment sample S37SD0030001 were < 30%, requiring estimation of positive and non-detected sample results of the sample.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Inorganic Review", April 1993, as amended for using within USEPA Region 3, and the NFESC document entitled "Navy IRCDQM" (September 1999).

The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NFESC Guidelines and the Quality Assurance Project Plan (QAPP)."

Tetra Tech NUS
Rebekah A. Haynie
Environmental Scientist

TetraTech NUS
Joseph A. Samchuck
Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as reported by the Laboratory
3. Appendix C - Support Documentation

Tetra Tech NUS **INTERNAL CORRESPONDENCE**

TO:	**MR. G. LATUILPPE**	**DATE:**	**APRIL 29, 2002**
FROM:	**BERNARD F SPADA III**	**COPIES:**	**DV FILE**

SUBJECT: **ORGANIC DATA VALIDATION- VOA/SVOA/PEST/PCB**
CTO 325, NSWC INDIAN HEAD
SDG A0205

SAMPLES: 3/Aqueous

S37TB020602-1	S37TW0020001*	S37TW0030001*

3/Soils

S51SB0010101	S51SB0010201	S51SBDUP101

Overview

The sample set for CTO 803, NSWC INDIAN HEAD, SDG A0205 consists of two (2) environmental aqueous samples, two (2) environmental soil samples, one (1) trip blank, and one (1) field duplicate. All samples were analyzed for volatile organic compounds (VOC) by CLP Methods OLM04.1 (soils) and OLC02.1 (aqueous). The samples denoted with an asterisk (*) were analyzed for semivolatile organic compounds (SVOC), pesticides (PEST), and polychlorinated biphenyls (PCB) by method CLP OLC02.1. The duplicate pair is S51SBDUP101 and S51SB0010101.

The samples were collected by Tetra Tech NUS on February 6 and 11, 2002 and analyzed by Mitkem Corporation. All analyses were conducted in accordance with Naval Facilities Engineering Service Center (NFESC) Quality Assurance/Quality Control (QA/QC) criteria using CLP Methods OLM04.2 and OLC02.1 analytical and reporting protocols.

The data contained in this SDG were validated with regard to the following parameters: data completeness, holding times, GCMS tuning, initial/continuing calibrations, laboratory method blank results, surrogate spike recoveries, blank spike/blank spike duplicate results, internal standard recoveries, chromatographic resolution, compound identification, compound quantitation, field duplicate precision, and detection limits. Areas of concern are listed below.

Major

- The volatile aqueous initial calibration was below the 0.05 relative response factor (RRF) quality control criteria for acetone. All associated non-detects were rejected (UR).
- The volatile aqueous continuing calibration performed on February 16 at 12:05 was below the 0.05 relative response factor (RRF) quality control criteria for acetone and 2-butanone. All associated non-detects were rejected (UR).

Minor

- Samples S51SB0010201 and S37TW0020001 had results below the detection limit but above the method detection limit. These results were qualified as estimated (J) due to uncertainty near

detection limit.

The following compounds were detected in the solid method blank:

Compound	Maximum Concentration	Blank Action Level
Acetone	9.0 ug/kg	90 ug/kg
Methylene chloride	4.0 ug/kg	40 ug/kg

Sample aliquot, percent solids, and dilution factors were taken into consideration when applying the blank action levels. Positive results for acetone and methylene chloride below the blank action level were qualified as non-detected (B).

- Sample S37TW0020001 surrogate recoveries were >150%. The sample was re-extracted with similar results. However a difference between the extracts were noticed. Positive results were reported in the original extract and non-detects were reported in the re-extraction for endosulfan I and gamma-BHC. Because the original results were associated with high %Ds, the reviewer used the non-detected re-extraction results for endosulfan I, endrin, and gamma-BHC. These results were quailfied as estimated (UJ), due to extraction holding time exceedance.

Notes

The volatile continuing calibration performed on February 16 at 12:05 exceeded the 25%D (but were <50%) quality control criteria for chloromethane, 1,1-dichloroethane, 1,2-dichloropropane, 4-methyl-2-pentanone, 2-hexanone, and 1,2,4-trichlorobenzene. No action was taken for acetone and 2-butanone because they were already rejected for a more severe surrogate recovery non-compliance. No action was taken for the remaining compounds because all results are non-detected.

The volatile soil initial calibration exceeded the 30% relative standard deviation (RSD) quality control criteria for acetone. No action was taken because acetone was already qualified for method blank contamination.

The volatile soil continuing calibration performed on February 20 at 17:59 exceeded the 25%D (but was <50%) quality control criteria for chloroethane, methylene chloride, 2-butanone, and 2-hexanone. No action was taken for methylene chloride because its results were already qualified for method blank contamination. No action was taken for the remaining compounds because all results are non-detected.

The volatile soil continuing calibration performed on February 20 at 17:59 exceeded the 25%D (and was >50%) quality control criteria for acetone. No action was taken because acetone was already qualified for method blank contamination.

The Form I's and the EDD did not correspond correctly for the semivolatiles fraction. The Form I indicated that samples S37TW0020001 and S33SB0010101 were analyzed and the EDD indicates S37TW0020001 and S37TW0030001. Also, the results for S37TW0020001 on the Form I correspond to sample S37TW0030001 on the EDD and the results for S33SB0010101 on the Form I correspond to sample S37TW0020001 on the EDD. Another discrepancy is that sample S33SB0010101 was not to be analyzed for semivolatiles. Upon informing the laboratory of this inconsistency, it was determined that the results on the EDD were correct. The laboratory reprocessed the data and sent new copies of the CLP forms associated with these samples. The reprocessed data is included at the beginning of the support documentation.

Executive Summary

Laboratory Performance: Qualifications were made based on calibration non-compliances, %D between analytical columns for PEST/PCBs, method blank contamination, and surrogate non-compliance.

Other Factors Affecting Data Quality: None.

The data for these analyses were reviewed with reference to U.S. EPA National Functional Guidelines for Data Validation as modified by EPA Region III (9/94) and the NFESC guidelines entitled Navy IRCDQM (Sept. 1999). The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NFESC Guidelines and the Quality Assurance Project Plan (QAPP)."

Tetra Tech NUS

Bernard F Spada III
Chemist/Data Validator

Tetra Tech NUS

Joseph A. Samchuck
Quality Assurance Officer

Attachments:

Appendix A – Qualified Analytical Results
Appendix B – Results as Reported by the Laboratory
Appendix C – Support Documentation

Tetra Tech NUS **INTERNAL CORRESPONDENCE**

TO : **G. LATULIPPE** **DATE:** **APRIL 29, 2002**

FROM: **ERIN M. FAUST** **COPIES:** **DV FILE**

SUBJECT: **INORGANIC DATA VALIDATION – TAL METALS**
CTO 325 NSWC INDIAN HEAD
SAMPLE DELIVERY GROUP (SDG) – A0205

SAMPLES: 7/Soil/

S33SB0010101	S33SB0010201	S33SB0020101
S33SB0020201	S33SB0030101	S33SB0030201
S33SBDUP0101		

7/Aqueous/

S33RB020702-1	S33TW0010001	S33TW0020001
S33TW0030001	S34TW0010001	S37TW0020001
S37TW0030001		

Overview

The sample set for CTO 325, NSWC Indian Head, SDG A0205, consists of seven (7) soil environmental samples, six (6) aqueous environmental samples and one (1) aqueous rinsate blank, S33RB020702-1. One (1) field duplicate pair (S33SBDUP0101 / S33SB0030201) is included within this SDG.

All soil samples were analyzed for target analyte list (TAL) metals. All aqueous samples, with the exception of samples S34TW0010001and S33RB020702-1, were analyzed for total and dissolved TAL metals. Sample S34TW0010001 was analyzed for total and dissolved beryllium and copper and dissolved mercury. Sample S33RB020702-1 was analyzed for total TAL metals only. The samples were collected by Tetra Tech NUS on February 2, 7, 8 and 12, 2001 and analyzed by Mitkem Corporation under Naval Facilities Engineering Service Center (NFESC) Quality Assurance / Quality Control (QA/QC) criteria. Metals analyses were conducted using the Contract Laboratory Program (CLP) method ILM04.1.

Metals analyses, with the exception of mercury were conducted using Inductively Coupled Plasma (ICP) instrumentation. Mercury analyses were conducted using Cold Vapor Atomic Absorption (CVAA) instrumentation.

Summary

All analytes were successfully analyzed. The findings offered in this report are based upon a general review of all available data. The data review was based on data completeness, holding times, calibration data, laboratory method/preparation blanks, ICP interference check sample results, matrix spike results, laboratory duplicate results, field duplicate results, laboratory control sample (LCS) results, ICP serial dilution results, detection limits and analyte quantitation.

Areas of concern with respect to data quality are listed below.

Minor Problems

- The Contract Required Detection Limit (CRDL) percent recoveries for antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, nickel, selenium, silver, thallium, vanadium and zinc were >110% quality control limit, affecting all samples except S33SB0010001 and S33SB0010201. Positive results less than two times the CRDL reported for antimony, arsenic, beryllium, chromium, cobalt, nickel, thallium, vanadium and zinc were qualified as biased high, "K". Positive results greater than two times the CRDL reported for cadmium, cobalt, manganese, selenium, silver and thallium were qualified as estimated, "J", due to conflicting noncompliances. No validation action was required for lead because the results were either reported by the laboratory as nondetected, qualifies "B" due to laboratory blank contamination or were greater than 2X the CRDL.

- The CRDL percent recovery for copper was >110% quality control limit, affecting all samples except S33TW0030001, S33TW0030001-F, S34TW0010001-F, S33RB020702-1, S33SB0010101 and S33SB0010201. Positive results less than two times the CRDL reported for copper were qualified as biased high, "K" or estimated, "J", due to conflicting noncompliances.

- The CRDL percent recoveries for antimony, arsenic, beryllium, cadmium, chromium, cobalt, copper, lead, manganese, nickel, selenium, silver thallium, vanadium and zinc were >110% quality control limit, affecting samples S33SB0010101 and S33SB0010201. The positive results less than two times the CRDL reported for beryllium, copper and nickel were qualified as biased high, "K". The positive results less than two times the CRDL reported for cobalt and manganese were qualified as estimated, "J", due to conflicting noncompliances. No validation action was required for the remaining analytes because the results were either reported by the laboratory as nondetected, qualifies "B" due to laboratory blank contamination or were greater than 2X the CRDL.

- The following contaminants were detected in the laboratory method/preparation blanks at the following maximum concentrations :

Analyte	Maximum Concentration	Action Level
Aluminum	13.8 µg/L	13.8 mg/kg
Antimony	4.8 µg/L	4.8 mg/kg
Barium[1]	0.314 mg/kg	1.57 mg/kg
Calcium	54.6 µg/L	54.6 mg/kg
Chromium[2]	0.087 mg/kg	0.435 mg/kg
Chromium[3]	0.106 mg/kg	0.53 mg/kg
Cobalt	1.2 µg/L	1.2 mg/kg
Copper	2.0 µg/L	2.0 mg/kg
Iron[3]	5.803 mg/kg	29.015 mg/kg
Lead[3]	0.310 mg/kg	1.55 mg/kg
Magnesium	55.6 µg/L	55.6 mg/kg
Manganese[3]	0.432 mg/kg	2.16 mg/kg
Nickel	2.3 µg/L	2.3 mg/kg
Sodium	685.9 µg/L	685.9 mg/kg
Zinc	4.8 µg/L	4.8 mg/kg
Zinc[3]	3.385 mg/kg	16.925 mg/kg

[1] Maximum concentration present in a soil preparation blank, affecting all samples.
[2] Maximum concentration present in a soil preparation blank, affecting all samples except S33SB0010101 and S33SB0010102.

[3] Maximum concentration present in a soil preparation blank, affecting samples S33SB0010101 and S33SB0010102.

Samples Affected: All soil samples

An action level of 5x the maximum contaminant level has been used to evaluate sample data for blank contamination. Sample aliquot, percent solids and dilution factors were taken into consideration when evaluating for blank contamination. The positive results less than the action level reported for calcium, nickel, sodium and zinc were qualified, "B", as a result of blank contamination. No validation action was required for the remaining analytes because the results were either greater than the action level or were nondetected.

Analyte	Maximum Concentration	Action Level
Aluminum	13.8 µg/L	69.0 µg/L
Aluminum[1]	16.85 µg/L	84.25 µg/L
Antimony	4.8 µg/L	24.0 µg/L
Barium	0.40 µg/L	2.0 µg/L
Barium[1]	1.624 µg/L	8.12 µg/L
Calcium	54.6 µg/L	273 µg/L
Calcium[1]	113.906 µg/L	569.53 µg/L
Cobalt	1.2 µg/L	6.0 µg/L
Copper	2.0 µg/L	10.0 µg/L
Copper[1]	3.651 µg/L	18.255 µg/L
Lead	0.70 µg/L	3.5 µg/L
Magnesium	55.6 µg/L	278 µg/L
Manganese[2]	2.809 µg/L	14.045 µg/L
Nickel	2.3 µg/L	11.0 µg/L
Sodium	685.9 µg/L	3429.5 µg/L
Zinc	4.8 µg/L	24.0 µg/L
Zinc[1]	13.067 µg/L	65.33 µg/L

[1] Maximum concentration present in an aqueous preparation blank, affecting the dissolved metals matrix.
[2] Maximum concentration present in an aqueous preparation blank, affecting the total metals matrix.

Samples Affected: All aqueous samples

An action level of 5x the maximum contaminant level has been used to evaluate sample data for blank contamination. Sample aliquot, percent solids and dilution factors were taken into consideration when evaluating for blank contamination. The positive results less than the action level reported for aluminum, antimony, cobalt, copper, lead, nickel, sodium and zinc were qualified, "B", as a result of blank contamination. No validation action was required for the remaining analytes because the results were either greater than the action level or were nondetected.

- The interfering analyte calcium was present in sample S37TW0020001-F at a concentration that was comparable to the level of calcium in the Interference Check Sample (ICS) solution. Several analytes namely antimony, arsenic, barium, cadmium, cobalt, copper, lead, manganese, nickel, potassium, selenium, silver, sodium, thallium and zinc were present in the ICS solution at concentrations which exceeded the absolute value of the Instrument Detection Limit (IDL). Interference affects exist for cadmium, copper, selenium, silver and thallium in the affected sample. The positive result reported for cadmium was qualified as estimated, "J"

due to conflicting noncompliances. The nondetected results reported for copper, selenium, silver and thallium were qualified as biased low, "UL".

- The interfering analyte calcium was present in sample S37TW0030001 at a concentration that was comparable to the level of calcium in the Interference Check Sample (ICS) solution. Several analytes namely antimony, arsenic, barium, cadmium, cobalt, copper, lead, manganese, nickel, potassium, selenium, silver, sodium, thallium and zinc were present in the ICS solution at concentrations which exceeded the absolute value of the Instrument Detection Limit (IDL). Interference affects exist for cadmium, copper, selenium, silver, thallium and zinc in the affected sample. The positive result reported for silver was qualified as estimated, "J" due to conflicting noncompliances. The nondetected results reported for cadmium, copper, selenium, thallium and zinc were qualified as biased low, "UL".

- The interfering analyte calcium was present in sample S37TW0020001 at a concentration that was comparable to the level of calcium in the Interference Check Sample (ICS) solution. Several analytes namely antimony, arsenic, barium, cadmium, cobalt, copper, lead, manganese, nickel, potassium, selenium, silver, sodium, thallium and zinc were present in the ICS solution at concentrations which exceeded the absolute value of the Instrument Detection Limit (IDL). Interference affects exist for cadmium, copper, selenium, silver, thallium and zinc in the affected sample. The positive result reported for selenium was qualified as estimated, "J" due to conflicting noncompliances. The nondetected results reported for cadmium, copper, silver, thallium and zinc were qualified as biased low, "UL".

- The interfering analyte calcium was present in sample S37TW0030001-F at a concentration that was comparable to the level of calcium in the Interference Check Sample (ICS) solution. Several analytes namely antimony, arsenic, barium, cadmium, cobalt, copper, lead, manganese, nickel, potassium, selenium, silver, sodium, thallium and zinc were present in the ICS solution at concentrations which exceeded the absolute value of the Instrument Detection Limit (IDL). Interference affects exist for arsenic, cadmium, copper, selenium, silver and thallium in the affected sample. The positive result reported for arsenic was qualified as biased high, "K". The positive result reported for cadmium was qualified as estimated, "J" due to conflicting noncompliances. The nondetected results reported for copper, selenium, silver and thallium were qualified as biased low, "UL".

- The interfering analyte iron was present in sample S33SB0010201 at a concentration that was comparable to the level of iron in the Interference Check Sample (ICS) solution. Several analytes namely antimony, arsenic, barium, cadmium, cobalt, copper, lead, manganese, nickel, potassium, selenium, silver, sodium, thallium and zinc were present in the ICS solution at concentrations which exceeded the absolute value of the Instrument Detection Limit (IDL). Interference affects exist for antimony, arsenic, cadmium, selenium, silver and thallium in the affected sample. The positive result reported for arsenic was qualified as biased high, "K". The nondetected results reported for antimony, cadmium, selenium, silver and thallium were qualified as biased low, "UL".

- The interfering analyte iron was present in sample S33SB0020201 at a concentration that was comparable to the level of iron in the Interference Check Sample (ICS) solution. Several analytes namely antimony, arsenic, barium, cadmium, cobalt, copper, lead, manganese, nickel, potassium, selenium, silver, sodium, thallium and zinc were present in the ICS solution at concentrations which exceeded the absolute value of the Instrument Detection Limit (IDL). Interference affects exist for antimony, arsenic, cadmium, cobalt, selenium, silver and thallium in the affected sample. The positive result reported for arsenic was qualified as biased high, "K". The positive results reported for cobalt and thallium were qualified as estimated, "J" due to conflicting noncompliances. The nondetected results reported for antimony, cadmium, selenium and silver were qualified as biased low, "UL".

- The interfering analyte iron was present in sample S33SB0030201 at a concentration that was comparable to the level of iron in the Interference Check Sample (ICS) solution. Several analytes namely antimony, arsenic, barium, cadmium, cobalt, copper, lead, manganese, nickel, potassium, selenium, silver, sodium, thallium and zinc were present in the ICS solution at concentrations which exceeded the absolute value of the Instrument Detection Limit (IDL). Interference affects exist for antimony, arsenic, cadmium, cobalt, copper, lead, selenium, silver and thallium in the affected sample. The positive results reported for arsenic and thallium were qualified as biased high, "K". The positive results reported for cobalt, copper, lead and selenium were qualified as estimated, "J" due to conflicting noncompliances. The nondetected results reported for antimony, cadmium and silver were qualified as biased low, "UL".

- The interfering analyte iron was present in sample S33SBDUP0101 at a concentration that was comparable to the level of iron in the Interference Check Sample (ICS) solution. Several analytes namely antimony, arsenic, barium, cadmium, cobalt, copper, lead, manganese, nickel, potassium, selenium, silver, sodium, thallium and zinc were present in the ICS solution at concentrations which exceeded the absolute value of the Instrument Detection Limit (IDL). Interference affects exist for antimony, arsenic, cadmium, cobalt, copper, lead, selenium, silver and thallium in the affected sample. The positive result reported for arsenic was qualified as biased high, "K". The positive results reported for cobalt, copper, lead and thallium were qualified as estimated, "J" due to conflicting noncompliances. The nondetected results reported for antimony, cadmium, selenium and silver were qualified as biased low, "UL".

- The Matrix Spike (MS) percent recovery for antimony was < 75% quality control limit, affecting the soil matrix. Nondetected results reported for antimony were qualified as biased low, "UL".

- Field duplicate imprecision (RPD>50%) was noted for manganese, affecting the soil matrix. Positive results reported for manganese were qualified as estimated, "J".

- The ICP serial dilution percent differences for cobalt, lead and potassium were >10% quality control limit, affecting the soil matrix. Positive results reported for these analytes were qualified as estimated, "J". A direction of bias could not be determined.

- The ICP serial dilution percent difference for barium was >10% quality control limit, affecting the total aqueous matrix. Positive results reported for barium were qualified as estimated, "J". A direction of bias could not be determined.

Notes

The rinsate blank sample was not used to establish blank action levels and was not qualified due to laboratory blank contamination.

The ICS percent recovery for selenium was >120% quality control limit, affecting samples S33TW0030001, S33RB020702-1 and S33TW0030001-F. No validation action was required because all results were reported by the laboratory as nondetected.

The MS percent recovery for selenium was >125% quality control limit, affecting the dissolved aqueous matrix. No validation action was required because all results were reported by the laboratory as nondetected.

Executive Summary

Laboratory Performance: Several analytes were qualified due to calibration noncompliance. Several analytes were present in the laboratory method/preparation blanks.

Other Factors Affecting Data Quality: Antimony was qualified due to MS noncompliance, affecting the soil matrix. Cobalt, lead and potassium were qualified due to ICP serial dilution noncompliance, affecting the soil matrix. Barium was qualified due to ICP serial dilution noncompliance, affecting the total aqueous matrix. Field duplicate imprecision was noted for manganese, affecting the soil matrix. The interfering analytes calcium or iron were present in several samples.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Inorganic Data Validation", April 1993 as amended for use within USEPA Region III, and the NFESC document entitled "Navy Installation Restoration Chemical Data Quality Manual" (September 1999).

The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NFESC Guidelines and the Quality Assurance Project Plan (QAPP)."

Tetra Tech NUS
Erin M. Faust
Environmental Scientist

Tetra Tech NUS
Joseph A. Samchuck
Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as reported by the Laboratory
3. Appendix C - Support Documentation

Tetra Tech NUS **INTERNAL CORRESPONDENCE**

TO: **G. LATULIPPE** **DATE:** **April 26, 2002**

FROM: **EDWARD SEDLMYER** **COPIES:** **DV FILE**

SUBJECT: **ORGANIC DATA VALIDATION – EXP**
CTO 325, NSWC INDIAN HEAD
SDG 10218

SAMPLES: 3 / Aqueous

FD01310202	S37SW0010001	S37SW0020001

3 / Solid

FD01310201	S37SD0010001	S37SD0020001

OVERVIEW

The sample set for CTO 325; NSWC Indian Head, SDG 10218 consists of three (3) aqueous environmental samples and three sediment environmental samples. Two pairs of field duplicates were included in the SDG: S37SW0010001 / FD01310202 and S37SD0010001 / FD01310201. The samples were analyzed for explosives (EXP).

The samples were collected by TetraTech NUS on January 31, 2002 and analyzed by Severn Trent Laboratories Inc. All analyses were conducted in accordance with Naval Facilities Engineering Service Center (NFESC) Quality Assurance/Quality Control (QA/QC) criteria using USEPA SW-846 Method 8330 and MCAWW 353.2 analytical and reporting protocols.

The findings in this report are based upon a general review of all available data including: data completeness, holding times, initial / continuing calibrations, laboratory method blank results, surrogate spike recoveries, blank spike results, matrix spike/matrix spike duplicate results, field duplicate results, compound identification, compound quantitation, and detection limits. Areas of concern are listed below.

Major Problems

- None.

Minor Problems

- The following compound was detected in the soil method blank at the maximum concentration indicated below:

Compound	Concentration (mg/kg)	Action Level (mg/kg)
Nitrocellulose	0.44	2.2

An action level of 5X the maximum contaminant level has been used to evaluate sample data for contamination. Dilution factors and sample aliquots were taken into consideration during the application of all action levels. The affected positive results were qualified (B) as a result of blank contamination for nitrocellulose.

Notes

The continuing calibration analyzed on 2/12/02 @05:44 had a %D that exceeded the 15% quality control limit for 4-amino-2,6-dinitrotoluene. No qualification action was taken because the calibration was not associated with any samples in this SDG.

The surrogate recovery was greater than the upper quality control limit of 140% in samples S37SD0020001, S37SD0010001, and FD01310201 for the nitroquanidine analyses. No qualification action was taken because nitroquanidine was not detected in the samples.

The tetryl recovery was less than the quality control limit of 55% for the MS/MSD performed on sample S37SW0020001. However, the LCS recovery was compliant. Therefore, no qualification action was taken based on this non-compliance.

The nitrocellulose recovery was less than the quality control limit of 53% for the MS/MSD associated with the sediment samples (2042493). However, the LCS recovery was compliant. Therefore, no qualification action was taken based on this non-compliance.

EXECUTIVE SUMMARY

Laboratory Performance Issues: Nitrocellulose was detected in the solid method blank resulting in qualification of the data.

Other Factors Affecting Data Quality: None.

The data for these analyses were reviewed with reference to the EPA Functional Guidelines for Organic Data Validation (9/94) as modified by Region III and the NFESC guidelines "Navy IRCDQM" (September, 1999). The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NFESC guidelines and the Quality Assurance Project Plan (QAPP)."

Edward Sedlmyer
TetraTech NUS

Edward Sedlmyer
Chemist/Data Validator

TetraTech NUS

Joseph A. Samchuck
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - Support Documentation

Tetra Tech NUS **INTERNAL CORRESPONDENCE**

TO: **G. LATULIPPE** **DATE:** **APRIL 26, 2002**

FROM: **EDWARD SEDLMYER** **COPIES:** **DV FILE**

SUBJECT: **ORGANIC DATA VALIDATION – EXP**
CTO 325, NSWC INDIAN HEAD
SDG 60111

SAMPLES: 4 / Aqueous

S37RB020502-1	S37SW0030001	S37TW0010001	S37TWDUP001

6 / Solid

S37SB0010101	S37SB0010201	S37SB0020101	S37SB0030101
S37SB0030201	S37SD0030001		

OVERVIEW

The sample set for CTO 325; NSWC Indian Head, SDG 60111 consists of three (3) aqueous environmental samples, six (6) solid environmental samples, and one (1) field quality control sample. The samples were analyzed for explosives (EXP). One pair of field duplicates was included in the SDG: S37TW0010001 and S37TWUP001.

The samples were collected by TetraTech NUS on February 5, 2002 and analyzed by Severn Trent Laboratories Inc. All analyses were conducted in accordance with Naval Facilities Engineering Service Center (NFESC) Quality Assurance/Quality Control (QA/QC) criteria using USEPA SW-846 Method 8330 and MCAWW 353.2 analytical and reporting protocols.

The findings in this report are based upon a general review of all available data including: data completeness, holding times, initial / continuing calibrations, laboratory method blank results, surrogate spike recoveries, blank spike results, matrix spike/matrix spike duplicate results, field duplicate results, compound identification, compound quantitation, and detection limits. Areas of concern are listed below.

Major Problems

- None.

Minor Problems

- The following compound was detected in the soil method blank at the maximum concentration indicated below:

Compound	Concentration (mg/kg)	Action Level (mg/kg)
Nitrocellulose	0.44	2.2

An action level of 5X the maximum contaminant level has been used to evaluate sample data for contamination. Dilution factors and sample aliquots were taken into consideration during the application of all action levels. The affected positive results were qualified (B) as a result of blank contamination for nitrocellulose.

- The percent solids were less than 30% for sample S37SD0030001. The positive and non-detected results were qualified "J" and "UJ" respectively for this sample.

- Positive results less than the reporting limit (RL) were qualified as estimated "J", due to uncertainty near the detection limit.

Notes

The continuing calibration analyzed on 2/12/02 @05:44 had a %D that exceeded the 15% quality control limit for 4-amino-2,6-dinitrotoluene. No action was taken because this calibration was not associated with any samples contained in this SDG.

The continuing calibration analyzed on 2/14/02 @06:07 had a %D that exceeded the 15% quality control limit for RDX. No action was taken because this calibration was not associated with any samples contained in this SDG.

The surrogate recoveries were greater than the upper quality control limit of 140% in samples S37SB0010201, S37SB0030201, S37SB0020101, and S37SD0030001 for the nitroquanidine analyses. No qualification action was taken because nitroquanidine was not detected in any of the samples.

The nitroquanidine recovery was less than the quality control limit of 60% for the MS/MSD performed on sample S37SB0010101. However, the LCS recovery was compliant. Therefore, no qualification action was taken based on this non-compliance.

The nitrocellulose recovery was less than the quality control limit of 53% for the MS/MSD associated with the solid samples (2042493). However, the LCS recovery was compliant. Therefore, no qualification action was taken based on this non-compliance.

Samples S37RB020502-1 and S37SB0030201 were reported with elevated detection limits due to matrix interference for 2,6-dinitrotoluene and nitroquanidine respectively. No qualification action was taken on this basis.

Due to matrix interference, an estimated result below the reporting limit, was not reported for nitroguanidine in sample S37SB0020101.

EXECUTIVE SUMMARY

Laboratory Performance Issues: Nitrocellulose was detected in the solid method blank resulting in qualification of the data.

Other Factors Affecting Data Quality: Sample S37SD0030001had percent solids less than 30%, resulting in qualification of the data.

The data for these analyses were reviewed with reference to the EPA Functional Guidelines for Organic Data Validation (9/94) as modified by Region III and the NFESC guidelines "Navy IRCDQM" (September, 1999). The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NFESC guidelines and the Quality Assurance Project Plan (QAPP)."

Edward Sedlmyer
TetraTech NUS

Edward Sedlmyer
Chemist/Data Validator

TetraTech NUS

Joseph A. Samchuck
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
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Tetra Tech NUS **INTERNAL CORRESPONDENCE**

TO:	**G. LATULIPPE**	**DATE:**	**April 26, 2002**
FROM:	**EDWARD SEDLMYER**	**COPIES:**	**DV FILE**
SUBJECT:	**ORGANIC DATA VALIDATION – EXP CTO 325, NSWC INDIAN HEAD SDG 80106**		

SAMPLES: 4 / Aqueous

S33RB020702-1 S33TW0030001 S37TW0020001 S37TW0030001

2 / Solid

S33SB0010101 S33SB0010201

OVERVIEW

The sample set for CTO 325; NSWC Indian Head, SDG 80106 consists of three (3) aqueous environmental samples, two (2) solid environmental samples, and one (1) field quality control sample. The samples were analyzed for explosives (EXP). Samples with S37 designations were also analyzed for nitrocellulose.

The samples were collected by TetraTech NUS on February 6 and 7, 2002 and analyzed by Severn Trent Laboratories Inc. All analyses were conducted in accordance with Naval Facilities Engineering Service Center (NFESC) Quality Assurance/Quality Control (QA/QC) criteria using USEPA SW-846 Method 8330 and MCAWW 353.2 analytical and reporting protocols.

The findings in this report are based upon a general review of all available data including: data completeness, holding times, initial / continuing calibrations, laboratory method blank results, surrogate spike recoveries, blank spike results, matrix spike/matrix spike duplicate results, compound identification, compound quantitation, and detection limits. Areas of concern are listed below.

Major Problems

- None.

Minor Problems

- Positive results less than the reporting limit (RL) were qualified as estimated "J", due to uncertainty near the detection limit.

Notes

The continuing calibration analyzed on 2/12/02 @05:44 had a %D that exceeded the 15% (but <30%) quality control limit for 4-amino-2,6-dinitrotoluene. No action was taken on the 4-amino-2,6-dinitrotoluene result for samples S37TW0030001, S33TW0030001, and S33RB020702-1.

The continuing calibration analyzed on 2/14/02 @06:07 had a %D that exceeded the 15% (but <30%) quality control limit for RDX. No action was taken on the RDX results for samples S33SB0010101 and S33SB0010201.

The surrogate recovery was greater than the upper quality control limit of 133% in sample S37TW0020001 for the nitroquanidine analyses. No qualification action was taken because nitroquanidine was not detected in the sample.

The nitroquanidine recovery was less than the quality control limit of 60% for the MS/MSD associated with the solid samples. However, the LCS recovery was compliant. Therefore, no qualification action was taken based on this non-compliance.

Samples S33RB020702-1, S37TW0020001, and S37TW0030001 were reported with elevated detection limits due to matrix interference for several compounds. No qualification action was taken on this basis.

Due to matrix interference, estimated results below the reporting limit, were not reported for 2-nitrotoluene and 3-nitrotoluene in sample S33RB020702-1.

EXECUTIVE SUMMARY

Laboratory Performance Issues: Several compounds exceeded the continuing calibration %D criteria, resulting in qualification of the data.

Other Factors Affecting Data Quality: Sample S37SD0030001had percent solids less than 30%, resulting in qualification of the data.

The data for these analyses were reviewed with reference to the EPA Functional Guidelines for Organic Data Validation (9/94) as modified by Region III and the NFESC guidelines "Navy IRCDQM" (September, 1999). The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NFESC guidelines and the Quality Assurance Project Plan (QAPP)."

Edward Sedlmyer
TetraTech NUS

Edward Sedlmyer
Chemist/Data Validator

TetraTech NUS

Joseph A. Samchuck
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - Support Documentation

Tetra Tech NUS **INTERNAL CORRESPONDENCE**

TO: **G. LATULIPPE** **DATE:** **April 26, 2002**

FROM: **EDWARD SEDLMYER** **COPIES:** **DV FILE**

SUBJECT: **ORGANIC DATA VALIDATION – EXP**
CTO 325, NSWC INDIAN HEAD
SDG 90121

SAMPLES: 1 / Aqueous

S33TW0010001

2 / Solid

S33SB0020101 S33SB0020201

OVERVIEW

The sample set for CTO 325; NSWC Indian Head, SDG 90121 consists of one (1) aqueous environmental sample and two (2) solid environmental samples. The samples were analyzed for explosives (EXP).

The samples were collected by TetraTech NUS on February 8, 2002 and analyzed by Severn Trent Laboratories Inc. All analyses were conducted in accordance with Naval Facilities Engineering Service Center (NFESC) Quality Assurance/Quality Control (QA/QC) criteria using USEPA SW-846 Method 8330 analytical and reporting protocols.

The findings in this report are based upon a general review of all available data including: data completeness, holding times, initial / continuing calibrations, laboratory method blank results, surrogate spike recoveries, blank spike results, matrix spike/matrix spike duplicate results, compound identification, compound quantitation, and detection limits. Areas of concern are listed below.

Major Problems

- None.

Minor Problems

- None.

Notes

The continuing calibration analyzed on 2/12/02 @05:44 had a %D that exceeded the 15% (but <30%) quality control limit for 4-amino-2,6-dinitrotoluene. No action was taken on the 4-amino-2,6-dinitrotoluene result for sample S33TW0030001.

The continuing calibration analyzed on 2/14/02 @06:07 had a %D that exceeded the 15% (but <30%) quality control limit for RDX. No action was taken on the RDX results for samples S33SB0020101 and S33SB0020201.

The surrogate recovery was greater than the upper quality control limit of 133% in sample S37TW0020001 for the nitroquanidine analyses. No qualification action was taken because nitroquanidine was not detected in the sample.

The nitroquanidine recovery was less than the quality control limit of 60% for the MS/MSD associated with the solid samples. However, the LCS recovery was compliant. Therefore, no qualification action was taken based on this non-compliance.

Sample S33TW0010001 was reported with elevated detection limits due to matrix interference for 1,3,5-trinitrobenzene, 4-nitrotoluene, and 3-nitrotoluene. No qualification action was taken on this basis.

Due to matrix interference, estimated results below the reporting limit, were not reported for 2,4-dinitrotoluene 4-amino-2,6-dinitrotoluene, 2-amino-4,6-dinitrotoluene, and 2,6-dinitrotoluene, in sample S33TW0010001.

EXECUTIVE SUMMARY

Laboratory Performance Issues: Several compounds exceeded the continuing calibration %D criteria, resulting in qualification of the data.

Other Factors Affecting Data Quality: None.

The data for these analyses were reviewed with reference to the EPA Functional Guidelines for Organic Data Validation (9/94) as modified by Region III and the NFESC guidelines "Navy IRCDQM" (September, 1999). The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NFESC guidelines and the Quality Assurance Project Plan (QAPP)."

Edward Sedlmyer
TetraTech NUS

Edward Sedlmyer
Chemist/Data Validator

TetraTech NUS

Joseph A. Samchuck
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - Support Documentation

Tetra Tech NUS **INTERNAL CORRESPONDENCE**

TO: **G. LATULIPPE** **DATE:** **FEBRUARY 22, 2002**

FROM: **REBEKAH A. HAYNIE** **COPIES:** **DV FILE**

SUBJECT: **INORGANIC DATA VALIDATION – BERYLLIUM AND COPPER**
CTO 325-NSWC INDIAN HEAD
SAMPLE DELIVERY GROUP (SDG) – 90144

SAMPLES: 2/Soil/

S34SB0010101 S34SBDUP0101

Overview

The sample set for CTO 325, NSWC Indian Head, SDG 90144, consists of two (2) soil environmental samples. This is a field duplicate pair.

Both samples were analyzed for beryllium and copper. Analyses were conducted using EPA method ILM04.1. The samples were collected by TetraTech NUS on January 30, 2002 and analyzed by Mitkem Corporation under Naval Facilities Engineering Service Center (NFESC) Quality Assurance/Quality Control (QA/QC) criteria.

All analyses were conducted using Inductively Coupled Plasma (ICP) methodologies.

Summary

Both samples were successfully analyzed. The findings offered in this report are based upon a general review of all available data. The data review was based on data completeness, holding times, calibration data, laboratory blank results, ICP interference check sample (ICS) results, laboratory control spike (LCS) samples, field duplicate precision, and ICP serial dilutions. Criteria were met for all parameters investigated with the exception of laboratory blank contamination.

Problems with respect to data quality are listed below.

Minor Problems

- The following contaminant was detected in the laboratory soil method blank at the following maximum concentration:

Analyte	Maximum Concentration	Action Level
Copper	2.20 µg/L	2.20 mg/kg

An action level of 5X the maximum concentration was used to evaluate the sample data for blank contamination. Sample aliquot, percent solids and dilution factors were taken into consideration when evaluating for blank contamination. Qualification of the sample results was not necessary, as copper results reported by the laboratory were greater than 5X the contamination level.

Executive Summary

Laboratory Performance: None.

Other Factors Affecting Data Quality: None.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Inorganic Review", February 1994, Region 3 Modifications (April 1993), and the NFESC document entitled "Navy IRCDQM" (September 1999).

The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NFESC Guidelines and the Quality Assurance Project Plan (QAPP)."

Rebekah A. Haynie

Tetra Tech NUS
Rebekah A. Haynie
Environmental Scientist

TetraTech NUS
Joseph A. Samchuck
Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as reported by the Laboratory
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Tetra Tech NUS **INTERNAL CORRESPONDENCE**

TO:	**G. LATULIPPE**	**DATE:**	**APRIL 26, 2002**
FROM:	**EDWARD SEDLMYER**	**COPIES:**	**DV FILE**
SUBJECT:	**ORGANIC DATA VALIDATION – EXP CTO 325, NSWC INDIAN HEAD SDGs 130111**		
SAMPLES:	1 / Aqueous		
	S33TW0020001		
	3 / Solid		
	S33SB0030101 S33SB0030201 S33SBDUP0101		

OVERVIEW

The sample set for CTO 325; NSWC Indian Head, SDG 130111 consists of one (1) aqueous environmental sample and three (3) solid environmental samples. One pair of field duplicates was included in the SDG: S33SB0030201 / S33SBDUP0101. The samples were analyzed for explosives (EXP).

The samples were collected by TetraTech NUS on February 12, 2002 and analyzed by Severn Trent Laboratories Inc. All analyses were conducted in accordance with Naval Facilities Engineering Service Center (NFESC) Quality Assurance/Quality Control (QA/QC) criteria using USEPA SW-846 Method 8330 analytical and reporting protocols.

The findings in this report are based upon a general review of all available data including: data completeness, holding times, initial / continuing calibrations, laboratory method blank results, surrogate spike recoveries, blank spike results, matrix spike/matrix spike duplicate results, field duplicate results, compound identification, compound quantitation, and detection limits. Areas of concern are listed below.

Major Problems

- None.

Minor Problems

- The surrogate recoveries were less than 10% for all samples associated with the nitroquanidine aqueous batch extracted on 2/18/02. The sample batch was re-extracted, 14 days after collection, and re-analyzed with acceptable results. The re-extracted results are considered the valid results. The non-detected nitroquanidine result for sample S33TW0020001 was qualified "UJ" as estimated.

Notes

The continuing calibration analyzed on 2/12/02 @05:44 had a %D that exceeded the 15% quality control limit for 4-amino-2,6-dinitrotoluene. No qualification action was taken because the calibration was not associated with any samples in this SDG.

The nitroquanidine recovery was less than the quality control limit of 60% for the MS/MSD performed on sample S33SB0030101. However, the LCS recovery was compliant. Therefore, no qualification action was taken based on this non-compliance.

EXECUTIVE SUMMARY

Laboratory Performance Issues: Nitrocellulose was detected in the solid method blank resulting in qualification of the data.

Other Factors Affecting Data Quality: None.

The data for these analyses were reviewed with reference to the EPA Functional Guidelines for Organic Data Validation (9/94) as modified by Region III and the NFESC guidelines "Navy IRCDQM" (September, 1999). The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NFESC guidelines and the Quality Assurance Project Plan (QAPP)."

Edward Sedlmyer
TetraTech NUS

Edward Sedlmyer
Chemist/Data Validator

TetraTech NUS

Joseph A. Samchuck
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - Support Documentation

Tetra Tech NUS **INTERNAL CORRESPONDENCE**

TO: **G. LATULIPPE** **DATE:** **April 12, 2002**

FROM: **EDWARD SEDLMYER** **COPIES:** **DV FILE**

SUBJECT: **ORGANIC DATA VALIDATION – EXP**
CTO 325, NSWC INDIAN HEAD
SDG 310181

SAMPLES: 2 / Solid

S34SB0010101 S34SBDUP0101

OVERVIEW

The sample set for CTO 325; NSWC Indian Head, SDG 310181 consists of two (2) solid environmental samples. Sample S34SBDUP0101 is the field duplicate of sample S34SB0010101. The samples were analyzed for explosives (EXP).

The samples were collected by TetraTech NUS on January 30, 2002 and analyzed by Severn Trent Laboratories Inc. All analyses were conducted in accordance with Naval Facilities Engineering Service Center (NFESC) Quality Assurance/Quality Control (QA/QC) criteria using USEPA SW-846 Method 8330 and MCAWW 353.2 analytical and reporting protocols.

The findings in this report are based upon a general review of all available data including: data completeness, holding times, initial / continuing calibrations, laboratory method blank results, surrogate spike recoveries, blank spike results, matrix spike/matrix spike duplicate results, field duplicate results, compound identification, compound quantitation, and detection limits. Areas of concern are listed below.

Major Problems

- None.

Minor Problems

- The following compound was detected in the soil method blank at the maximum concentration indicated below:

Compound	Concentration (mg/kg)	Action Level (mg/kg)
Nitrocellulose	0.44	2.2

An action level of 5X the maximum contaminant level has been used to evaluate sample data for contamination. Dilution factors and sample aliquots were taken into consideration during the application of all action levels. The affected positive results were qualified (B) as a result of blank contamination for nitrocellulose.

Notes

The continuing calibration analyzed on 2/12/02 @05:44 had a %D that exceeded the 15% quality control limit for 4-amino-2,6-dinitrotoluene. No qualification action was taken because the calibration was not associated with any samples in this SDG.

The nitroquanidine recovery was less than the quality control limit of 60% for the MS/MSD performed on sample S34SB0010101. However, the LCS recovery was compliant. Therefore, no qualification action was taken based on this non-compliance.

EXECUTIVE SUMMARY

Laboratory Performance Issues: Nitrocellulose was detected in the solid method blank resulting in qualification of the data.

Other Factors Affecting Data Quality: None.

The data for these analyses were reviewed with reference to the EPA Functional Guidelines for Organic Data Validation (9/94) as modified by Region III and the NFESC guidelines "Navy IRCDQM" (September, 1999). The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NFESC guidelines and the Quality Assurance Project Plan (QAPP)."

Edward Sedlmyer
TetraTech NUS

Edward Sedlmyer
Chemist/Data Validator

_____
TetraTech NUS

Joseph A. Samchuck
Data Validation Quality Assurance Officer

Attachments:

1. Appendix A - Qualified Analytical Results
2. Appendix B - Results as Reported by the Laboratory
3. Appendix C - Support Documentation

APPENDIX H

DATABASE

sb33_res -
full appendix results

order	001	002	003	004	005	006	007	008
location	S33SB001/TW001	S33SB001/TW001	S33SB002/TW002	S33SB002/TW002	S33SB003/S33TP003	S33SB003/S33TP003	S33SB003/S33TP003	S33SB003/S33TP003
matrix	SB	SB	SB	SB	SB	SB	SB	SB
nsample	S33SB0010101	S33SB0010201	S33SB0020101	S33SB0020201	S33SB0030101	S33SB0030201	S33SB0030201-AVG	S33SB0030201-D
sample	S33SB0010101	S33SB0010201	S33SB0020101	S33SB0020201	S33SB0030101	S33SB0030201	S33SBDUP0101	S33SBDUP0101
sample_dat	02/07/02	02/07/02	02/08/02	02/08/02	02/12/02	02/12/02	02/12/02	02/12/02
depth_rang	6 - 8	14 - 16	6 - 8	14 - 16	3 - 5	8 - 10	8 - 10	8 - 10
cto_proj	325	325	325	325	325	325	325	325
sort	c_001	c_002	c_003	c_004	c_005	c_006	c_007	c_008
Explosives (mg/kg)								
1,3,5-TRINITROBENZENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
1,3-DINITROBENZENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
2,4,6-TRINITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
2,4-DINITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
2,6-DINITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
2-AMINO-4,6-DINITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
2-NITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
3-NITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
4-AMINO-2,6-DINITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
4-NITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
HMX	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NITROBENZENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
NITROGLYCERIN	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
NITROGUANIDINE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
RDX	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TETRYL	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U
Inorganics (mg/kg)								
ALUMINUM	6520	5870	2760	4880	7660	12500	12750	13000
ANTIMONY	0.19 UL	0.18 UL	0.16 UL	0.21 UL	0.21 UL	0.23 UL	0.23 UL	0.23 UL
ARSENIC	6.1	5.3 K	1.6 K	5.6 K	3.2 K	25 K	21.45 K	17.9 K
BARIUM	29.5	40.3	17.3	29.4	15.9	22.4	21.4	20.4
BERYLLIUM	0.34 K	1.3 K	0.16 K	1.5 K	0.22 K	1.9 K	1.7 K	1.5 K
CADMIUM	0.038 U	0.035 UL	0.032 U	0.043 UL	0.042 U	0.046 UL	0.046 UL	0.046 UL
CALCIUM	551	1170	165	640	8.9 U	14.1 B	22.35 B	30.6 B
CHROMIUM	15.1	18	11.6	21.2	16.6	44.1	45.8	47.5
COBALT	0.97 B	3 J	0.22 B	2 J	1.5 J	2.5 J	2 J	1.5 J
COPPER	3.6 K	7 K	3.3 K	13.2	7.6 K	4.7 J	4.3 J	3.9 J
IRON	12700	17700	7770	32300	15400	50200	45250	40300
LEAD	8.4 J	9.3 J	4.4 J	7.9 J	8 J	10.1 J	8.65 J	7.2 J
MAGNESIUM	625	897	177	641	554	1930	1955	1980
MANGANESE	2.4 J	16.8 J	1.4 J	21.8 J	20.9 J	228 J	167.5 J	107 J
MERCURY	0.047 U	0.055	0.055 U	0.046 U	0.055 U	0.057 U	0.058 U	0.059 U
NICKEL	2.9 K	9.6 K	0.94 B	13 K	3.1 K	9.5 K	8.4 K	7.3 K
POTASSIUM	546 J	981 J	292 J	853 J	543 J	3990 J	4045 J	4100 J
SELENIUM	0.38 U	0.35 UL	0.32 U	0.43 UL	0.42 U	0.61 J	0.42	0.46 UL
SILVER	0.094 U	0.088 UL	0.081 U	0.11 UL	0.11 U	0.11 UL	0.115 UL	0.12 UL
SODIUM	79.7 B	26.7 B	24.3 B	29.3 B	24.8 B	37.4 B	35.6 B	33.8 B
THALLIUM	0.38 U	0.35 UL	0.33 K	0.63 J	0.42 U	1.1 K	1.015 J	0.93 J
VANADIUM	36.2	29.9	14.4 K	36.8	25.1	55.6	52.55	49.5
ZINC	12.1 B	37	5.9 K	36.3	14.6	49.3	44.05	38.8

from sb33_sam.dbf
from sb33_res.dbf
from sb33_res.xls
from q:\sql_server\indian_head

order	001	002	003	004	005	006
location	S33SB001/TW001	S33SB001/TW001	S33SB002/TW002	S33SB002/TW002	S33SB003/TW003	S33SB003/TW003
matrix	GW	GW	GW	GW	GW	GW
nsample	S33TW0010001	S33TW0010001-F	S33TW0020001	S33TW0020001-F	S33TW0030001	S33TW0030001-F
sample	S33TW0010001	S33TW0010001-F	S33TW0020001	S33TW0020001-F	S33TW0030001	S33TW0030001-F
sample_dat	02/08/02	02/09/02	02/12/02	02/13/02	02/12/02	02/08/02
cto_proj	325	325	325	325	325	325
sort	**c_001**	**c_002**	**c_003**	**c_004**	**c_005**	**c_006**
Explosives (ug/L)						
1,3,5-TRINITROBENZENE	0.23 U		0.2 U		0.2 U	
1,3-DINITROBENZENE	0.2 U		0.2 U		0.2 U	
2,4,6-TRINITROTOLUENE	0.2 U		0.2 U		0.2 U	
2,4-DINITROTOLUENE	0.2 U		0.2 U		0.2 U	
2,6-DINITROTOLUENE	0.2 U		0.11 J		0.13 J	
2-AMINO-4,6-DINITROTOLUENE	0.2 U		0.2 U		0.2 U	
2-NITROTOLUENE	0.2 U		0.2 U		0.2 U	
3-NITROTOLUENE	0.45 U		0.2 U		0.2 U	
4-AMINO-2,6-DINITROTOLUENE	0.2 U		0.2 U		0.2 U	
4-NITROTOLUENE	0.42 U		0.2 U		0.2 U	
HMX	0.5 U		0.5 U		0.5 U	
NITROBENZENE	0.2 U		0.2 U		0.2 U	
NITROGLYCERIN	2.5 U		2.5 U		2.5 U	
NITROGUANIDINE	20 U		20 UJ		20 U	
RDX	0.5 U		0.5 U		0.5 U	
TETRYL	0.2 U		0.2 U		0.2 U	
Inorganics (ug/L)						
ALUMINUM	286		435		15400	
ANTIMONY	1.9 B		1.5 B		1 U	
ARSENIC	2 U		2 U		11.8 K	
BARIUM	25.8 J		21.8 J		117 J	
BERYLLIUM	0.2 U		0.2 U		2.8 K	
CADMIUM	0.2 U		0.2 U		0.2 U	
CALCIUM	3780		2570		5400	
CHROMIUM	1.7 K		1.8 K		56	
COBALT	3.9 B		3.1 B		42.8 K	
COPPER	1.4 B		1.7 B		26.8	
IRON	700		1060		30600	
LEAD	0.4 U		0.77 B		9.8	
MAGNESIUM	1130		905		4210	
MANGANESE	59.3		62.8		191	
MERCURY	0.14 U		0.14 U		0.13 U	
NICKEL	4.6 B		2.8 B		31 K	
POTASSIUM	1380		1470		7290	
SELENIUM	2 U		2 U		2 U	
SILVER	0.5 U		0.5 U		0.5 U	
SODIUM	3110 B		6070		6320	
THALLIUM	2 U		2 U		2 U	
VANADIUM	1.1 K		2 K		76.4 K	
ZINC	16.9 B		18.3 B		129	
Inorganics, Filtered (ug/L)						
ALUMINUM		53.5 B		17.2 B		18.6 B
ANTIMONY		1 U		2.7 B		3.1 B
ARSENIC		2 U		2 U		2 U
BARIUM		25.3		21.8		22.9
BERYLLIUM		0.2 U		0.2 U		0.2 U
CADMIUM		0.2 U		0.2 U		0.2 U
CALCIUM		3800		2790		2760
CHROMIUM		0.75 K		0.4 U		0.64 K
COBALT		3.8 B		4 B		3.3 B
COPPER		1 U		1 U		2.6 B
IRON		223		23 U		23 U
LEAD		0.4 U		0.4 U		0.4 U
MAGNESIUM		1130		969		897
MANGANESE		62.7		61.2		61.5
MERCURY		0.15 U		0.13 U		0.11 U
NICKEL		4.4 B		2.6 B		3.4 B
POTASSIUM		1380		1280		1200
SELENIUM		2 U		2 U		2 U
SILVER		0.5 U		0.5 U		0.5 U
SODIUM		3090 B		2350 B		3070 B
THALLIUM		2 U		2 U		2 U
VANADIUM		0.3 U		0.37 K		0.3 U
ZINC		15 B		10.5 B		14.2 B

from tw33_sam.dbf
from tw33_res.dbf
from tw33_res.xls
from q:\sql_server\indian_head

order	001	002	003
location	S34SB001	S34SB001	S34SB001
matrix	SB	SB	SB
nsample	S34SB0010101	S34SB0010101-AVG	S34SB0010101-D
sample	S34SB0010101	S34SBDUP0101	S34SBDUP0101
sample_dat	01/30/02	01/30/02	01/30/02
depth_rang	4 - 4.5	4 - 4.5	4 - 4.5
cto_proj	325	325	325
sort	**c_001**	**c_002**	**c_003**
Explosives (mg/kg)			
1,3,5-TRINITROBENZENE	0.25 U	0.25 U	0.25 U
1,3-DINITROBENZENE	0.25 U	0.25 U	0.25 U
2,4,6-TRINITROTOLUENE	0.25 U	0.25 U	0.25 U
2,4-DINITROTOLUENE	0.25 U	0.25 U	0.25 U
2,6-DINITROTOLUENE	0.25 U	0.25 U	0.25 U
2-AMINO-4,6-DINITROTOLUENE	0.25 U	0.25 U	0.25 U
2-NITROTOLUENE	0.25 U	0.25 U	0.25 U
3-NITROTOLUENE	0.25 U	0.25 U	0.25 U
4-AMINO-2,6-DINITROTOLUENE	0.25 U	0.25 U	0.25 U
4-NITROTOLUENE	0.25 U	0.25 U	0.25 U
HMX	0.5 U	0.5 U	0.5 U
NITROBENZENE	0.25 U	0.25 U	0.25 U
NITROCELLULOSE	0.73 B	0.6 B	0.47 B
NITROGLYCERIN	2.5 U	2.5 U	2.5 U
NITROGUANIDINE	0.1 U	0.1 U	0.1 U
RDX	0.5 U	0.5 U	0.5 U
TETRYL	0.65 U	0.65 U	0.65 U
Inorganics (mg/kg)			
BERYLLIUM	0.65	0.565	0.48
COPPER	110	85.55	61.1

from sb34_sam.dbf
from sb34_res.dbf
from sb34_res.xls
from q:\sql_server\indian_head

tw34_res
full appendix results

order	001	002	003	004	005	006
location	S34TW001	S34TW001	S34TW002	S34TW002	S34TW003	S34TW003
matrix	GW	GW	GW	GW	GW	GW
nsample	S34TW0010001	S34TW0010001-F	S34TW0020001	S34TW0020001-F	S34TW0030001	S34TW0030001-F
sample	S34TW0010001	S34TW0010001-F	S34TW0020001	S34TW0020001-F	S34TW0030001	S34TW0030001-F
sample_dat	02/08/02	02/08/02	02/04/02	02/04/02	02/04/02	02/04/02
cto_proj	325	325	325	325	325	325
sort	**c_001**	**c_002**	**c_003**	**c_004**	**c_005**	**c_006**
Inorganics (ug/L)						
BERYLLIUM	1.6 K		0.2 U		1.2 K	
COPPER	1 U		1 U		3 K	
Inorganics, Filtered (ug/L)						
BERYLLIUM		1.7 K		0.2 U		1.1 K
COPPER		1 U		1 U		1 U

from tw34_sam.dbf
from tw34_res.dbf
from tw34_res.xls
from q:\sql_server\indian_head

order	001	002	003	004	005
location	S37SB001/TW001	S37SB001/TW001	S37SB002/TW002	S37SB003/TW003	S37SB003/TW003
matrix	SB	SB	SB	SB	SB
nsample	S37SB0010101	S37SB0010201	S37SB0020101	S37SB0030101	S37SB0030201
sample	S37SB0010101	S37SB0010201	S37SB0020101	S37SB0030101	S37SB0030201
sample_dat	02/05/02	02/05/02	02/05/02	02/05/02	02/05/02
depth_rang	2 - 4	4 - 6	2 - 4	2 - 4	4 - 6
cto_proj	325	325	325	325	325
sort	**c_001**	**c_002**	**c_003**	**c_004**	**c_005**
Volatile Organics (ug/kg)					
1,1,1-TRICHLOROETHANE	13 U	11 U	10 U	10 U	10 U
1,1,2,2-TETRACHLOROETHANE	13 U	11 U	10 U	10 U	10 U
1,1,2-TRICHLOROETHANE	13 U	11 U	10 U	10 U	10 U
1,1,2-TRICHLOROTRIFLUOROETHANE	13 U	11 U	10 U	10 U	10 U
1,1-DICHLOROETHANE	13 U	11 U	10 U	10 U	10 U
1,1-DICHLOROETHENE	13 U	11 U	10 U	10 U	10 U
1,2,4-TRICHLOROBENZENE	13 U	11 U	10 U	10 U	10 U
1,2-DIBROMO-3-CHLOROPROPANE	13 U	11 U	10 U	10 U	10 U
1,2-DIBROMOETHANE	13 U	11 U	10 U	10 U	10 U
1,2-DICHLOROBENZENE	13 U	11 U	10 U	10 U	10 U
1,2-DICHLOROETHANE	13 U	11 U	10 U	10 U	10 U
1,2-DICHLOROPROPANE	13 U	11 U	10 U	10 U	10 U
1,3-DICHLOROBENZENE	13 U	11 U	10 U	10 U	10 U
1,4-DICHLOROBENZENE	13 U	11 U	10 U	10 U	10 U
2-BUTANONE	13 U	11 U	10 U	10 U	10 U
2-HEXANONE	13 U	11 U	10 U	10 U	10 U
4-METHYL-2-PENTANONE	13 U	11 U	10 U	10 U	10 U
ACETONE	4 J	18	10 U	2 J	10 U
BENZENE	13 U	11 U	10 U	10 U	10 U
BROMODICHLOROMETHANE	13 U	11 U	10 U	10 U	10 U
BROMOFORM	13 U	11 U	10 U	10 U	10 U
BROMOMETHANE	13 U	11 U	10 U	10 U	10 U
CARBON DISULFIDE	13 U	11 U	10 U	10 U	10 U
CARBON TETRACHLORIDE	13 U	11 U	10 U	10 U	10 U
CHLOROBENZENE	13 U	11 U	10 U	10 U	10 U
CHLORODIBROMOMETHANE	13 U	11 U	10 U	10 U	10 U
CHLOROETHANE	13 U	11 U	10 U	10 U	10 U
CHLOROFORM	13 U	11 U	10 U	10 U	10 U
CHLOROMETHANE	13 U	11 U	10 U	10 U	10 U
CIS-1,2-DICHLOROETHENE	13 U	11 U	10 U	10 U	10 U
CIS-1,3-DICHLOROPROPENE	13 U	11 U	10 U	10 U	10 U
CYCLOHEXANE	13 U	11 U	10 U	10 U	10 U
DICHLORODIFLUOROMETHANE	13 U	11 U	10 U	10 U	10 U
DIETHYL ETHER	13 U	11 U	10 U	10 U	10 U
ETHYLBENZENE	13 U	11 U	10 U	10 U	10 U
ISOPROPYLBENZENE	13 U	11 U	10 U	10 U	10 U
METHYL ACETATE	13 U	11 U	10 U	10 U	10 U
METHYL CYCLOHEXANE	13 U	11 U	10 U	10 U	10 U
METHYL TERT-BUTYL ETHER	13 U	11 U	10 U	10 U	10 U
METHYLENE CHLORIDE	13 U	11 U	10 U	10 U	10 U
STYRENE	13 U	11 U	10 U	10 U	10 U
TETRACHLOROETHENE	13 U	11 U	10 U	10 U	10 U
TOLUENE	13 U	11 U	10 U	10 U	10 U
TOTAL XYLENES	13 U	11 U	10 U	10 U	10 U
TRANS-1,2-DICHLOROETHENE	13 U	11 U	10 U	10 U	10 U
TRANS-1,3-DICHLOROPROPENE	13 U	11 U	10 U	10 U	10 U
TRICHLOROETHENE	13 U	11 U	10 U	10 U	10 U
TRICHLOROFLUOROMETHANE	13 U	11 U	10 U	10 U	10 U
VINYL CHLORIDE	13 U	11 U	10 U	10 U	10 U
Semivolatile Organics (ug/kg)					
1,1-BIPHENYL	340 U	380 U	350 UJ	350 U	370 U
2,2'-OXYBIS(1-CHLOROPROPANE)	340 U	380 U	350 UJ	350 U	370 U
2,4,5-TRICHLOROPHENOL	860 U	960 U	890 UJ	890 U	930 U
2,4,6-TRICHLOROPHENOL	340 U	380 U	350 UJ	350 U	370 U
2,4-DICHLOROPHENOL	340 U	380 U	350 UJ	350 U	370 U
2,4-DIMETHYLPHENOL	340 U	380 U	350 UJ	350 U	370 U
2,4-DINITROPHENOL	860 U	960 U	890 UJ	890 U	930 U
2-CHLORONAPHTHALENE	340 U	380 U	350 UJ	350 U	370 U
2-CHLOROPHENOL	340 U	380 U	350 UJ	350 U	370 U
2-METHYLNAPHTHALENE	78 J	380 U	350 UJ	350 U	97 J
2-METHYLPHENOL	340 U	380 U	350 UJ	350 U	370 U
2-NITROANILINE	860 U	960 U	890 UJ	890 U	930 U
2-NITROPHENOL	340 U	380 U	350 UJ	350 U	370 U
3,3'-DICHLOROBENZIDINE	340 U	380 U	350 UJ	350 U	370 U
3-NITROANILINE	860 U	960 U	890 UJ	890 U	930 U
4,6-DINITRO-2-METHYLPHENOL	860 U	960 U	890 UJ	890 U	930 U
4-BROMOPHENYL PHENYL ETHER	340 U	380 U	350 UJ	350 U	370 U
4-CHLORO-3-METHYLPHENOL	340 U	380 U	350 UJ	350 U	370 U
4-CHLOROANILINE	340 U	380 U	350 UJ	350 U	370 U

from sb37_sam.dbf
from sb37_res.dbf
from sb37_res.xls
from q:\sql_server\indian_head

order	001	002	003	004	005
location	S37SB001/TW001	S37SB001/TW001	S37SB002/TW002	S37SB003/TW003	S37SB003/TW003
matrix	SB	SB	SB	SB	SB
nsample	S37SB0010101	S37SB0010201	S37SB0020101	S37SB0030101	S37SB0030201
sample	S37SB0010101	S37SB0010201	S37SB0020101	S37SB0030101	S37SB0030201
sample_dat	02/05/02	02/05/02	02/05/02	02/05/02	02/05/02
depth_rang	2 - 4	4 - 6	2 - 4	2 - 4	4 - 6
cto_proj	325	325	325	325	325
sort	**c_001**	**c_002**	**c_003**	**c_004**	**c_005**
4-CHLOROPHENYL PHENYL ETHER	340 U	380 U	350 UJ	350 U	370 U
4-METHYLPHENOL	340 U	380 U	350 UJ	350 U	370 U
4-NITROANILINE	860 U	960 U	890 UJ	890 U	930 U
4-NITROPHENOL	860 U	960 U	890 UJ	890 U	930 U
ACENAPHTHENE	340 U	380 U	350 UJ	350 U	370 U
ACENAPHTHYLENE	340 U	380 U	350 UJ	350 U	370 U
ACETOPHENONE	340 U	380 U	70 B	350 U	370 U
ANTHRACENE	340 U	380 U	350 UJ	350 U	370 U
ATRAZINE	340 U	380 U	350 UJ	350 U	370 U
BENZALDEHYDE	340 U	380 U	350 UJ	350 U	370 U
BENZO(A)ANTHRACENE	340 U	380 U	41 J	350 U	370 U
BENZO(A)PYRENE	340 U	380 U	350 UJ	350 U	370 U
BENZO(B)FLUORANTHENE	340 U	380 U	110 J	350 U	370 U
BENZO(G,H,I)PERYLENE	340 U	380 U	350 UJ	350 U	370 U
BENZO(K)FLUORANTHENE	340 U	380 U	44 J	350 U	370 U
BIS(2-CHLOROETHOXY)METHANE	340 U	380 U	350 UJ	350 U	370 U
BIS(2-CHLOROETHYL)ETHER	340 U	380 U	350 UJ	350 U	370 U
BIS(2-ETHYLHEXYL)PHTHALATE	68 B	94 B	64 B	48 B	51 B
BUTYL BENZYL PHTHALATE	340 U	380 U	350 UJ	350 U	370 U
CAPROLACTAM	340 U	380 U	350 UJ	350 U	370 U
CARBAZOLE	340 U	380 U	350 UJ	350 U	370 U
CHRYSENE	340 U	380 U	70 J	350 U	370 U
DI-N-BUTYL PHTHALATE	340 U	380 U	350 UJ	350 U	370 U
DI-N-OCTYL PHTHALATE	340 U	380 U	350 UJ	350 U	370 U
DIBENZO(A,H)ANTHRACENE	340 U	380 U	350 UJ	350 U	370 U
DIBENZOFURAN	340 U	380 U	350 UJ	350 U	370 U
DIETHYL PHTHALATE	340 U	380 U	350 UJ	350 U	370 U
DIMETHYL PHTHALATE	340 U	380 U	350 UJ	350 U	370 U
FLUORANTHENE	340 U	380 U	87 J	350 U	86 J
FLUORENE	340 U	380 U	350 UJ	350 U	370 U
HEXACHLOROBENZENE	340 U	380 U	350 UJ	350 U	370 U
HEXACHLOROBUTADIENE	340 U	380 U	350 UJ	350 U	370 U
HEXACHLOROCYCLOPENTADIENE	340 U	380 U	350 UJ	350 U	370 U
HEXACHLOROETHANE	340 U	380 U	350 UJ	350 U	370 U
INDENO(1,2,3-CD)PYRENE	340 U	380 U	350 UJ	350 U	370 U
ISOPHORONE	340 U	380 U	350 UJ	350 U	370 U
N-NITROSO-DI-N-PROPYLAMINE	340 UR	380 U	350 UJ	350 U	370 U
N-NITROSODIPHENYLAMINE	340 U	380 UR	350 UR	350 UR	370 UR
NAPHTHALENE	340 U	380 U	350 UJ	350 U	370 U
PENTACHLOROPHENOL	860 U	960 U	890 UJ	890 U	930 U
PHENANTHRENE	340 U	380 U	41 J	350 U	370 U
PHENOL	340 U	380 U	350 UJ	350 U	370 U
PYRENE	340 U	380 U	99 J	350 U	86 J
Pesticides/PCBs (ug/kg)					
4,4'-DDD	3.4 U	3.8 U	3.5 U	3.6 U	3.7 U
4,4'-DDE	3.4 U	3.8 U	3.5 U	3.6 U	3.7 U
4,4'-DDT	3.4 U	3.9	4.7	3.6 U	3.7 U
ALDRIN	1.8 U	2 U	1.8 U	1.8 U	1.9 U
ALPHA-BHC	1.8 U	2 U	1.8 U	1.8 U	1.9 U
ALPHA-CHLORDANE	1.8 U	2 U	1.8 U	1.8 U	1.9 U
AROCLOR-1016	34 U	38 U	35 U	36 U	37 U
AROCLOR-1221	69 U	77 U	72 U	73 U	75 U
AROCLOR-1232	34 U	38 U	35 U	36 U	37 U
AROCLOR-1242	34 U	38 U	35 U	36 U	37 U
AROCLOR-1248	34 U	38 U	35 U	36 U	37 U
AROCLOR-1254	34 U	38 U	35 U	36 U	37 U
AROCLOR-1260	34 U	38 U	35 U	36 U	37 U
BETA-BHC	1.8 U	2 U	1.8 U	1.8 U	1.9 U
DELTA-BHC	1.8 U	2 U	1.8 U	1.8 U	1.9 U
DIELDRIN	3.4 U	3.8 U	3.5 U	3.6 U	3.7 U
ENDOSULFAN I	1.8 U	2 U	1.8 U	1.8 U	1.9 U
ENDOSULFAN II	3.4 U	3.8 U	3.5 U	3.6 U	3.7 U
ENDOSULFAN SULFATE	3.4 U	3.8 U	3.5 U	3.6 U	3.7 U
ENDRIN	3.4 U	3.8 U	3.5 U	3.6 U	3.7 U
ENDRIN ALDEHYDE	3.4 U	3.8 U	3.5 U	3.6 U	3.7 U
ENDRIN KETONE	3.4 U	3.8 U	3.5 U	3.6 U	3.7 U
GAMMA-BHC (LINDANE)	1.8 U	2 U	1.8 U	1.8 U	1.9 U
GAMMA-CHLORDANE	1.8 U	2 U	1.8 U	1.8 U	1.9 U
HEPTACHLOR	1.8 U	2 U	1.8 U	1.8 U	1.9 U
HEPTACHLOR EPOXIDE	1.8 U	2 U	1.8 U	1.8 U	1.9 U

from sb37_sam.dbf
from sb37_res.dbf
from sb37_res.xls
from q:\sql_server\indian_head

order	001	002	003	004	005
location	S37SB001/TW001	S37SB001/TW001	S37SB002/TW002	S37SB003/TW003	S37SB003/TW003
matrix	SB	SB	SB	SB	SB
nsample	S37SB0010101	S37SB0010201	S37SB0020101	S37SB0030101	S37SB0030201
sample	S37SB0010101	S37SB0010201	S37SB0020101	S37SB0030101	S37SB0030201
sample_dat	02/05/02	02/05/02	02/05/02	02/05/02	02/05/02
depth_rang	2 - 4	4 - 6	2 - 4	2 - 4	4 - 6
cto_proj	325	325	325	325	325
sort	**c_001**	**c_002**	**c_003**	**c_004**	**c_005**
METHOXYCHLOR	18 U	20 U	18 U	18 U	19 U
TOXAPHENE	180 U	200 U	180 U	180 U	190 U
Explosives (mg/kg)					
1,3,5-TRINITROBENZENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
1,3-DINITROBENZENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
2,4,6-TRINITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
2,4-DINITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
2,6-DINITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
2-AMINO-4,6-DINITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
2-NITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
3-NITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
4-AMINO-2,6-DINITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
4-NITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
HMX	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NITROBENZENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 U
NITROCELLULOSE	0.59 B	0.63 B	0.6 B	0.47 B	0.64 B
NITROGLYCERIN	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
NITROGUANIDINE	0.1 U	0.1 U	0.1 U	0.1 U	0.19 U
RDX	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TETRYL	0.65 U	0.65 U	0.65 U	0.65 U	0.65 U
Inorganics (mg/kg)					
ALUMINUM	382 J	554 J	3410 J	3900 J	1010 J
ANTIMONY	0.17 UL	0.16 UL	0.19 UL	0.2 UL	0.15 UL
ARSENIC	0.8 K	0.87 K	2.6 K	4.3 K	1.1 K
BARIUM	5.5	5.9	8.6	13.4	6.1
BERYLLIUM	0.095 K	0.093 K	0.12 K	0.13 K	0.084 K
CADMIUM	0.1 K	0.031 U	0.038 U	0.039 U	0.031 U
CALCIUM	78.5	571	2040	25.7	148
CHROMIUM	2.8 K	4.1	15	9.2	3.4 K
COBALT	0.79 B	0.7 B	3.7 K	4.7 K	1.1 K
COPPER	1.8 K	2.4 K	14.7	5.6 K	3.6 K
IRON	2600 J	3030 J	8970 J	11200 J	3550 J
LEAD	15.5	8.2	22.9	13.5	7.2
MAGNESIUM	56.5 B	112	2530	133	95.3
MANGANESE	60.4	28.8	76.6	108	53.2
MERCURY	0.025 U	0.024 U	0.023 U	0.027 U	0.027 U
NICKEL	3.8 K	3.8 K	16.1	3.1 K	4 K
POTASSIUM	61.6 B	82.5 B	186	182	70.9 B
SELENIUM	0.34 U	0.31 U	0.38 U	0.39 U	0.31 U
SILVER	0.084 U	0.079 U	0.096 U	0.098 U	0.077 U
SODIUM	52.3 B	58.3 B	821	47.9 B	34.5 B
THALLIUM	0.34 U	0.31 U	0.38 U	0.39 U	0.31 U
VANADIUM	4 K	4.1 K	17.5 K	15 K	4.9 K
ZINC	9.1	8.2	14.7	9.6	8.6

from sb37_sam.dbf
from sb37_res.dbf
from sb37_res.xls
from q:\sql_server\indian_head

tw37_res -
full appendix results

order	001	002	003	004	005	006	007	008	009	010
location	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB002/TW002	S37SB002/TW002	S37SB003/TW003	S37SB003/TW003
matrix	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
nsample	S37TW0010001	S37TW0010001-AVG	S37TW0010001-D	S37TW0010001-F	S37TW0010001-F-AVG	S37TW0010001-F-D	S37TW0020001	S37TW0020001-F	S37TW0030001	S37TW0030001-F
sample	S37TW0010001	S37TWDUP001	S37TWDUP001	S37TW0010001-F	S37TWDUP001-F	S37TWDUP001-F	S37TW0020001	S37TW0020001-F	S37TW0030001	S37TW0030001-F
sample_dat	02/05/02	02/05/02	02/05/02	02/05/02	02/05/02	02/05/02	02/06/02	02/08/02	02/06/02	02/08/02
cto_proj	325	325	325	325	325	325	325	325	325	325
sort	**c_001**	**c_002**	**c_003**	**c_004**	**c_005**	**c_006**	**c_007**	**c_008**	**c_009**	**c_010**
Volatile Organics (ug/L)										
1,1,1-TRICHLOROETHANE	1 U	1 U	1 U				1 U		1 U	
1,1,2,2-TETRACHLOROETHANE	1 U	1 U	1 U				1 U		1 U	
1,1,2-TRICHLOROETHANE	1 U	1 U	1 U				1 U		1 U	
1,1-DICHLOROETHANE	1 U	1 U	1 U				1 U		1 U	
1,1-DICHLOROETHENE	1 U	1 U	1 U				1 U		1 U	
1,2,4-TRICHLOROBENZENE	1 U	1 U	1 U				1 U		1 U	
1,2-DIBROMO-3-CHLOROPROPANE	1 U	1 U	1 U				1 U		1 U	
1,2-DIBROMOETHANE	1 U	1 U	1 U				1 U		1 U	
1,2-DICHLOROBENZENE	1 U	1 U	1 U				1 U		1 U	
1,2-DICHLOROETHANE	1 U	1 U	1 U				1 U		1 U	
1,2-DICHLOROPROPANE	1 U	1 U	1 U				1 U		1 U	
1,3-DICHLOROBENZENE	1 U	1 U	1 U				1 U		1 U	
1,4-DICHLOROBENZENE	1 U	1 U	1 U				1 U		1 U	
2-BUTANONE	5 UR	5 UR	5 UR				5 UR		5 UR	
2-HEXANONE	5 U	5 U	5 U				5 U		5 U	
4-METHYL-2-PENTANONE	5 U	5 U	5 U				5 U		5 U	
ACETONE	5 UR	5 UR	5 UR				5 UR		5 UR	
BENZENE	1 U	1 U	1 U				1 U		1 U	
BROMOCHLOROMETHANE	1 U	1 U	1 U				1 U		1 U	
BROMODICHLOROMETHANE	1 U	1 U	1 U				1 U		1 U	
BROMOFORM	1 U	1 U	1 U				1 U		1 U	
BROMOMETHANE	1 U	1 U	1 U				1 U		1 U	
CARBON DISULFIDE	1 U	1 U	1 U				1 U		1 U	
CARBON TETRACHLORIDE	1 U	1 U	1 U				1 U		1 U	
CHLOROBENZENE	1 U	1 U	1 U				1 U		1 U	
CHLORODIBROMOMETHANE	1 U	1 U	1 U				1 U		1 U	
CHLOROETHANE	1 U	1 U	1 U				1 U		1 U	
CHLOROFORM	1 U	1 U	1 U				1 U		1 U	
CHLOROMETHANE	1 U	1 U	1 U				1 U		1 U	
CIS-1,2-DICHLOROETHENE	1 U	1 U	1 U				1 U		1 U	
CIS-1,3-DICHLOROPROPENE	1 U	1 U	1 U				1 U		1 U	
DIETHYL ETHER	1 U	1 U	1 U				1 U		1 U	
ETHYLBENZENE	1 U	1 U	1 U				1 U		1 U	
METHYLENE CHLORIDE	2 U	2 U	2 U				2 U		2 U	
STYRENE	1 U	1 U	1 U				1 U		1 U	
TETRACHLOROETHENE	1 U	1 U	1 U				1 U		1 U	
TOLUENE	1 U	1 U	1 U				1 U		1 U	
TOTAL XYLENES	1 U	1 U	1 U				2		1 U	
TRANS-1,2-DICHLOROETHENE	1 U	1 U	1 U				1 U		1 U	
TRANS-1,3-DICHLOROPROPENE	1 U	1 U	1 U				1 U		1 U	
TRICHLOROETHENE	1 U	1 U	1 U				1 U		1 U	
VINYL CHLORIDE	1 U	1 U	1 U				1 U		1 U	
Semivolatile Organics (ug/L)										
2,2'-OXYBIS(1-CHLOROPROPANE)	5 U	5 U	5 U				5 U		5 U	
2,4,5-TRICHLOROPHENOL	20 U	20 U	20 U				20 U		20 U	
2,4,6-TRICHLOROPHENOL	5 U	5 U	5 U				5 U		5 U	

from tw37_sam.dbf
from tw37_res.dbf
from tw37_res.xls
from q:\sql_server\indian_head

order	001	002	003	004	005	006	007	008	009	010
location	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB002/TW002	S37SB002/TW002	S37SB003/TW003	S37SB003/TW003
matrix	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
nsample	S37TW0010001	S37TW0010001-AVG	S37TW0010001-D	S37TW0010001-F	S37TW0010001-F-AVG	S37TW0010001-F-D	S37TW0020001	S37TW0020001-F	S37TW0030001	S37TW0030001-F
sample	S37TW0010001	S37TWDUP001	S37TWDUP001	S37TW0010001-F	S37TWDUP001-F	S37TWDUP001-F	S37TW0020001	S37TW0020001-F	S37TW0030001	S37TW0030001-F
sample_dat	02/05/02	02/05/02	02/05/02	02/05/02	02/05/02	02/05/02	02/06/02	02/08/02	02/06/02	02/08/02
cto_proj	325	325	325	325	325	325	325	325	325	325
sort	**c_001**	**c_002**	**c_003**	**c_004**	**c_005**	**c_006**	**c_007**	**c_008**	**c_009**	**c_010**
2,4-DICHLOROPHENOL	5 U	5 U	5 U				5 U		5 U	
2,4-DIMETHYLPHENOL	5 U	5 U	5 U				5 U		5 U	
2,4-DINITROPHENOL	20 U	20 U	20 U				20 U		20 U	
2,4-DINITROTOLUENE							5 U		5 U	
2,6-DINITROTOLUENE							5 U		5 U	
2-CHLORONAPHTHALENE	5 U	5 U	5 U				5 U		5 U	
2-CHLOROPHENOL	5 U	5 U	5 U				5 U		5 U	
2-METHYLNAPHTHALENE	5 U	5 U	5 U				6		5 U	
2-METHYLPHENOL	5 U	5 U	5 U				5 U		5 U	
2-NITROANILINE	20 U	20 U	20 U				20 U		20 U	
2-NITROPHENOL	5 U	5 U	5 U				5 U		5 U	
3,3'-DICHLOROBENZIDINE	5 U	5 U	5 U				5 U		5 U	
3-NITROANILINE	20 U	20 U	20 U				20 U		20 U	
4,6-DINITRO-2-METHYLPHENOL	20 U	20 U	20 U				20 U		20 U	
4-BROMOPHENYL PHENYL ETHER	5 U	5 U	5 U				5 U		5 U	
4-CHLORO-3-METHYLPHENOL	5 U	5 U	5 U				5 U		5 U	
4-CHLOROANILINE	5 U	5 U	5 U				5 U		5 U	
4-CHLOROPHENYL PHENYL ETHER	5 U	5 U	5 U				5 U		5 U	
4-METHYLPHENOL	5 U	5 U	5 U				5 U		5 U	
4-NITROANILINE	20 U	20 U	20 U				20 U		20 U	
4-NITROPHENOL	20 U	20 U	20 U				20 U		20 U	
ACENAPHTHENE	5 U	5 U	5 U				2 J		5 U	
ACENAPHTHYLENE	5 U	5 U	5 U				5 U		5 U	
ANTHRACENE	5 U	5 U	5 U				5 U		5 U	
BENZO(A)ANTHRACENE	5 U	5 U	5 U				5 U		5 U	
BENZO(A)PYRENE	5 U	5 U	5 U				5 U		5 U	
BENZO(B)FLUORANTHENE	5 U	5 U	5 U				5 U		5 U	
BENZO(G,H,I)PERYLENE	5 U	5 U	5 U				5 U		5 U	
BENZO(K)FLUORANTHENE	5 U	5 U	5 U				5 U		5 U	
BIS(2-CHLOROETHOXY)METHANE	5 U	5 U	5 U				5 U		5 U	
BIS(2-CHLOROETHYL)ETHER	5 U	5 U	5 U				5 U		5 U	
BIS(2-ETHYLHEXYL)PHTHALATE	5 U	2 J	2 J				5 U		5 U	
BUTYL BENZYL PHTHALATE	5 U	5 U	5 U				5 U		5 U	
CHRYSENE	5 U	5 U	5 U				5 U		5 U	
DI-N-BUTYL PHTHALATE	5 U	5 U	5 U				5 U		5 U	
DI-N-OCTYL PHTHALATE	5 U	5 U	5 U				5 U		5 U	
DIBENZO(A,H)ANTHRACENE	5 U	5 U	5 U				5 U		5 U	
DIBENZOFURAN	5 U	5 U	5 U				5 U		5 U	
DIETHYL PHTHALATE	5 U	5 U	5 U				5 U		5 U	
DIMETHYL PHTHALATE	5 U	5 U	5 U				5 U		5 U	
FLUORANTHENE	5 U	5 U	5 U				5 U		5 U	
FLUORENE	5 U	5 U	5 U				3 J		5 U	
HEXACHLOROBENZENE	5 U	5 U	5 U				5 U		5 U	
HEXACHLOROBUTADIENE	5 U	5 U	5 U				5 U		5 U	
HEXACHLOROCYCLOPENTADIENE	5 U	5 U	5 U				5 U		5 U	
HEXACHLOROETHANE	5 U	5 U	5 U				5 U		5 U	
INDENO(1,2,3-CD)PYRENE	5 U	5 U	5 U				5 U		5 U	

from tw37_sam.dbf
from tw37_res.dbf
from tw37_res.xls
from q:\sql_server\indian_head

order	001	002	003	004	005	006	007	008	009	010
location	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB002/TW002	S37SB002/TW002	S37SB003/TW003	S37SB003/TW003
matrix	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
nsample	S37TW0010001	S37TW0010001-AVG	S37TW0010001-D	S37TW0010001-F	S37TW0010001-F-AVG	S37TW0010001-F-D	S37TW0020001	S37TW0020001-F	S37TW0030001	S37TW0030001-F
sample	S37TW0010001	S37TWDUP001	S37TWDUP001	S37TW0010001-F	S37TWDUP001-F	S37TWDUP001-F	S37TW0020001	S37TW0020001-F	S37TW0030001	S37TW0030001-F
sample_dat	02/05/02	02/05/02	02/05/02	02/05/02	02/05/02	02/05/02	02/06/02	02/08/02	02/06/02	02/08/02
cto_proj	325	325	325	325	325	325	325	325	325	325
sort	**c_001**	**c_002**	**c_003**	**c_004**	**c_005**	**c_006**	**c_007**	**c_008**	**c_009**	**c_010**
ISOPHORONE	5 U	5 U	5 U				5 U		5 U	
N-NITROSO-DI-N-PROPYLAMINE	5 U	5 U	5 U				5 U		5 U	
N-NITROSODIPHENYLAMINE	5 U	5 U	5 U				5 U		5 U	
NAPHTHALENE	5 U	5 U	5 U				10		5 U	
NITROBENZENE							5 U		5 U	
PENTACHLOROPHENOL	20 U	20 U	20 U				20 U		20 U	
PHENANTHRENE	5 U	5 U	5 U				4 J		5 U	
PHENOL	5 U	5 U	5 U				5 U		5 U	
PYRENE	5 U	5 U	5 U				5 U		5 U	
Pesticides/PCBs (ug/L)										
4,4'-DDD	0.02 U	0.02 U	0.02 U				0.02 U		0.02 U	
4,4'-DDE	0.02 U	0.02 U	0.02 U				0.02 U		0.02 U	
4,4'-DDT	0.02 U	0.02 U	0.02 U				0.02 U		0.02 U	
ALDRIN	0.01 U	0.01 U	0.01 U				0.01 U		0.01 U	
ALPHA-BHC	0.01 U	0.01 U	0.01 U				0.01 U		0.01 U	
ALPHA-CHLORDANE	0.01 U	0.01 U	0.01 U				0.01 U		0.01 U	
AROCLOR-1016	0.2 U	0.2 U	0.2 U				0.2 U		0.2 U	
AROCLOR-1221	0.4 U	0.4 U	0.4 U				0.4 U		0.4 U	
AROCLOR-1232	0.2 U	0.2 U	0.2 U				0.2 U		0.2 U	
AROCLOR-1242	0.2 U	0.2 U	0.2 U				0.2 U		0.2 U	
AROCLOR-1248	0.2 U	0.2 U	0.2 U				0.2 U		0.2 U	
AROCLOR-1254	0.2 U	0.2 U	0.2 U				0.2 U		0.2 U	
AROCLOR-1260	0.2 U	0.2 U	0.2 U				0.2 U		0.2 U	
BETA-BHC	0.01 U	0.01 U	0.01 U				0.01 U		0.01 U	
DELTA-BHC	0.01 U	0.01 U	0.01 U				0.01 U		0.01 U	
DIELDRIN	0.02 U	0.02 U	0.02 U				0.02 U		0.02 U	
ENDOSULFAN I	0.01 U	0.01 U	0.01 U				0.01 UJ		0.01 U	
ENDOSULFAN II	0.02 U	0.02 U	0.02 U				0.02 U		0.02 U	
ENDOSULFAN SULFATE	0.02 U	0.02 U	0.02 U				0.02 U		0.02 U	
ENDRIN	0.02 U	0.02 U	0.02 U				0.02 UJ		0.02 U	
ENDRIN ALDEHYDE	0.02 U	0.02 U	0.02 U				0.02 U		0.02 U	
ENDRIN KETONE	0.02 U	0.02 U	0.02 U				0.02 U		0.02 U	
GAMMA-BHC (LINDANE)	0.01 U	0.01 U	0.01 U				0.01 UJ		0.01 U	
GAMMA-CHLORDANE	0.01 U	0.01 U	0.01 U				0.01 U		0.01 U	
HEPTACHLOR	0.01 U	0.01 U	0.01 U				0.01 U		0.01 U	
HEPTACHLOR EPOXIDE	0.01 U	0.01 U	0.01 U				0.01 U		0.01 U	
METHOXYCHLOR	0.1 U	0.1 U	0.1 U				0.1 U		0.1 U	
TOXAPHENE	1 U	1 U	1 U				1 U		1 U	
Explosives (ug/L)										
1,3,5-TRINITROBENZENE	0.2 U	0.2 U	0.2 U				1.4 U		0.2 U	
1,3-DINITROBENZENE	0.2 U	0.2 U	0.2 U				0.2 U		0.2 U	
2,4,6-TRINITROTOLUENE	0.2 U	0.2 U	0.2 U				0.39 U		0.2 U	
2,4-DINITROTOLUENE	0.2 U	0.2 U	0.2 U				0.2 U		0.2 U	
2,6-DINITROTOLUENE	0.2 U	0.2 U	0.2 U				0.2 U		0.2 U	
2-AMINO-4,6-DINITROTOLUENE	0.2 U	0.2 U	0.2 U				1.8 U		0.2 U	
2-NITROTOLUENE	0.2 U	0.2 U	0.2 U				1.1 U		0.2 U	
3-NITROTOLUENE	0.2 U	0.2 U	0.2 U				2.1 U		1.1 U	

from tw37_sam.dbf
from tw37_res.dbf
from tw37_res.xls
from q:\sql_server\indian_head

order	001	002	003	004	005	006	007	008	009	010
location	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB002/TW002	S37SB002/TW002	S37SB003/TW003	S37SB003/TW003
matrix	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
nsample	S37TW0010001	S37TW0010001-AVG	S37TW0010001-D	S37TW0010001-F	S37TW0010001-F-AVG	S37TW0010001-F-D	S37TW0020001	S37TW0020001-F	S37TW0030001	S37TW0030001-F
sample	S37TW0010001	S37TWDUP001	S37TWDUP001	S37TW0010001-F	S37TWDUP001-F	S37TWDUP001-F	S37TW0020001	S37TW0020001-F	S37TW0030001	S37TW0030001-F
sample_dat	02/05/02	02/05/02	02/05/02	02/05/02	02/05/02	02/05/02	02/06/02	02/08/02	02/06/02	02/08/02
cto_proj	325	325	325	325	325	325	325	325	325	325
sort	**c_001**	**c_002**	**c_003**	**c_004**	**c_005**	**c_006**	**c_007**	**c_008**	**c_009**	**c_010**
4-AMINO-2,6-DINITROTOLUENE	0.2 U	0.2 U	0.2 U				0.41 U		0.2 U	
4-NITROTOLUENE	0.2 U	0.2 U	0.2 U				0.92 U		0.2 U	
HMX	0.5 U	0.5 U	0.5 U				0.5 U		0.5 U	
NITROBENZENE	0.2 U	0.2 U	0.2 U				0.2 U		0.087 J	
NITROCELLULOSE	500 U	500 U	500 U				500 U		500 U	
NITROGLYCERIN	2.5 U	2.5 U	2.5 U				2.5 U		2.5 U	
NITROGUANIDINE	20 U	20 U	20 U				20 U		20 U	
RDX	0.5 U	0.5 U	0.5 U				1.2		0.5 U	
TETRYL	0.2 U	0.2 U	0.2 U				0.2 U		0.2 U	
Inorganics (ug/L)										
ALUMINUM	214	153.25	92.5				14.9 B		11.5 B	
ANTIMONY	1.6 B	1.5 B	1.4 B				1.6 B		4.5 B	
ARSENIC	6.1 K	5.95 K	5.8 K				2 U		2 U	
BARIUM	149 J	153 J	157 J				299		92.1 J	
BERYLLIUM	0.2 U	0.2 U	0.2 U				0.2 U		0.2 U	
CADMIUM	0.41 K	0.435 K	0.46 K				0.2 UL		0.2 UL	
CALCIUM	94600	97250	99900				231000		131000	
CHROMIUM	1 B	0.885 B	0.77 B				0.4 U		0.4 U	
COBALT	4.7 K	4.7 K	4.7 K				0.43 B		1.2 B	
COPPER	1 U	1 U	1 U				1 UL		1 UL	
IRON	10500	10750	11000				444		194	
LEAD	0.4 U	0.4 U	0.4 U				0.4 U		0.4 U	
MAGNESIUM	24900 J	25500 J	26100 J				13900		47400	
MANGANESE	2840 J	2910 J	2980 J				183		56.7	
MERCURY	0.07 U	0.0695 U	0.069 U				0.14 U		0.14 U	
NICKEL	4.7 B	4.6 B	4.5 B				2.1 B		10.8 B	
POTASSIUM	6660 J	6720 J	6780 J				4400		7640	
SELENIUM	2.5 K	2.95 K	3.4 K				3.1 J		2 UL	
SILVER	0.5 U	0.5 U	0.5 U				0.5 UL		0.86 J	
SODIUM	155000	156500	158000				72900		216000	
THALLIUM	2 U	2 U	2 U				2 UL		2 UL	
VANADIUM	0.3 U	0.3 U	0.3 U				0.3 U		0.3 K	
ZINC	5.7 B	4.4 B	3.1 B				2 UL		2 UL	
Inorganics, Filtered (ug/L)										
ALUMINUM				18.9	21.15	23.4		55.5 B		31.8 B
ANTIMONY				2.9 B	2.2 B	1.5 B		3.5 B		1.2 B
ARSENIC				2 U	2 U	2 U		2 U		3.2 K
BARIUM				127 J	129 J	131 J		134		229
BERYLLIUM				0.2 U	0.2 U	0.2 U		0.2 U		0.2 U
CADMIUM				0.2 U	0.2 U	0.2 U		0.98 J		0.76 J
CALCIUM				91700	92150	92600		171000		149000
CHROMIUM				0.86 B	0.815 B	0.77 B		0.66 K		0.4 U
COBALT				4.3 B	4.2 B	4.1 B		11.4 K		2.5 B
COPPER				1 U	1 U	1 U		1 UL		1 UL
IRON				3260	2775	2290		15100		12700
LEAD				0.4 U	0.4 U	0.4 U		0.4 U		0.4 U
MAGNESIUM				23800 J	24050 J	24300 J		34900		26500

from tw37_sam.dbf
from tw37_res.dbf
from tw37_res.xls
from q:\sql_server\indian_head

tw37_res -
full appendix results

order	001	002	003	004	005	006	007	008	009	010
location	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB001/TW001	S37SB002/TW002	S37SB002/TW002	S37SB003/TW003	S37SB003/TW003
matrix	GW	GW	GW	GW	GW	GW	GW	GW	GW	GW
nsample	S37TW0010001	S37TW0010001-AVG	S37TW0010001-D	S37TW0010001-F	S37TW0010001-F-AVG	S37TW0010001-F-D	S37TW0020001	S37TW0020001-F	S37TW0030001	S37TW0030001-F
sample	S37TW0010001	S37TWDUP001	S37TWDUP001	S37TW0010001-F	S37TWDUP001-F	S37TWDUP001-F	S37TW0020001	S37TW0020001-F	S37TW0030001	S37TW0030001-F
sample_dat	02/05/02	02/05/02	02/05/02	02/05/02	02/05/02	02/05/02	02/06/02	02/08/02	02/06/02	02/08/02
cto_proj	325	325	325	325	325	325	325	325	325	325
sort	**c_001**	**c_002**	**c_003**	**c_004**	**c_005**	**c_006**	**c_007**	**c_008**	**c_009**	**c_010**
MANGANESE				2660 J	2700 J	2740 J		3310		2050
MERCURY				0.072 U	0.071 U	0.07 U		0.14 U		0.11 U
NICKEL				4.5 B	4.25 B	4 B		14.9 K		5.6 B
POTASSIUM				6470 J	6550 J	6630 J		4570		6470
SELENIUM				2 U	2 U	2 U		2 UL		2 UL
SILVER				0.71 B	0.81 B	0.91 B		0.5 UL		0.5 UL
SODIUM				153000	153000	153000		321000		717000
THALLIUM				2 U	2 U	2 U		2 UL		2 UL
VANADIUM				0.3 U	0.3 U	0.3 U		0.3 U		0.3 U
ZINC				2 U	2 U	2 U		29.4 B		9.8 B

from tw37_sam.dbf
from tw37_res.dbf
from tw37_res.xls
from q:\sql_server\indian_head

sw37_res -
full appendix results

order	001	002	003	004	005
location	S37SD001/SW001	S37SD001/SW001	S37SD001/SW001	S37SD002/SW002	S37SD003/SW003
matrix	SW	SW	SW	SW	SW
nsample	S37SW0010001	S37SW0010001-AVG	S37SW0010001-D	S37SW0020001	S37SW0030001
sample	S37SW0010001	FD01310202	FD01310202	S37SW0020001	S37SW0030001
sample_dat	01/31/02	01/31/02	01/31/02	01/31/02	02/05/02
cto_proj	325	325	325	325	325
sort	**c_001**	**c_002**	**c_003**	**c_004**	**c_005**
Volatile Organics (ug/L)					
1,1,1-TRICHLOROETHANE	1 U	1 U	1 U	1 U	1 U
1,1,2,2-TETRACHLOROETHANE	1 U	1 U	1 U	1 U	1 U
1,1,2-TRICHLOROETHANE	1 U	1 U	1 U	1 U	1 U
1,1-DICHLOROETHANE	1 U	1 U	1 U	1 U	1 U
1,1-DICHLOROETHENE	1 U	1 U	1 U	1 U	1 U
1,2,4-TRICHLOROBENZENE	1 U	1 U	1 U	1 U	1 U
1,2-DIBROMO-3-CHLOROPROPANE	1 U	1 U	1 U	1 U	1 U
1,2-DIBROMOETHANE	1 U	1 U	1 U	1 U	1 U
1,2-DICHLOROBENZENE	1 U	1 U	1 U	1 U	1 U
1,2-DICHLOROETHANE	1 U	1 U	1 U	1 U	1 U
1,2-DICHLOROPROPANE	1 U	1 U	1 U	1 U	1 U
1,3-DICHLOROBENZENE	1 U	1 U	1 U	1 U	1 U
1,4-DICHLOROBENZENE	1 U	1 U	1 U	1 U	1 U
2-BUTANONE	5 U	5 U	5 U	5 U	5 UR
2-HEXANONE	5 U	5 U	5 U	5 U	5 U
4-METHYL-2-PENTANONE	5 U	5 U	5 U	5 U	5 U
ACETONE	5 UR	5 UR	5 UR	5 UR	5 UR
BENZENE	1 U	1 U	1 U	1 U	1 U
BROMOCHLOROMETHANE	1 U	1 U	1 U	1 U	1 U
BROMODICHLOROMETHANE	1 U	1 U	1 U	1 U	1 U
BROMOFORM	1 U	1 U	1 U	1 U	1 U
BROMOMETHANE	1 U	1 U	1 U	1 U	1 U
CARBON DISULFIDE	1 U	1 U	1 U	1 U	1 U
CARBON TETRACHLORIDE	1 U	1 U	1 U	1 U	1 U
CHLOROBENZENE	1 U	1 U	1 U	1 U	1 U
CHLORODIBROMOMETHANE	1 U	1 U	1 U	1 U	1 U
CHLOROETHANE	1 U	1 U	1 U	1 U	1 U
CHLOROFORM	1 U	1 U	1 U	1 U	1 U
CHLOROMETHANE	1 U	1 U	1 U	1 U	1 U
CIS-1,2-DICHLOROETHENE	1 U	1 U	1 U	1 U	1 U
CIS-1,3-DICHLOROPROPENE	1 U	1 U	1 U	1 U	1 U
DIETHYL ETHER	1 U	1 U	1 U	1 U	1 U
ETHYLBENZENE	1 U	1 U	1 U	1 U	1 U
METHYLENE CHLORIDE	2 U	2 U	2 U	2 U	2 U
STYRENE	1 U	1 U	1 U	1 U	1 U
TETRACHLOROETHENE	1 U	1 U	1 U	1 U	1 U
TOLUENE	1 U	1 U	1 U	1 U	1 U
TOTAL XYLENES	1 U	1 U	1 U	1 U	1 U
TRANS-1,2-DICHLOROETHENE	1 U	1 U	1 U	1 U	1 U
TRANS-1,3-DICHLOROPROPENE	1 U	1 U	1 U	1 U	1 U
TRICHLOROETHENE	1 U	1 U	1 U	1 U	1 U
VINYL CHLORIDE	1 U	1 U	1 U	1 U	1 U
Semivolatile Organics (ug/L)					
2,2'-OXYBIS(1-CHLOROPROPANE)	5 U	5 U	5 U	5 U	5 U
2,4,5-TRICHLOROPHENOL	20 U	20 U	20 U	20 U	20 U
2,4,6-TRICHLOROPHENOL	5 U	5 U	5 U	5 U	5 U
2,4-DICHLOROPHENOL	5 U	5 U	5 U	5 U	5 U
2,4-DIMETHYLPHENOL	5 U	5 U	5 U	5 U	5 U
2,4-DINITROPHENOL	20 U	20 U	20 U	20 U	20 U
2-CHLORONAPHTHALENE	5 U	5 U	5 U	5 U	5 U
2-CHLOROPHENOL	5 U	5 U	5 U	5 U	5 U
2-METHYLNAPHTHALENE	2 J	2 J	5 U	5 U	5 U
2-METHYLPHENOL	5 U	5 U	5 U	5 U	5 U
2-NITROANILINE	20 U	20 U	20 U	20 U	20 U
2-NITROPHENOL	5 U	5 U	5 U	5 U	5 U
3,3'-DICHLOROBENZIDINE	5 U	5 U	5 U	5 U	5 U
3-NITROANILINE	20 U	20 U	20 U	20 U	20 U
4,6-DINITRO-2-METHYLPHENOL	20 U	20 U	20 U	20 U	20 U
4-BROMOPHENYL PHENYL ETHER	5 U	5 U	5 U	5 U	5 U
4-CHLORO-3-METHYLPHENOL	5 U	5 U	5 U	5 U	5 U
4-CHLOROANILINE	5 U	5 U	5 U	5 U	5 U
4-CHLOROPHENYL PHENYL ETHER	5 U	5 U	5 U	5 U	5 U
4-METHYLPHENOL	5 U	5 U	5 U	5 U	3 J
4-NITROANILINE	20 U	20 U	20 U	20 U	20 U
4-NITROPHENOL	20 U	20 U	20 U	20 U	20 U
ACENAPHTHENE	5 U	5 U	5 U	5 U	5 U
ACENAPHTHYLENE	5 U	5 U	5 U	5 U	5 U
ANTHRACENE	5 U	5 U	5 U	5 U	5 U
BENZO(A)ANTHRACENE	5 U	5 U	5 U	5 U	5 U
BENZO(A)PYRENE	5 U	5 U	5 U	5 U	5 U

from sw_sam.dbf
from sw_res.dbf
from sw_res.xls
from q:\sql_server\indian_head

order	001	002	003	004	005
location	S37SD001/SW001	S37SD001/SW001	S37SD001/SW001	S37SD002/SW002	S37SD003/SW003
matrix	SW	SW	SW	SW	SW
nsample	S37SW0010001	S37SW0010001-AVG	S37SW0010001-D	S37SW0020001	S37SW0030001
sample	S37SW0010001	FD01310202	FD01310202	S37SW0020001	S37SW0030001
sample_dat	01/31/02	01/31/02	01/31/02	01/31/02	02/05/02
cto_proj	325	325	325	325	325
sort	**c_001**	**c_002**	**c_003**	**c_004**	**c_005**
BENZO(B)FLUORANTHENE	5 U	5 U	5 U	5 U	5 U
BENZO(G,H,I)PERYLENE	5 U	5 U	5 U	5 U	5 U
BENZO(K)FLUORANTHENE	5 U	5 U	5 U	5 U	5 U
BIS(2-CHLOROETHOXY)METHANE	5 U	5 U	5 U	5 U	5 U
BIS(2-CHLOROETHYL)ETHER	5 U	5 U	5 U	5 U	5 U
BIS(2-ETHYLHEXYL)PHTHALATE	5 U	5 U	5 U	5 U	5 U
BUTYL BENZYL PHTHALATE	5 U	5 U	5 U	5 U	5 U
CHRYSENE	5 U	5 U	5 U	5 U	5 U
DI-N-BUTYL PHTHALATE	5 U	5 U	5 U	5 U	5 U
DI-N-OCTYL PHTHALATE	5 U	5 U	5 U	5 U	5 U
DIBENZO(A,H)ANTHRACENE	5 U	5 U	5 U	5 U	5 U
DIBENZOFURAN	5 U	5 U	5 U	5 U	5 U
DIETHYL PHTHALATE	5 U	5 U	5 U	5 U	5 U
DIMETHYL PHTHALATE	5 U	5 U	5 U	5 U	5 U
FLUORANTHENE	5 U	5 U	5 U	5 U	5 U
FLUORENE	5 U	5 U	5 U	5 U	5 U
HEXACHLOROBENZENE	5 U	5 U	5 U	5 U	5 U
HEXACHLOROBUTADIENE	5 U	5 U	5 U	5 U	5 U
HEXACHLOROCYCLOPENTADIENE	5 U	5 U	5 U	5 U	5 U
HEXACHLOROETHANE	5 U	5 U	5 U	5 U	5 U
INDENO(1,2,3-CD)PYRENE	5 U	5 U	5 U	5 U	5 U
ISOPHORONE	5 U	5 U	5 U	5 U	5 U
N-NITROSO-DI-N-PROPYLAMINE	5 U	5 U	5 U	5 U	5 U
N-NITROSODIPHENYLAMINE	5 U	5 U	5 U	5 U	5 U
NAPHTHALENE	5	5	5 U	5 U	5 U
PENTACHLOROPHENOL	20 U	20 U	20 U	20 U	20 U
PHENANTHRENE	5 U	5 U	5 U	5 U	5 U
PHENOL	5 U	2 J	2 J	5 U	5 U
PYRENE	5 U	5 U	5 U	5 U	5 U
Pesticides/PCBs (ug/L)					
4,4'-DDD	0.02 U	0.02 U	0.02 U	0.02 U	0.032
4,4'-DDE	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
4,4'-DDT	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
ALDRIN	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
ALPHA-BHC	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
ALPHA-CHLORDANE	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
AROCLOR-1016	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
AROCLOR-1221	0.4 U	0.4 U	0.4 U	0.4 U	0.4 U
AROCLOR-1232	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
AROCLOR-1242	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
AROCLOR-1248	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
AROCLOR-1254	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
AROCLOR-1260	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
BETA-BHC	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
DELTA-BHC	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
DIELDRIN	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
ENDOSULFAN I	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
ENDOSULFAN II	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
ENDOSULFAN SULFATE	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
ENDRIN	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
ENDRIN ALDEHYDE	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
ENDRIN KETONE	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
GAMMA-BHC (LINDANE)	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
GAMMA-CHLORDANE	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
HEPTACHLOR	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
HEPTACHLOR EPOXIDE	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
METHOXYCHLOR	0.1 U	0.1 U	0.1 U	0.1 U	0.1 U
TOXAPHENE	1 U	1 U	1 U	1 U	1 U
Explosives (ug/L)					
1,3,5-TRINITROBENZENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
1,3-DINITROBENZENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
2,4,6-TRINITROTOLUENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
2,4-DINITROTOLUENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
2,6-DINITROTOLUENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
2-AMINO-4,6-DINITROTOLUENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
2-NITROTOLUENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
3-NITROTOLUENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
4-AMINO-2,6-DINITROTOLUENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
4-NITROTOLUENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
HMX	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
NITROBENZENE	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U

from sw_sam.dbf
from sw_res.dbf
from sw_res.xls
from q:\sql_server\indian_head

order	001	002	003	004	005
location	S37SD001/SW001	S37SD001/SW001	S37SD001/SW001	S37SD002/SW002	S37SD003/SW003
matrix	SW	SW	SW	SW	SW
nsample	S37SW0010001	S37SW0010001-AVG	S37SW0010001-D	S37SW0020001	S37SW0030001
sample	S37SW0010001	FD01310202	FD01310202	S37SW0020001	S37SW0030001
sample_dat	01/31/02	01/31/02	01/31/02	01/31/02	02/05/02
cto_proj	325	325	325	325	325
sort	**c_001**	**c_002**	**c_003**	**c_004**	**c_005**
NITROCELLULOSE	500 U	500 U	500 U	500 U	500 U
NITROGLYCERIN	2.5 U	2.5 U	2.5 U	2.5 U	2.5 U
NITROGUANIDINE	20 U	20 U	20 U	20 U	20 U
RDX	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
TETRYL	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Inorganics (ug/L)					
ALUMINUM	91.9 B	95.7 B	99.5 B	134 B	1350
ANTIMONY	3.4 B	2.35 B	1.3 B	3.5 B	1 U
ARSENIC	2 U	2 U	2 U	2 U	2 U
BARIUM	74.4 J	74.3 J	74.2 J	73.7 J	124 J
BERYLLIUM	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
CADMIUM	0.21 K	0.225 K	0.24 K	0.27 K	0.41 K
CALCIUM	72200	71900	71600	70600	17300
CHROMIUM	0.5 U	0.85 B	1.2 B	0.5 U	1.9 B
COBALT	1.1 B	1.1 B	1.1 B	0.99 B	29.6 K
COPPER	4.8 B	4.8 B	4.8 B	6.1 B	1 U
IRON	124 B	139.5 B	155 B	140 B	9080
LEAD	0.4 U	0.4 U	0.4 U	0.4 U	9.1
MAGNESIUM	127000 J	126500 J	126000 J	124000 J	12900 J
MANGANESE	61 J	62.45 J	63.9 J	61.5 J	2430 J
MERCURY	0.067 U	0.0665 U	0.066 U	0.07 U	0.071 U
NICKEL	2.4 B	2.25 B	2.1 B	2.3 B	10.3 K
POTASSIUM	54400 J	54500 J	54600 J	50400 J	3340 J
SELENIUM	2.1 K	1.55	2 U	2 U	2 U
SILVER	0.5 U	0.5 U	0.5 U	0.5 U	0.5 U
SODIUM	980000	984000	988000	978000	112000
THALLIUM	5 K	6.35 K	7.7 K	6.2 K	2 U
VANADIUM	8.4 K	8.25 K	8.1 K	8.2 K	1.9 K
ZINC	2 U	2 U	2 U	2 U	42.7

from sw_sam.dbf
from sw_res.dbf
from sw_res.xls
from q:\sql_server\indian_head

order	001	002	003	004	005
location	S37SD001/SW001	S37SD001/SW001	S37SD001/SW001	S37SD002/SW002	S37SD003/SW003
nsample	S37SD0010001	S37SD0010001-AVG	S37SD0010001-D	S37SD0020001	S37SD0030001
sample	S37SD0010001	FD01310201	FD01310201	S37SD0020001	S37SD0030001
sample_dat	01/31/02	01/31/02	01/31/02	01/31/02	02/05/02
sacode	ORIG	AVG	DUP	NORMAL	NORMAL
depth_rang	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
sort	**c_001**	**c_002**	**c_003**	**c_004**	**c_005**
Volatile Organics (ug/kg)					
1,1,1-TRICHLOROETHANE	12 U	11.5 U	11 U	12 U	110 UJ
1,1,2,2-TETRACHLOROETHANE	12 U	11.5 U	11 U	12 U	110 UJ
1,1,2-TRICHLOROETHANE	12 U	11.5 U	11 U	12 U	110 UJ
1,1,2-TRICHLOROTRIFLUOROETHANE	12 U	11.5 U	11 U	12 U	110 UJ
1,1-DICHLOROETHANE	12 U	11.5 U	11 U	12 U	110 UJ
1,1-DICHLOROETHENE	12 U	11.5 U	11 U	12 U	110 UJ
1,2,4-TRICHLOROBENZENE	12 U	11.5 U	11 U	12 U	110 UJ
1,2-DIBROMO-3-CHLOROPROPANE	12 U	11.5 U	11 U	12 U	110 UJ
1,2-DIBROMOETHANE	12 U	11.5 U	11 U	12 U	110 UJ
1,2-DICHLOROBENZENE	12 U	11.5 U	11 U	12 U	110 UJ
1,2-DICHLOROETHANE	12 U	11.5 U	11 U	12 U	110 UJ
1,2-DICHLOROPROPANE	12 U	11.5 U	11 U	12 U	110 UJ
1,3-DICHLOROBENZENE	12 U	11.5 U	11 U	12 U	110 UJ
1,4-DICHLOROBENZENE	12 U	11.5 U	11 U	12 U	110 UJ
2-BUTANONE	12 U	11.5 U	11 U	12 U	110 UJ
2-HEXANONE	12 U	11.5 U	11 U	12 U	110 UJ
4-METHYL-2-PENTANONE	12 U	11.5 U	11 U	12 U	110 UJ
ACETONE	12 U	11.5 U	11 U	12 U	85 J
BENZENE	12 U	11.5 U	11 U	12 U	110 UJ
BROMODICHLOROMETHANE	12 U	11.5 U	11 U	12 U	110 UJ
BROMOFORM	12 U	11.5 U	11 U	12 U	110 UJ
BROMOMETHANE	12 U	11.5 U	11 U	12 U	110 UJ
CARBON DISULFIDE	12 U	11.5 U	11 U	12 U	110 UJ
CARBON TETRACHLORIDE	12 U	11.5 U	11 U	12 U	110 UJ
CHLOROBENZENE	12 U	11.5 U	11 U	12 U	110 UJ
CHLORODIBROMOMETHANE	12 U	11.5 U	11 U	12 U	110 UJ
CHLOROETHANE	12 U	11.5 U	11 U	12 U	110 UJ
CHLOROFORM	12 U	11.5 U	11 U	12 U	110 UJ
CHLOROMETHANE	12 U	11.5 U	11 U	12 U	110 UJ
CIS-1,2-DICHLOROETHENE	12 U	11.5 U	11 U	12 U	110 UJ
CIS-1,3-DICHLOROPROPENE	12 U	11.5 U	11 U	12 U	110 UJ
CYCLOHEXANE	12 U	11.5 U	11 U	12 U	110 UJ
DICHLORODIFLUOROMETHANE	12 U	11.5 U	11 U	12 U	110 UJ
DIETHYL ETHER	12 U	11.5 U	11 U	12 U	110 UJ
ETHYLBENZENE	12 U	11.5 U	11 U	12 U	110 UJ
ISOPROPYLBENZENE	12 U	11.5 U	11 U	12 U	110 UJ
METHYL ACETATE	12 U	11.5 U	11 U	12 U	110 UJ
METHYL CYCLOHEXANE	12 U	11.5 U	11 U	12 U	110 UJ
METHYL TERT-BUTYL ETHER	12 U	11.5 U	11 U	12 U	110 UJ
METHYLENE CHLORIDE	12 U	11.5 U	11 U	12 U	110 UJ
STYRENE	12 U	11.5 U	11 U	12 U	110 UJ
TETRACHLOROETHENE	12 U	11.5 U	11 U	12 U	110 UJ
TOLUENE	12 U	11.5 U	11 U	12 U	110 UJ
TOTAL XYLENES	12 U	11.5 U	11 U	12 U	110 UJ
TRANS-1,2-DICHLOROETHENE	12 U	11.5 U	11 U	12 U	110 UJ
TRANS-1,3-DICHLOROPROPENE	12 U	11.5 U	11 U	12 U	110 UJ
TRICHLOROETHENE	12 U	11.5 U	11 U	12 U	110 UJ
TRICHLOROFLUOROMETHANE	12 U	11.5 U	11 U	12 U	110 UJ
VINYL CHLORIDE	12 U	11.5 U	11 U	12 U	110 UJ
Semivolatile Organics (ug/kg)					
1,1-BIPHENYL	360 U	365 U	370 U	400 U	2300 UJ
2,2'-OXYBIS(1-CHLOROPROPANE)	360 U	365 U	370 U	400 U	2300 UJ
2,4,5-TRICHLOROPHENOL	920 U	930 U	940 U	1000 U	5800 UJ
2,4,6-TRICHLOROPHENOL	360 U	365 U	370 U	400 U	2300 UJ
2,4-DICHLOROPHENOL	360 U	365 U	370 U	400 U	2300 UJ
2,4-DIMETHYLPHENOL	360 U	365 U	370 U	400 U	2300 UJ
2,4-DINITROPHENOL	920 U	930 U	940 U	1000 U	5800 UJ
2-CHLORONAPHTHALENE	360 U	365 U	370 U	400 U	2300 UJ
2-CHLOROPHENOL	360 U	365 U	370 U	400 U	2300 UJ
2-METHYLNAPHTHALENE	390	287.5	370 U	400 U	2000 J
2-METHYLPHENOL	360 U	365 U	370 U	400 U	2300 UJ
2-NITROANILINE	920 U	930 U	940 U	1000 U	5800 UJ
2-NITROPHENOL	360 U	365 U	370 U	400 U	2300 UJ
3,3'-DICHLOROBENZIDINE	360 U	365 U	370 U	400 U	2300 UJ
3-NITROANILINE	920 U	930 U	940 U	1000 U	5800 UJ
4,6-DINITRO-2-METHYLPHENOL	920 U	930 U	940 U	1000 U	5800 UJ
4-BROMOPHENYL PHENYL ETHER	360 U	365 U	370 U	400 U	2300 UJ
4-CHLORO-3-METHYLPHENOL	360 U	365 U	370 U	400 U	2300 UJ
4-CHLOROANILINE	360 U	365 U	370 U	400 U	2300 UJ
4-CHLOROPHENYL PHENYL ETHER	360 U	365 U	370 U	400 U	2300 UJ

from sd_sam.dbf
from sd_res.dbf
from sd_res.xls
from q:\sql_server\indian_head\

order	001	002	003	004	005
location	S37SD001/SW001	S37SD001/SW001	S37SD001/SW001	S37SD002/SW002	S37SD003/SW003
nsample	S37SD0010001	S37SD0010001-AVG	S37SD0010001-D	S37SD0020001	S37SD0030001
sample	S37SD0010001	FD01310201	FD01310201	S37SD0020001	S37SD0030001
sample_dat	01/31/02	01/31/02	01/31/02	01/31/02	02/05/02
sacode	ORIG	AVG	DUP	NORMAL	NORMAL
depth_rang	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
sort	**c_001**	**c_002**	**c_003**	**c_004**	**c_005**
4-METHYLPHENOL	360 U	365 U	370 U	400 U	2300 UJ
4-NITROANILINE	920 U	930 U	940 U	1000 U	5800 UJ
4-NITROPHENOL	920 U	930 U	940 U	1000 U	5800 UJ
ACENAPHTHENE	360 U	365 U	370 U	400 U	2300 UJ
ACENAPHTHYLENE	61 J	61 J	370 U	400 U	2300 UJ
ACETOPHENONE	360 U	365 U	370 U	400 U	2300 UJ
ANTHRACENE	360 U	365 U	370 U	400 U	2300 UJ
ATRAZINE	360 U	365 U	370 U	400 U	2300 UJ
BENZALDEHYDE	360 U	365 U	370 U	400 U	700 J
BENZO(A)ANTHRACENE	360 U	445	710	400 U	2300 UJ
BENZO(A)PYRENE	360 U	405	630	400 U	2300 UJ
BENZO(B)FLUORANTHENE	360 U	320 J	320 J	400 U	2300 UJ
BENZO(G,H,I)PERYLENE	360 U	150 J	150 J	400 U	2300 UJ
BENZO(K)FLUORANTHENE	360 U	83 J	83 J	400 U	2300 UJ
BIS(2-CHLOROETHOXY)METHANE	360 U	365 U	370 U	400 U	2300 UJ
BIS(2-CHLOROETHYL)ETHER	360 U	365 U	370 U	400 U	2300 UJ
BIS(2-ETHYLHEXYL)PHTHALATE	60 B	215 U	370 U	41 B	610 B
BUTYL BENZYL PHTHALATE	360 U	365 U	370 U	400 U	2300 UJ
CAPROLACTAM	360 U	365 U	370 U	400 U	2300 UJ
CARBAZOLE	360 U	365 U	370 U	400 U	2300 UJ
CHRYSENE	360 U	640	1100	400 U	2300 UJ
DI-N-BUTYL PHTHALATE	360 U	365 U	370 U	400 U	2300 UJ
DI-N-OCTYL PHTHALATE	360 U	365 U	370 U	400 U	2300 UJ
DIBENZO(A,H)ANTHRACENE	360 U	57 J	57 J	400 U	2300 UJ
DIBENZOFURAN	360 U	365 U	370 U	400 U	2300 UJ
DIETHYL PHTHALATE	360 U	365 U	370 U	400 U	2300 UJ
DIMETHYL PHTHALATE	360 U	365 U	370 U	400 U	2300 UJ
FLUORANTHENE	360 U	170 J	170 J	400 U	2300 UJ
FLUORENE	360 U	365 U	370 U	400 U	2300 UJ
HEXACHLOROBENZENE	360 U	365 U	370 U	400 U	2300 UJ
HEXACHLOROBUTADIENE	360 U	365 U	370 U	400 U	2300 UJ
HEXACHLOROCYCLOPENTADIENE	360 U	365 U	370 U	400 U	2300 UJ
HEXACHLOROETHANE	360 U	365 U	370 U	400 U	2300 UJ
INDENO(1,2,3-CD)PYRENE	360 U	79 J	79 J	400 U	2300 UJ
ISOPHORONE	360 U	365 U	370 U	400 U	2300 UJ
N-NITROSO-DI-N-PROPYLAMINE	360 U	365 U	370 U	400 U	2300 UJ
N-NITROSODIPHENYLAMINE	360 UR	365 UR	370 UR	400 UR	2300 UR
NAPHTHALENE	360 U	365 U	370 U	400 U	640 J
PENTACHLOROPHENOL	920 U	930 U	940 U	1000 U	5800 UJ
PHENANTHRENE	360 U	260 J	260 J	400 U	2300 UJ
PHENOL	360 U	365 U	370 U	400 U	2300 UJ
PYRENE	360 U	640	1100	400 U	520 J
Pesticides/PCBs (ug/kg)					
4,4'-DDD	3.6 U	3.65 U	3.7 U	4 U	180 J
4,4'-DDE	3.6 U	3.65 U	3.7 U	4 U	73 J
4,4'-DDT	3.6 U	3.65 U	3.7 U	4 U	23 UJ
ALDRIN	1.9 U	1.9 U	1.9 U	2.1 U	12 UJ
ALPHA-BHC	1.9 U	1.9 U	1.9 U	2.1 U	12 UJ
ALPHA-CHLORDANE	1.9 U	1.9 U	1.9 U	2.1 U	12 UJ
AROCLOR-1016	36 U	36.5 U	37 U	40 U	230 UJ
AROCLOR-1221	73 U	74.5 U	76 U	81 U	470 UJ
AROCLOR-1232	36 U	36.5 U	37 U	40 U	230 UJ
AROCLOR-1242	36 U	36.5 U	37 U	40 U	230 UJ
AROCLOR-1248	36 U	36.5 U	37 U	40 U	230 UJ
AROCLOR-1254	36 U	36.5 U	37 U	40 U	230 UJ
AROCLOR-1260	36 U	36.5 U	37 U	40 U	230 UJ
BETA-BHC	1.9 U	1.9 U	1.9 U	2.1 U	12 UJ
DELTA-BHC	1.9 U	1.9 U	1.9 U	2.1 U	12 UJ
DIELDRIN	3.6 U	3.65 U	3.7 U	4 U	23 UJ
ENDOSULFAN I	1.9 U	1.9 U	1.9 U	2.1 U	12 UJ
ENDOSULFAN II	3.6 U	3.65 U	3.7 U	4 U	23 UJ
ENDOSULFAN SULFATE	3.6 U	3.65 U	3.7 U	4 U	23 UJ
ENDRIN	3.6 U	3.65 U	3.7 U	4 U	23 UJ
ENDRIN ALDEHYDE	3.6 U	3.65 U	3.7 U	4 U	23 UJ
ENDRIN KETONE	3.6 U	3.65 U	3.7 U	4 U	23 UJ
GAMMA-BHC (LINDANE)	1.9 U	1.9 U	1.9 U	2.1 U	12 UJ
GAMMA-CHLORDANE	1.9 U	1.9 U	1.9 U	2.1 U	12 UJ
HEPTACHLOR	1.9 U	1.9 U	1.9 U	2.1 U	12 UJ
HEPTACHLOR EPOXIDE	1.9 U	1.9 U	1.9 U	2.1 U	12 UJ
METHOXYCHLOR	19 U	19 U	19 U	21 U	120 UJ
TOXAPHENE	190 U	190 U	190 U	210 U	1200 UJ

from sd_sam.dbf
from sd_res.dbf
from sd_res.xls
from q:\sql_server\indian_head\

order	001	002	003	004	005
location	S37SD001/SW001	S37SD001/SW001	S37SD001/SW001	S37SD002/SW002	S37SD003/SW003
nsample	S37SD0010001	S37SD0010001-AVG	S37SD0010001-D	S37SD0020001	S37SD0030001
sample	S37SD0010001	FD01310201	FD01310201	S37SD0020001	S37SD0030001
sample_dat	01/31/02	01/31/02	01/31/02	01/31/02	02/05/02
sacode	ORIG	AVG	DUP	NORMAL	NORMAL
depth_rang	0 - 1	0 - 1	0 - 1	0 - 1	0 - 1
sort	**c_001**	**c_002**	**c_003**	**c_004**	**c_005**
Explosives (mg/kg)					
1,3,5-TRINITROBENZENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 UJ
1,3-DINITROBENZENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 UJ
2,4,6-TRINITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 UJ
2,4-DINITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 UJ
2,6-DINITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 UJ
2-AMINO-4,6-DINITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 UJ
2-NITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 UJ
3-NITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 UJ
4-AMINO-2,6-DINITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 UJ
4-NITROTOLUENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 UJ
HMX	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ
NITROBENZENE	0.25 U	0.25 U	0.25 U	0.25 U	0.25 UJ
NITROCELLULOSE	0.49 B	0.59 B	0.69 B	0.69 B	4.5 J
NITROGLYCERIN	2.5 U	2.5 U	2.5 U	2.5 U	2.5 UJ
NITROGUANIDINE	0.1 U	0.1 U	0.1 U	0.1 U	0.1 UJ
RDX	0.5 U	0.5 U	0.5 U	0.5 U	0.5 UJ
TETRYL	0.65 U	0.65 U	0.65 U	0.65 U	0.65 UJ
Inorganic (mg/kg)					
ALUMINUM	356 J	356 J	356 J	208 J	10200 J
ANTIMONY	0.21 UL	0.215 UL	0.22 UL	0.24 UL	1.4 UJ
ARSENIC	0.69 K	1.645 K	2.6 K	0.64 K	11.5 J
BARIUM	4.2 J	4.15 J	4.1 J	3 J	140 J
BERYLLIUM	0.17 K	0.155 K	0.14 K	0.071 K	2 J
CADMIUM	0.076 K	0.067 K	0.058 K	0.16 K	1.5 J
CALCIUM	129	100.85	72.7	82.7	4550 J
CHROMIUM	4 K	3.65 K	3.3 K	2.3 K	18 J
COBALT	0.95 K	0.95 K	0.95 K	0.56 B	34.2 J
COPPER	0.55 B	1.425 B	2.3 B	1.2 B	100 J
IRON	5970 J	5500 J	5030 J	1620 J	25800 J
LEAD	6.8	6.25	5.7	8.5	456 J
MAGNESIUM	101	102.5	104	70.1	2550 J
MANGANESE	73.6 J	67.75 J	61.9 J	34.2 J	435 J
MERCURY	0.023 U	0.0255 U	0.028 U	0.027 U	0.18 UJ
NICKEL	1.5 K	1.6 K	1.7 K	0.78 K	51.9 J
POTASSIUM	101 B	89.3 B	77.6 B	75.2 B	1590 J
SELENIUM	0.42 UL	0.43 UL	0.44 UL	0.48 UL	2.8 UJ
SILVER	0.7 K	0.64 K	0.58 K	0.22 K	0.69 UJ
SODIUM	101	85.9	70.8	112	1530 B
THALLIUM	0.62 U	0.64 U	0.66 U	0.72 U	2.8 UJ
VANADIUM	5.3 K	6.85 K	8.4 K	3.1 K	43.5 J
ZINC	11.6	12.55	13.5	10.5 B	141 J

from sd_sam.dbf
from sd_res.dbf
from sd_res.xls
from q:\sql_server\indian_head\

order	001	002	003	004
location	S51SB001/50SB001	S51SB001/50SB001	S51SB001/50SB001	S51SB001/50SB001
matrix	SB	SB	SB	SB
nsample	S51SB0010101	S51SB0010101-AVG	S51SB0010101-D	S51SB0010201
sample	S51SB0010101	S51SBDUP0101	S51SBDUP0101	S51SB0010201
sample_dat	02/11/02	02/11/02	02/11/02	02/11/02
depth_rang	1.5 - 2	1.5 - 2	1.5 - 2	2 - 3
cto_proj	325	325	325	325
sort	**c_001**	**c_002**	**c_003**	**c_004**
Volatile Organics (ug/kg)				
1,1,1-TRICHLOROETHANE	11 U	11 U	11 U	13 U
1,1,2,2-TETRACHLOROETHANE	11 U	11 U	11 U	13 U
1,1,2-TRICHLOROETHANE	11 U	11 U	11 U	13 U
1,1,2-TRICHLOROTRIFLUOROETHANE	11 U	11 U	11 U	13 U
1,1-DICHLOROETHANE	11 U	11 U	11 U	13 U
1,1-DICHLOROETHENE	11 U	11 U	11 U	13 U
1,2,4-TRICHLOROBENZENE	11 U	11 U	11 U	13 U
1,2-DIBROMO-3-CHLOROPROPANE	11 U	11 U	11 U	13 U
1,2-DIBROMOETHANE	11 U	11 U	11 U	13 U
1,2-DICHLOROBENZENE	11 U	11 U	11 U	13 U
1,2-DICHLOROETHANE	11 U	11 U	11 U	13 U
1,2-DICHLOROPROPANE	11 U	11 U	11 U	13 U
1,3-DICHLOROBENZENE	11 U	11 U	11 U	13 U
1,4-DICHLOROBENZENE	11 U	11 U	11 U	13 U
2-BUTANONE	11 U	11 U	11 U	13 U
2-HEXANONE	11 U	11 U	11 U	13 U
4-METHYL-2-PENTANONE	11 U	11 U	11 U	13 U
ACETONE	11 U	11 U	11 U	13 U
BENZENE	11 U	11 U	11 U	3 J
BROMODICHLOROMETHANE	11 U	11 U	11 U	13 U
BROMOFORM	11 U	11 U	11 U	13 U
BROMOMETHANE	11 U	11 U	11 U	13 U
CARBON DISULFIDE	11 U	11 U	11 U	13 U
CARBON TETRACHLORIDE	11 U	11 U	11 U	13 U
CHLOROBENZENE	11 U	11 U	11 U	13 U
CHLORODIBROMOMETHANE	11 U	11 U	11 U	13 U
CHLOROETHANE	11 U	11 U	11 U	13 U
CHLOROFORM	11 U	11 U	11 U	13 U
CHLOROMETHANE	11 U	11 U	11 U	13 U
CIS-1,2-DICHLOROETHENE	11 U	11 U	11 U	13 U
CIS-1,3-DICHLOROPROPENE	11 U	11 U	11 U	13 U
CYCLOHEXANE	11 U	11 U	11 U	13 U
DICHLORODIFLUOROMETHANE	11 U	11 U	11 U	13 U
DIETHYL ETHER	11 U	11 U	11 U	13 U
ETHYLBENZENE	11 U	11 U	11 U	13 U
ISOPROPYLBENZENE	11 U	11 U	11 U	13 U
METHYL ACETATE	11 U	11 U	11 U	13 U
METHYL CYCLOHEXANE	11 U	11 U	11 U	13 U
METHYL TERT-BUTYL ETHER	11 U	11 U	11 U	13 U
METHYLENE CHLORIDE	5 B	5 B	5 B	4 B
STYRENE	11 U	11 U	11 U	13 U
TETRACHLOROETHENE	11 U	11 U	11 U	13 U
TOLUENE	11 U	11 U	11 U	2 J
TOTAL XYLENES	11 U	11 U	11 U	13 U
TRANS-1,2-DICHLOROETHENE	11 U	11 U	11 U	13 U
TRANS-1,3-DICHLOROPROPENE	11 U	11 U	11 U	13 U
TRICHLOROETHENE	11 U	11 U	11 U	13 U
TRICHLOROFLUOROMETHANE	11 U	11 U	11 U	13 U
VINYL CHLORIDE	11 U	11 U	11 U	13 U

from sb51_sam.dbf
from sb51_res.dbf
from sb51_res.xls
from q:\sql_server\indian_head

APPENDIX I

HUMAN HEALTH RISK SCREENING CALCULATIONS

HUMAN HEALTH RISK ASSESSMENT METHODOLOGY

1.0 Introduction

This Appendix presents the methodology that was used to prepare the human health risk screening for the SSP sites at IHDIV-NSWC.

1.1 Estimation of Exposure

For purposes of this risk screening analysis, maximum detected site concentrations and exposure assumptions used to derive the U.S. EPA Region 3 RBCs (for soil and tap water ingestion under residential land use) were used to assess potential exposure to environmental media at the SSP sites. The RBCs consider the following exposure pathways under residential land use:

- Soil ingestion
- Tap water ingestion
- Inhalation of vapors from tap water exposure

The equations and exposure factors used by U.S. EPA Region 3 to calculate the RBCs are provided in the remainder of this section and are based on residential land use. Potential exposures for likely receptors at IHDIV-NSWC are expected to be less intense than those anticipated for a resident. In addition, it is not likely that a receptor would be exposed to the maximum site concentrations over the entire exposure duration. Consequently, the use of the maximum site concentration and the equations and exposure factors used to calculate RBCs are considered to be a conservative approach to estimating exposure (and risk). This conservative approach assures that the SSP sites will not be inappropriately dismissed as "no further action" sites during the SSP evaluation.

Calculation of Residential Soil RBCs for Carcinogenic Health Effects

According to Region III guidance, residential soil RBCs for carcinogens are based on ingestion of soil by child and adult residents according to the following equation:

$$RBC = \frac{TR \times ATc}{EFr \times CSFo \times \left(\frac{IFSadj}{CF}\right)}$$

where:

RBC = Risk-based concentration (mg/kg)

TR	=	Target cancer risk = 1×10^{-6}
CSFo	=	Chemical-specific oral cancer slope factor (risk per mg/kg-day)
IFSadj	=	Age-adjusted soil ingestion factor = 114.29 mg-year/kg-day
ATc	=	Averaging time for carcinogens (days) = 70 years x 365 days/year = 25,550 days
EFr	=	Exposure frequency = 350 days/year
CF	=	Conversion factor (1×10^6 mg/kg)

Calculation of Residential Tap Water RBCs for Carcinogenic Health Effects

Residential tap water RBCs for carcinogens are based on ingestion of water and inhalation of vapors emitted from water for child and adult residents by the following equation:

$$RBC = \frac{TR \times ATc \times CF}{EFr \times \left([K \times IFAadj \times CSFi] + [IFWadj \times CSFo]\right)}$$

where:

RBC	=	Risk-based concentration (µg/L)
TR	=	Target cancer risk = 1×10^{-6}
CSFo	=	Chemical-specific oral cancer slope factor (risk per mg/kg/day)
CSFi	=	Chemical-specific inhalation cancer slope factor (mg/kg-day)
IFAadj	=	Age-adjusted inhalation factor = 11.66 m^3-year/kg-day
IFWadj	=	Age-adjusted water ingestion factor = 1.09 L-year/kg-day
EFr	=	Exposure frequency = 350 days/year
K	=	Volatilization factor = 0.5 L/m^3
ATc	=	Averaging time for carcinogens (days) = 70 years x 365 days/year = 25,550 days
CF	=	Conversion factor (1,000 µg/mg)

Calculation of Residential Soil RBCs for Noncarcinogenic Health Effects

According to Region 3 guidance, residential soil RBCs for noncarcinogens are based on ingestion of soil by a child resident using the following equation:

$$RBC = \frac{THQ \times RfDo \times BWc \times ATn}{EFr \times EDc \times \left(\frac{IRSc}{CF}\right)}$$

where:

RBC	=	Risk-based concentration (mg/kg)

THQ	=	Target hazard quotient = 1
RfDo	=	Chemical-specific oral reference dose (mg/kg-day)
BWc	=	Body weight of a child, age 1 to 6 years = 15 kg
ATn	=	Averaging time for noncarcinogens (days)
	=	EDc x 365 days/year = 2,190 days
EFr	=	Exposure frequency = 350 days/year
EDc	=	Exposure duration, age 1 to 6 years = 6 years
IRSc	=	Soil ingestion rate for a child, age 1 to 6 years = 200 mg/day
CF	=	Conversion factor (1×10^6 mg/kg)

Calculation of Residential Tap Water RBCs for Noncarcinogenic Health Effects

Residential tap water RBCs for noncarcinogens are based on ingestion of water and inhalation of vapors emitted from water for an adult resident using the following equation:

$$RBC = \frac{THQ \times BWa \times ATn \times CF}{EFr \times EDtot \times \left(\frac{K \times IRAa}{RfDi} + \frac{IRWa}{RfDo}\right)}$$

where:

RBC	=	Risk-based concentration (µg/L)
THQ	=	Target hazard quotient = 1
RfDo	=	Chemical-specific oral reference dose (mg/kg-day)
RfDi	=	Chemical-specific inhalation reference dose (mg/kg-day)
BWa	=	Body weight of an adult = 70 kg
ATn	=	Averaging time for noncarcinogens (days)
	=	EDtot x 365 days/year = 10,950 days
EFr	=	Exposure frequency = 350 days/year
EDtot	=	Exposure duration = 30 years
K	=	Volatilization factor = 0.5 L/m^3
IRAa	=	Adult inhalation rate = 20 m^3/day
IRWa	=	Adult tap water ingestion rate = 2 L/day
CF	=	Conversion factor (1,000 µg/mg)

Exposure to Lead

The methodologies presented in this section cannot be used to evaluate exposure to lead because of the absence of published dose-response parameters for this chemical. Exposure to lead is conservatively

addressed using the U.S. EPA Integrated Exposure Uptake Biokinetic Model (IEUBK) for lead (U.S. EPA, 2001) for exposure to small children (ages 0 to 7 years). This model may be used to evaluate exposure to lead in water and soil and is designed to estimate blood lead levels based on either default or site-specific input values.

Studies indicate that infants and young children are extremely susceptible to adverse effects from exposure to lead. Considerable behavioral and developmental impairments have been noted in small children with elevated blood lead levels. The threshold for toxic effects from this chemical is believed to be in the range of 10 µg/dL to 15 µg/dL. Blood lead levels greater than 10 µg/dL are considered to be a "concern."

According to U.S. EPA guidance for the IEUBK Model (U.S. EPA, 2001), the average concentration is to be used for the lead exposure point concentration. The guidance recommends "using a simple average or arithmetic mean of soil lead concentrations from a representative area in the child's yard, and an average of dust lead concentrations from representative areas frequented by children inside the house." This rationale is appropriate for areas that are sufficiently small so that any part of the area may be accessible to a typical child living at a random residence located within the area. The Guidance also states that "The Model is intended to describe a single residential-level exposure setting" with the "implicit assumption that the input parameters characterize long-term residential exposures scenarios in such settings." As can be seen from U.S. EPA's discussion, U.S. EPA considers the use of the average concentration appropriate and applicable for conservative residential situations. Therefore, the average concentration is used as the exposure point concentration for evaluating exposure to lead in this SSP report.

1.2 Toxicity Assessment

The toxicity assessment is an important component of the risk screening analysis because it focuses on the relationship between the dose of a compound (amount to which an individual or population is exposed) and the potential for adverse health effects resulting from exposure to that dose. The carcinogenic potency of a compound is often expressed in terms of a cancer slope factor (CSF). The potential of a compound to produce noncarcinogenic effects is often expressed in terms of a reference dose (RfD). In many respects, the toxicity assessment for this risk screening analysis is addressed during the development of the RBCs by incorporating the most recent CSFs and RfDs for carcinogenic and noncarcinogenic compounds, respectively.

CSFs and RfDs are obtained from the following references, listed in order of preference: 1) U.S. EPA's Integrated Risk Information System (IRIS), 2) U.S. EPA's Health Effects Assessment Summary Table (HEAST), 3) U.S. EPA's HEAST Alternative Methods, 4) U.S. EPA's National Center for Environmental Assessment Office (NCEA), 5) withdrawn values from IRIS, 6) withdrawn values from HEAST, and 7)

other applicable U.S. EPA documents. The U.S. EPA Region 3 RBC table, which is updated semi-annually, lists the toxicity criteria (CSFs/RfDs) and sources used to develop the RBCs presented in the U.S. EPA Region 3 RBC table (U.S. EPA, Region 3, 2002).

1.3 Risk Characterization

Risk characterization evaluates the potential for adverse effects from exposure to COPCs at the SSP sites by integrating information developed during the toxicity and exposure assessment. The U.S. EPA Region 3 RBCs for soil and tap water ingestion are the basis for the risk characterization conducted for the SSP. Risk characterization for the SSP risk screening analysis consists of calculating a ratio between the maximum detected concentration of a chemical in an environmental media at an SSP site and the corresponding RBC. Carcinogenic and noncarcinogenic effects are evaluated separately for exposure to environmental media.

Some chemicals exhibit both noncarcinogenic and carcinogenic health effects. For those chemicals that U.S. EPA has developed both CSFs and RfDs, the RBCs presented in the U.S. EPA Region 3 guidance (2002) are based on the toxicity criteria that will result in the most conservative screening criteria. The RBCs for arsenic and RDX are based on carcinogenic effects. However, U.S. EPA has also developed RfDs for these compounds based on their noncarcinogenic health effects. Consequently, it is necessary to evaluate noncarcinogenic risks for these constituents, as well as carcinogenic risks. Therefore, residential soil and tap water RBCs based on the noncarcinogenic health effects of these constituents were calculated using the methodology and exposure parameters presented in Section I.1.

The algorithms used to calculate the human health risk estimated for the risk screening analysis are presented in the remainder of this Appendix.

The human health risk estimates produced for the SSP sites are not considered to be reflective of actual current or anticipated future conditions because the current and anticipated land use at the sites is limited (military/industrial). However, the risk characterization is based on RBCs and exposure assumptions that reflect a residential land use scenario, which is conservative and assures that sites will not be inappropriately dismissed as "no further action" sites.

1.3.1 Human Health Effects – Carcinogens

For the purposes of this SSP report, incremental lifetime cancer risk (ILCR) estimates are those hypothetically incurred by a receptor exposed to COPCs in an environmental media according to the assumptions established Section I.1). Although the estimated ILCRs are not reflective of current or

anticipated future conditions at the SSP sites, the following equation is used to conservatively evaluate the cancer risks for chemicals that have potential or known carcinogenic effects:

$$ILCR = \sum (Cmax/RBC) \times 1 \times 10^{-6}$$

where:

ILCR	=	Incremental Lifetime Cancer Risk (unitless)
Cmax	=	Maximum detected site concentration (mg/kg or µg/L)
RBC	=	Risk-based concentration (mg/kg or µg/L)
1×10^{-6}	=	Risk assessment point of departure for carcinogenic effects (unitless)

Multiplying the C_{max}/RBC ratio by U.S. EPA's point of departure risk level, 1.0E-06, produces a risk estimate for the detected chemical. The ILCRs for all COPCs are summed to account for potential carcinogenic effects associated with multiple chemical exposures. The total ILCR is then compared to U.S. EPA's target cancer risk range of 1×10^{-4} to 1×10^{-6}, which is used to determine whether remediation is necessary at a site. According to U.S. EPA, for known or suspected carcinogens, "acceptable" exposure levels are generally concentration levels that represent an excess upper bound lifetime cancer risk of between 1×10^{-4} to 1×10^{-6} or less than 1×10^{-6}. A 1×10^{-4} ILCR estimate corresponds to the potential for the occurrence of one additional incidence of cancer in an exposed population of 10,000 individuals. Generally, an estimated ILCR greater than 1×10^{-4} is regarded as "unacceptable."

1.3.2 Human Health Effects – Noncarcinogens

Estimated hazard quotients (HQs) and hazard indices (HIs) for the SSP sites are those hypothetically incurred by a receptor exposed to COPCs in an environmental media according to the assumptions established in Section I.1. Although the estimated HQs and HIs are not reflective of current or anticipated future conditions at the SSP sites, the following equations are used to conservatively evaluate the potential for adverse noncarcinogenic health effects:

$$HQ = (Cmax/RBC) \times 1.0$$

$$HI = \sum HQs$$

where:

HQ	=	Hazard quotient (unitless)
C_{max}	=	Maximum detected site concentration (mg/kg or µg/L)
RBC	=	Risk-based concentration (mg/kg or µg/L)

HI = Hazard Index (unitless)

1.0 = Risk assessment point of departure for noncarcinogenic effects (unitless)

Multiplying the C_{max}/RBC ratio by U.S. EPA's point of departure risk level, 1.0, produces a risk estimate for the detected chemical. The HQs for all COPCs are summed to account for potential noncarcinogenic effects associated with multiple chemical exposures. The total HI is then compared to U.S. EPA's target level of 1.0. "Acceptable" exposure levels are generally concentration levels that represent an HI less than or equal to 1.0. However, because all chemicals do not exhibit the same mechanism of action or impact the same target organ, the exceedance of this value does necessarily constitute an "unacceptable" noncarcinogenic risk. If the estimated HI is greater than 1.0, noncarcinogenic effects are segregated according to the affected target organs and target organ HIs are presented, which represent the sum of those chemicals that impact similar target organs or exhibit similar mechanisms of action. Generally, estimated HIs greater than 1.0 for the target organs are considered to be "unacceptable."

1.4 Uncertainty Analysis

The general uncertainties associated with the human health risk screening analysis are presented in this section. Uncertainties for each site-specific risk screening analysis, including a discussion of how the uncertainty may affect the estimated risks, are provided in the site-specific sections.

Various uncertainties are associated with each step of the risk screening process. Uncertainty in the selection of COPCs is related to the current status of the predictive databases, the grouping of samples, and the procedures used to include or exclude constituents as COPCs. Uncertainty associated with the exposure assessment includes the values used as input variables for a given intake route/scenario, the assumptions made to determine exposure point concentrations, and the predictions regarding future land use and population characteristics. Uncertainty in the toxicity assessment includes the quality of the existing toxicity data needed to support dose-response relationships and the weight-of-evidence used for determining the carcinogenicity of COPCs. Uncertainty in risk characterization includes that associated with exposure to multiple chemicals and the cumulative uncertainty from combining conservative assumptions made in earlier steps of the risk assessment process.

Whereas various sources of uncertainty exist as described earlier, the direction of uncertainty can be influenced by the assumptions made throughout the risk screening analysis, including selection of COPCs and selection of values for dose-response relationships. In general, assumptions, which consider safety factors, are made so that the risk estimates are overestimated, rather than underestimated.

Generally, risk evaluations carry two types of uncertainty: 1) measurement and 2) informational uncertainty. Measurement uncertainty refers to the usual variance that accompanies scientific measurements. For example, this type of uncertainty is associated with analytical data collected for each site. The resultant risk screening analysis reflects the accumulated variances of the individual values used.

Informational uncertainty stems from inadequate availability of information needed to complete the toxicity and exposure assessments. Often, this gap is significant, such as the absence of information on the effects of human exposure to low doses of a chemical, on the biological mechanism of action of a chemical, or the behavior of a chemical in soil.

Once the risk screening analysis is complete, the results must be reviewed and evaluated to identify the type and magnitude of uncertainty involved. Reliance on results from the risk screening analysis without consideration of uncertainties, limitations, and assumptions inherent in the process can be misleading. For example, to account for uncertainties in the development of exposure assumptions, conservative estimates must be made to ensure that the particular assumptions made are protective of sensitive subpopulations or the maximum exposed individuals. If a number of conservative assumptions are combined in an exposure model, the resulting calculations can propagate the uncertainties associated with those assumptions, thereby producing a much larger uncertainty for the final results. This uncertainty is biased toward overpredicting both carcinogenic and noncarcinogenic risks. Thus, both the results of the risk screening analysis and the uncertainties associated with those results must be considered when making risk management decisions.

This interpretation is especially relevant when the risk estimates exceed the point-of-departure for defining "acceptable" risk. For example, when risks calculated using a high degree of uncertainty are less than an acceptable" risk level (i.e., 1×10^{-6}), the interpretation of no significant risk is typically straightforward. However, when risks calculated using a high degree of uncertainty exceed an "acceptable" risk level (i.e., 1×10^{-6}), a conclusion can be difficult unless uncertainty is considered.

1.4.1 Uncertainty in Selection of COPCs

Some uncertainty is associated with the selection of COPCs that may affect the numerical risk estimates presented in the site-specific risk screening analyses. The following issues may contribute to uncertainty in COPC selection for the SSP sites: the existing database, the inclusion of chemicals potentially attributable to background, the risk screening levels used, and the absence of risk screening levels for a few chemicals detected in the site media. A brief discussion of each of these issues is provided in the remainder of this section.

Existing Database

All data used for the SSP evaluation were validated according to U.S. EPA Region 3 data validation guidelines. Therefore, uncertainties associated with the quality of the data are considered to be minimal because data considered to be unreliable based on laboratory noncompliances have been qualified as such during data validation and were not used in the risk screening analysis.

Limited analytical data are available for some SSP sites. At some sites, only a few samples or one sample only were collected in a given media. The use of small data sets may result in additional uncertainty both in the COPC selection and in the calculated risks. However, the estimated risks associated with the SSP sites are calculated based on maximum site concentrations and the locations sampled were biased toward known contaminant sources. Therefore, the uncertainty associated with small data sets is reduced.

Chemicals Potentially Attributable to Background

COPCs were selected using available background/anthropogenic concentrations for soil. The 95 percent UTL of the mean background concentration was selected as the representative background/anthropogenic concentration and was used to conservatively screen detected site concentrations of inorganics. This method of screening inorganic compounds may result in retaining inorganic compounds as COPCs that would have been omitted as COPCs based on a more rigorous background evaluation, such as statistical testing. Therefore, overall site-related risks from soil may be overestimated by the background screening process.

COPC Screening Levels

The risk screening values used to select COPCs correspond to an ILCR of 1×10^{-6} and an HI of 0.1. The use of these values ensures that significant contributors to risk are evaluated for a site. The elimination of chemicals present at concentrations equal to or less than an ILCR of 1×10^{-6} and an HI less than 0.1 should not affect the final conclusions of the risk screening analysis because these chemicals are not expected to cause a potential health concern at the concentrations detected.

The use of the risk screening levels tend to result in a conservative estimate of COPCs for the site, as identified below.

- The risk screening values used to select COPCs are based on residential land use scenarios (i.e., residential land use for soil and tap water). The SSP sites are not likely to be developed for residential land use and soil and groundwater exposure to likely receptors (trespassers and military

personnel) are expected to be less than residential receptors (i.e., infrequent). Under current land use, exposure to groundwater is limited because shallow groundwater is not used as a potential drinking water source at IHDIV-NSWC.

- Because of the absence of available criteria, risk screening levels for soil were used to select COPCs for sediment. This approach may be relevant for sediment samples collected from drainage areas at the SSP sites, where standing water is not typically present at the location. However, this approach results in a conservative list of COPCs for sediment samples collected from water bodies where standing water is present because human exposure to these sediments would be expected to be less than exposure to soil.

- The risk screening levels for tap water were used to select COPCs for surface water because limited surface water criteria are available to evaluate exposure. This approach is considered to result in a conservative list of COPCs because surface water samples collected from the SSP sites were obtained from small creeks or drainage areas, where standing water was present. Exposure to surface water at these locations is expected to be less than direct exposure to water (tap water) used as a drinking water source.

Absence of COPC Screening Levels

Phenanthrene does not have published health criteria, and, therefore, no risk-based COPC screening levels have been developed by U.S. EPA. During the COPC screening for this SSP report, pyrene (the RBC for a structurally similar compound) was used as the surrogate for phenanthrene. Applying the RBC/toxicity value of one compound to another compound adds to the uncertainty in the risk screening analysis in regards to the selection of COPCs.

1.4.2 Uncertainty in the Exposure Assessment

Uncertainty in the exposure assessment arises because of the methods used to calculate exposure point concentrations, the determination of land use conditions, the selection of receptors and scenarios, and the selection of exposure parameters. Each of these is discussed below.

Land Use

The current land use patterns at IHDIV-NSWC and the SSP sites are well established. The SSP sites are currently inactive and are not used for specific military purposes. Current land use is not expected to change in the foreseeable future. For this SSP report, exposure to site media was evaluated assuming

that the site was used for residential purposes. Therefore, exposure is overestimated in regard to current land use patterns.

Exposure Point Concentrations

The maximum concentration of each COPC was used as the exposure point concentration (EPC) to quantify potential risks. As a result of using the maximum concentration, the potential risks are likely to be overestimated because it is unlikely that potential receptors would be exposed to the maximum concentration over the entire site for the assumed exposure period.

Exposure Parameters

The exposure factors, e.g., exposure frequency and duration, used to calculate the RBCs are based on reasonable maximum exposure (RME) assumptions for residential land use. Generally, exposure factors are based on surveys of physiological and lifestyle profiles across the United States. The attributes and activities studied in these surveys generally have a broad distribution. To avoid underestimation of potential risks, U.S. EPA used RME exposure factor values to calculate the RBCs, which are used to estimate potential risks in this SSP. Therefore, the selected values used in the development of the RBCs represent the upper bound of the observed or expected habits of the majority of the population.

1.4.3 Uncertainty in the Toxicological Evaluation

Uncertainties associated with the toxicity assessment (determination of RfDs and CSFs from which RBCs are calculated and use of available criteria) are presented in this section.

Derivation of Toxicity Criteria

Uncertainty associated with the toxicity assessment is associated with hazard assessment and dose-response evaluations for the COPCs. The hazard assessment deals with characterizing the nature and strength of the evidence of causation, or the likelihood that a chemical that induces adverse effects in animals will also induce adverse effects in humans. Hazard assessment of carcinogenicity is evaluated as a weight-of-evidence determination, using U.S. EPA methods. Positive animal cancer test data suggest that humans contain tissue(s), which may manifest a carcinogenic response; however, the animal data cannot necessarily be used to predict the target tissue in humans. In the hazard assessment of noncancer effects, however, positive animal data often suggest the nature of the effects (i.e., the target tissues and type of effects) anticipated in humans.

Uncertainty in hazard assessment arises from the nature and quality of the animal and human data. Uncertainty is reduced when similar effects are observed across species, strain, sex, and exposure route; when the magnitude of the response is clearly dose-related; when pharmacokinetic data indicate a similar fate in humans and animals; when postulated mechanisms of toxicity are similar for humans and animals; and when the chemical of concern is structurally similar to other chemicals for which the toxicity is more completely characterized.

Uncertainty in the dose-response evaluation includes the determination of a CSF for the carcinogenic assessment and derivation of an RfD or reference concentration (RfC) for the noncarcinogenic assessment. Uncertainty is introduced from interspecies (animal to human) extrapolation, which, in the absence of quantitative pharmacokinetic or mechanistic data, is usually based on consideration of interspecies differences in basal metabolic rate. Uncertainty also results from intraspecies variation. Most toxicity experiments are performed with animals that are very similar in age and genotype, so that intragroup biological variation is minimal, but the human population of concern may reflect a great deal of heterogeneity including unusual sensitivity or tolerance to the COPC. Even toxicity data from human occupational exposure reflect a bias because only those individuals sufficiently healthy to attend work regularly (the "healthy worker effect") and those not unusually sensitive to the chemical are likely to be occupationally exposed. Finally, uncertainty arises from the quality of the key study from which the quantitative estimate is derived and the database. For cancer effects, the uncertainty associated with dose-response factors is mitigated by assuming the 95% upper bound for the slope factor. Another source of uncertainty in carcinogenic assessment is the method by which data from high doses in animal studies are extrapolated to the dose range expected for environmentally exposed humans. The linearized multistage model, which is used in nearly all quantitative estimations of human risk from animal data, is based on a nonthreshold assumption of carcinogenesis. Evidence suggests, however, that epigenetic carcinogens, as well as many genotoxic carcinogens, have a threshold below which they are noncarcinogenic (Williams and Weisburger, 1991); therefore, the use of the linearized multistage model is conservative for chemicals that exhibit a threshold for carcinogenicity.

For noncancer effects, additional uncertainty factors may be applied in the derivation of the RfD or RfC to mitigate poor quality of the key study or gaps in the database. Additional uncertainty for noncancer effects arises from the use of an effect level in the estimation of an RfD or RfC because this estimation is predicated on the assumption of a threshold less than which adverse effects are not expected. Therefore, an uncertainty factor is usually applied to estimate a no-effect level. Additional uncertainty arises in estimation of an RfD or RfC for chronic exposure from subchronic data. Unless empirical data indicate that effects do not worsen with increasing duration of exposure, an additional uncertainty factor is applied to the no-effect level in the subchronic study. Uncertainty in the derivation of RfDs is mitigated by

the use of uncertainty and modifying factors that normally range between 3 and 10. The resulting combination of uncertainty and modifying factors may reach 1,000 or more.

The derivation of dermal RfDs and CSFs from oral values may cause uncertainty. This is particularly the case when no gastrointestinal absorption rates are available in the literature or when only qualitative statements regarding absorption are available.

Uncertainty Associated with Evaluation of Arsenic

Although the more restrictive basis for evaluating risk associated with exposure to arsenic is to assume this chemical is a carcinogen, carcinogenic effects are not the primary health effects expected to be manifested with exposure to arsenic. Scientific information indicates that humans are capable of metabolizing arsenic to expedite its elimination from the body. The elimination of arsenic from the body obviously mitigates the possibility for this chemical to manifest carcinogenic effects. Therefore, evaluating arsenic as a noncarcinogen would be more appropriate. However, arsenic was conservatively evaluated as a carcinogen, as well as a noncarcinogen in this risk screening analysis. Consequently, the carcinogenic risks for this chemical are probably overestimated to some degree.

Use of Chromium Toxicity Criteria

Some uncertainty is associated with the evaluation of total chromium analytical results. Chromium was assumed to be present in its hexavalent state. Because hexavalent chromium is considered to be more toxic than trivalent chromium, which essentially is a more prevalent form of chromium, risks for this chemical are probably overestimated to some degree.

Use of Aluminum, Copper, and Iron Toxicity Criteria

Potential risks from exposure to aluminum, copper, and iron were evaluated using NCEA provisional RfDs. The provisional RfDs for these chemicals are based on daily allowable intakes rather than adverse effect levels. Therefore, cumulative noncarcinogenic risks may be overestimated by quantifying risks from exposure to aluminum, copper, and iron.

1.4.4 Uncertainty in the Risk Characterization

Uncertainty in risk characterization results primarily from assumptions made regarding additivity of effects from exposure to multiple COPCs from various exposure routes. High uncertainty exists when summing cancer risks for several substances across different exposure pathways. This assumes that each substance has a similar effect and/or mode of action. Often compounds affect different organs, have

different mechanisms of action, and differ in their fate in the body, so additivity may not be an appropriate assumption. However, the assumption of additivity is made to provide a conservative estimate of risk.

Finally, the risk characterization does not consider antagonistic or synergistic effects. Little or no information is available to determine the potential for antagonism or synergism for the COPCs. Therefore, the impact of this uncertainty on the risk screening analysis cannot be determined because the uncertainty may result in either an underestimation or overestimation of potential human health risks.

REFERENCES

U.S. EPA (United States Environmental Protection Agency). 2001. User's Guide for the Biokinetic Model for Lead in Children (IEUBK) Windows version. EPA 9285.7-42. Office of Emergency and Remedial Response, Washington, D.C., May.

U.S. EPA, Region 3, 2002. Risk-Based Concentrations Table. Hazardous Waste Management Division, Philadelphia, Pennsylvania. April.

Williams, G.M. and J.H. Weisburger, 1991. "Chemical Carcinogenesis." Cassarett and Doull's Toxicology, the Basic Science of Poisons. 4th Edition, Pergamon Press, New York, New York.

LEAD MODELING RESULTS

Location: IHDIV-HSWC, Indian Head
Site Name: Sediment
Date: 5/16/2002
Run Mode: Site Risk Assessment

Soil/Dust Data
Average lead concentration in sediment = 157 mg/kg

The time step used in this model run: 1 - Every 4 Hours (6 times a day).

******Air******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc ug Pb/m^3
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

******Diet******

Age	Diet Intake(ug/day)
.5-1	5.530
1-2	5.780
2-3	6.490
3-4	6.240
4-5	6.010
5-6	6.340
6-7	7.000

******Drinking Water******

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 4.000 ug Pb/L

Location: IHDIV-HSWC, Indian Head (Page 2 of 3)
Site Name: Sediment
Date: 5/16/2002
Run Mode: Site Risk Assessment

******Soil& Dust******

Multiple Source Analysis Used
Average multiple source concentration: 119.900 ug/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
.5-1	157.000	119.900
1-2	157.000	119.900
2-3	157.000	119.900
3-4	157.000	119.900
4-5	157.000	119.900
5-6	157.000	119.900
6-7	157.000	119.900

******Alternate Intake******

Age	Alternate (ug Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

******Maternal Contribution: Infant Model******

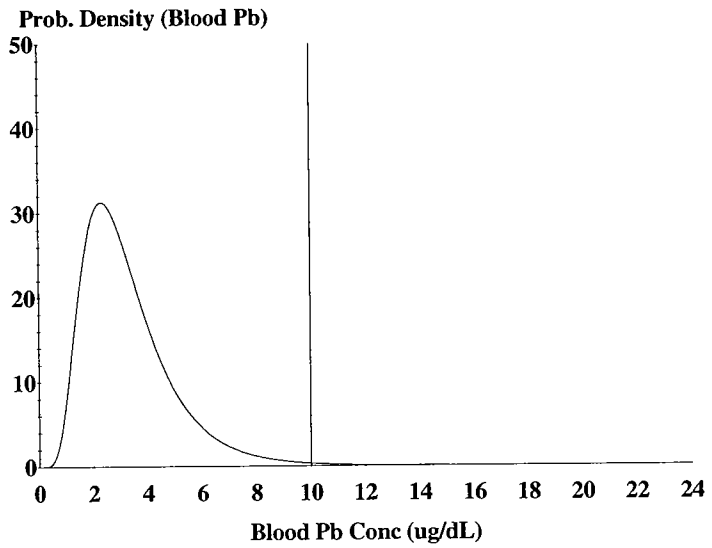
Maternal Blood Concentration: 2.500 ug Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:

****

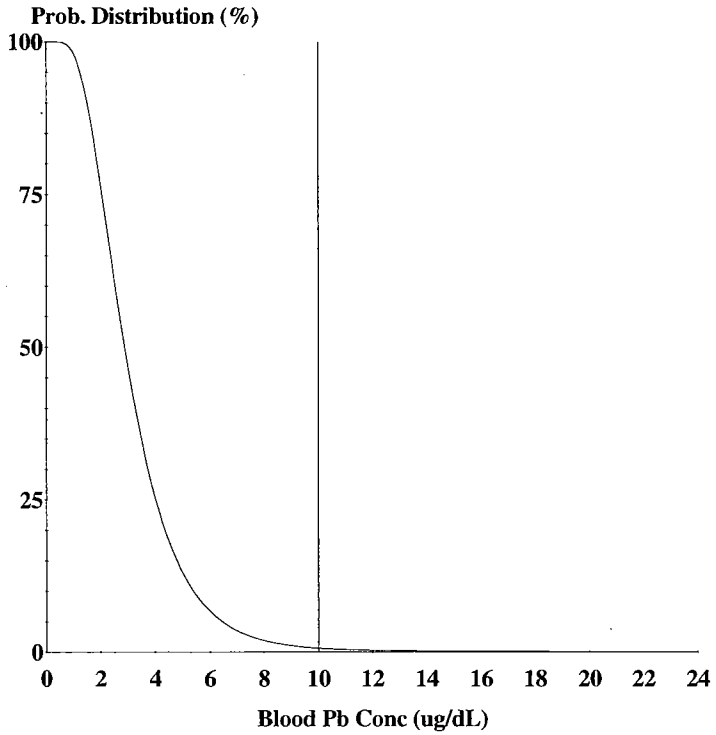
Year	Air (ug/dL)	Diet (ug/day)	Alternate (ug/day)	Water (ug/day)
5-1	0.021	2.576	0.000	0.373
1-2	0.034	2.677	0.000	0.926
2-3	0.062	3.030	0.000	0.971
3-4	0.067	2.943	0.000	1.000
4-5	0.067	2.878	0.000	1.054
5-6	0.093	3.053	0.000	1.117
6-7	0.093	3.379	0.000	1.139

Year	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
.5-1	3.245	6.216	3.4
1-2	5.124	8.761	3.7
2-3	5.166	9.230	3.4
3-4	5.219	9.229	3.2
4-5	3.925	7.924	2.8
5-6	3.552	7.817	2.5
6-7	3.363	7.975	2.3



Cutoff = 10.000 ug/dl
Geo Mean = 3.027
% Above = 0.515
% Below = 99.485

Age Range = 0 to 84 months
Time Step = Every 4 Hours
Run Mode = Research
Comment = Site 37 - Sediment



Cutoff = 10.000 ug/dl
Geo Mean = 3.027
% Above = 0.515

Age Range = 0 to 84 months
Time Step = Every 4 Hours
Run Mode = Research
Comment = Site 37 - Sediment

TABLE I-1

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH SUBSURFACE SOIL - SITE 33 - INDUSTRIAL EXPOSURES
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Scenario Timeframe: Current/Future
Medium: Subsurface Soil
Exposure Medium: Subsurface Soil
Exposure Point: Site 33

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Nondetects(2)	Average Concentration	Concentration Used for Screening(3)	Background Value(4)	U.S. EPA Region 3 RBC-Industrial (5)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Inorganics															
7429-90-5	Aluminum	2760		13000		mg/kg	S33SB0030201-D	6/6	NA	6740	13000	35400	200000 N	No	BSL, BKG
7440-38-2	Arsenic	1.6	K	25	K	mg/kg	S33SB0030201	6/6	NA	7.21	25	18.9	3.8 C	Yes	ASL
7440-39-3	Barium	15.9		40.3		mg/kg	S33SB0010201	6/6	NA	25.6	40.3	134	14000 N	No	BSL, BKG
7440-41-7	Beryllium	0.16	K	1.9	K	mg/kg	S33SB0030201	6/6	NA	0.870	1.9	3.3	410 N	No	BSL, BKG
7440-70-2	Calcium	165		1170		mg/kg	S33SB0010201	4/6	8.9 - 30.6	424	1170	2590	NA	No	NUT, BKG
7440-47-3	Chromium	11.6		47.5		mg/kg	S33SB0030201-D	6/6	NA	21.4	47.5	60.1	610 (7) N	No	BSL, BKG
7440-48-4	Cobalt	1.5	J	3	J	mg/kg	S33SB0010201	4/6	0.22 - 0.97	1.52	3	133	4100 N	No	BSL, BKG
7440-50-8	Copper	3.3	K	13.2		mg/kg	S33SB0020201	6/6	NA	6.50	13.2	48.6	8200 N	No	BSL, BKG
7439-89-6	Iron	7770		50200		mg/kg	S33SB0030201	6/6	NA	21853	50200	83100	61000 N	No	BSL, BKG
7439-92-1	Lead	4.4	J	10.1	J	mg/kg	S33SB0030201	6/6	NA	7.78	10.1	40.5	750 (8)	No	BSL, BKG
7439-95-4	Magnesium	177		1980		mg/kg	S33SB0030201-D	6/6	NA	808	1980	2640	NA	No	NUT, BKG
7439-96-5	Manganese	1.4	J	228	J	mg/kg	S33SB0030201	6/6	NA	38.5	228	4130	4100 N	No	BSL, BKG
7439-97-6	Mercury	0.055		0.055		mg/kg	S33SB0010201	1/6	0.046 - 0.059	0.031	0.055	0.18	61 (9) N	No	BSL, BKG
7440-02-0	Nickel	2.9	K	13	K	mg/kg	S33SB0020201	5/6	0.94	6.25	13	18.2	4100 N	No	BSL, BKG
7440-09-7	Potassium	292	J	4100	J	mg/kg	S33SB0030201-D	6/6	NA	1210	4100	2610	NA	No	NUT
7782-49-2	Selenium	0.61	J	0.61	J	mg/kg	S33SB0030201	1/6	0.32 - 0.46	0.228	0.61	13.3	1000 N	No	BSL, BKG
7440-28-0	Thallium	0.33	K	1.1	K	mg/kg	S33SB0030201	3/6	0.35 - 0.42	0.425	1.1	21.8	14 N	No	BSL, BKG
7440-62-2	Vanadium	14.4	K	55.6		mg/kg	S33SB0030201	6/6	NA	32.5	55.6	194	1400 N	No	BSL, BKG
7440-66-6	Zinc	5.9	K	49.3		mg/kg	S33SB0030201	5/6	12.1	24.0	49.3	70.4	61000 N	No	BSL, BKG

Notes:
(1) - Sample and duplicate are counted as two separate samples when determining the minimum and maximum detected concentrations.
(2) - Values presented are sample-specific quantitation limits.
(3) - The maximum detected concentration is used for screening purposes.
(4) - Background Soil Investigation Report for Indian Head Stump Neck Annex, Indian Head and Stump Neck Annex, TtNUS, February 2002 (Draft).
(5) - U.S. EPA Region 3 Risk-Based Concentration Table, April 2, 2002. (RBCs for noncarcinogenic compounds are divided by 10).
(7) - Rationale Codes
Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Essential Nutrient (NUT)
Below Screening Level (BSL)
Below Background Value (BKG)
(8) - Value is for hexavalent chromium.
(9) - Frequently Asked Questions (FAQs) on the Adult Lead Model, U.S. EPA, April 1999.
(10) - Value is for mercuric chloride.
Shaded cells indicate that the specified criterion has been exceeded or that the chemical has been selected as a COPC.

Definitions:
NA = Not Applicable.
SQL = Sample Quantitation Limit.
COPC = Chemical of Potential Concern.
J = Estimated Value.
C = Carcinogenic.
N = Noncarcinogenic.

Associated Samples:
S33SB0010101 S33SB0030101
S33SB0010201 S33SB0030201
S33SB0020101 S33SB0030201-D
S33SB0020201

TABLE I-2

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - SUBSURFACE SOIL - SITE 33 - INDUSTRIAL EXPOSURES
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)		
Chemical	Concentration (maximum) (mg/kg)	RBC[1] (mg/kg)	Estimated ILCR	Primary Target Organs	RBC[1] (mg/kg)	Estimated HQ
Arsenic	25	3.8	6.6E-06	Skin, Vascular	613	0.04
		Total Carcinogenic Risk	**6.6E-06**		**Total HI**	**0.04**

Target Organ HIs

Total Vascular HI =	0.04
Total Skin HI =	0.04

1 Risk-Based Concentration (RBC) Table (USEPA Region III, 2002). Industrial RBCs. The noncarcinogenic RBC is not presented in the USEPA Region III Risk Based Concentration Table and was calculated as per the methodology detail in Appendix I.

TABLE I-3

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH SEDIMENT - SITE 37 - INDUSTRIAL EXPOSURES
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Scenario Timeframe: Current/Future
Medium: Sediment
Exposure Medium: Sediment
Exposure Point: Site 37

CAS Number	Chemical	Minimum Concentration (1)	Minimum Qualifier	Maximum Concentration (1)	Maximum Qualifier	Units	Location of Maximum Concentration	Detection Frequency	Range of Nondetects(2)	Average Concentration	Concentration Used for Screening(3)	Background Value(4)	U.S. EPA Region 3 RBC-Industrial (5)	COPC Flag	Rationale for Contaminant Deletion or Selection(6)
Volatile Organic Compounds															
67-64-1	Acetone	85	J	85	J	ug/kg	S37SD0030001	1/3	11 - 12	32.3	85	NA	20000000 N	No	BSL
Semivolatile Organic Compounds															
91-57-6	2-Methylnaphthalene	390		2000	J	ug/kg	S37SD0030001	2/3	370 - 400	829	2000	NA	4100000 N	No	BSL
208-96-8	Acenaphthylene	61	J	61	J	ug/kg	S37SD0010001	1/3	370 - 2300	470	61	NA	12000000 (7) N	No	BSL
100-52-7	Benzaldehyde	700	J	700	J	ug/kg	S37SD0030001	1/3	360 - 400	361	700	NA	20000000 N	No	BSL
56-55-3	Benzo(a)anthracene	710		710		ug/kg	S37SD0010001-D	1/3	360 - 2300	598	710	NA	7800 C	No	BSL
50-32-8	Benzo(a)pyrene	630		630		ug/kg	S37SD0010001-D	1/3	360 - 2300	585	630	NA	780 C	No	ASL
205-99-2	Benzo(b)fluoranthene	320	J	320	J	ug/kg	S37SD0010001-D	1/3	360 - 2300	557	320	NA	7800 C	No	BSL
191-24-2	Benzo(g,h,i)perylene	150	J	150	J	ug/kg	S37SD0010001-D	1/3	360 - 2300	500	150	NA	6100000 (8) N	No	BSL
207-08-9	Benzo(k)fluoranthene	83	J	83	J	ug/kg	S37SD0010001-D	1/3	360 - 2300	478	83	NA	78000 C	No	BSL
218-01-9	Chrysene	1100		1100		ug/kg	S37SD0010001-D	1/3	360 - 2300	663	1100	NA	780000 C	No	BSL
53-70-3	Dibenzo(a,h)anthracene	57	J	57	J	ug/kg	S37SD0010001-D	1/3	360 - 2300	469	57	NA	780 C	No	BSL
206-44-0	Fluoranthene	170	J	170	J	ug/kg	S37SD0010001-D	1/3	360 - 2300	507	170	NA	8200000 N	No	BSL
193-39-5	Indeno(1,2,3-cd)pyrene	79	J	79	J	ug/kg	S37SD0010001-D	1/3	360 - 2300	476	79	NA	7800 C	No	BSL
91-20-3	Naphthalene	640	J	640	J	ug/kg	S37SD0030001	1/3	360 - 400	341	640	NA	4100000 N	No	BSL
85-01-8	Phenanthrene	260	J	260	J	ug/kg	S37SD0010001-D	1/3	360 - 2300	537	260	NA	6100000 (8) N	No	BSL
129-00-0	Pyrene	520	J	1100		ug/kg	S37SD0010001-D	2/3	360 - 400	453	1100	NA	6100000 N	No	BSL
Pesticides/PCBs															
72-54-8	4,4'-DDD	180	J	180	J	ug/kg	S37SD0030001	1/3	3.6 - 4	61.3	180	NA	24000 C	No	BSL
72-55-9	4,4'-DDE	73	J	73	J	ug/kg	S37SD0030001	1/3	3.6 - 4	25.6	73	NA	17000 C	No	BSL
Explosives															
9004-70-0	Nitrocellulose	4.5	J	4.5	J	mg/kg	S37SD0030001	1/3	0.49 - 0.69	1.71	4.5	NA	NA	No	NTX
Inorganics															
7429-90-5	Aluminum	208	J	10200	J	mg/kg	S37SD0030001	3/3	NA	3588	10200	52362	200000 N	No	BSL
7440-38-2	Arsenic	0.64	K	11.5	J	mg/kg	S37SD0030001	3/3	NA	4.60	11.5	63	3.8 C	Yes	ASL
7440-39-3	Barium	3	J	140	J	mg/kg	S37SD0030001	3/3	NA	49.1	140	577	14000 N	No	BSL
7440-41-7	Beryllium	0.071	K	2	J	mg/kg	S37SD0030001	3/3	NA	0.742	2	10.9	410 N	No	BSL
7440-43-9	Cadmium	0.058	K	1.5	J	mg/kg	S37SD0030001	3/3	NA	0.576	1.5	1.85	100 N	No	BSL
7440-70-2	Calcium	72.7		4550	J	mg/kg	S37SD0030001	3/3	NA	1578	4550	88137	NA	No	NUT
7440-47-3	Chromium	2.3	K	18	J	mg/kg	S37SD0030001	3/3	NA	7.98	18	79.2	610 (9) N	No	BSL
7440-48-4	Cobalt	0.95	K	34.2	J	mg/kg	S37SD0030001	2/3	0.56	11.8	34.2	118	4100 N	No	BSL
7440-50-8	Copper	100	J	100	J	mg/kg	S37SD0030001	1/3	0.55 - 2.3	33.8	100	297	8200 N	No	BSL
7439-89-6	Iron	1620	J	25800	J	mg/kg	S37SD0030001	3/3	NA	10973	25800	193218	61000 N	No	BSL
7439-92-1	Lead	5.7		456	J	mg/kg	S37SD0030001	3/3	NA	157	456	476	750 (10)	No	BSL
7439-95-4	Magnesium	70.1		2550	J	mg/kg	S37SD0030001	3/3	NA	908	2550	19043	NA	No	NUT
7439-96-5	Manganese	34.2	J	435	J	mg/kg	S37SD0030001	3/3	NA	179	435	2561	4100 N	No	BSL
7440-02-0	Nickel	0.78	K	51.9	J	mg/kg	S37SD0030001	3/3	NA	18.1	51.9	382	4100 N	No	BSL
7440-09-7	Potassium	1590	J	1590	J	mg/kg	S37SD0030001	1/3	75.2 - 101	557	1590	5061	NA	No	NUT
7440-22-4	Silver	0.22	K	0.7	K	mg/kg	S37SD0010001	2/3	0.69	0.402	0.7	0.92	1000 N	No	BSL
7440-23-5	Sodium	70.8		112		mg/kg	S37SD0020001	2/3	1530	321	112	472	NA	No	NUT
7440-62-2	Vanadium	3.1	K	43.5	J	mg/kg	S37SD0030001	3/3	NA	17.8	43.5	196	1400 N	No	BSL
7440-66-6	Zinc	11.6		141	J	mg/kg	S37SD0030001	2/3	10.5	52.9	141	1660	61000 N	No	BSL

TABLE I-3

OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - DIRECT CONTACT WITH SEDIMENT - SITE 37 - INDUSTRIAL EXPOSURES
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

Notes:
(1) - Minimum and maximum detected concentrations.
(2) - Values presented are sample-specific quantitation limits.
(3) - The maximum detected concentration is used for screening purposes.
(4) - Background Soil Investigation Report for Indian Head Stump Neck Annex, Indian Head and Stump Neck Annex, TtNUS, February 2002 (Draft).
Sedminent background values are presented for informational purposes only. Sediment is not screened against background, see text.
(5) - U.S. EPA Region 3 Risk-Based Concentration Table, April 2, 2002. (RBCs for noncarcinogenic compounds are divided by 10).
(6) - Rationale Codes — Selection Reason: Above Screening Levels (ASL)
Deletion Reason: Essential Nutrient (NUT)
(7) - Value is for acenaphthene. — Below Screening Level (BSL)
(8) - Value is for pyrene. — Below Background Value (BKG)
(9) - Value is for hexavalent chromium. — No Toxicity Information (NTX)
(10) - Frequently Asked Questions (FAQs) on the Adult Lead Model, U.S. EPA, April 1999.
Shaded cells indicate that the specified criterion has been exceeded or that the chemical has been selected as a COPC.

Definitions:
NA = Not Applicable.
SQL = Sample Quantitation Limit.
COPC = Chemical of Potential Concern.
J = Estimated Value.
C = Carcinogenic.
N = Noncarcinogenic.
ARAR/TBC = Applicable or Relevant and Appropriate Requirement/To Be Considered

Associated Samples:
S37SD0010001
S37SD0010001-D
S37SD0020001
S37SD0030001

TABLE I-4

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs - SEDIMENT - SITE 37 - INDUSTRIAL EXPOSURES
INDIAN HEAD DIVISION NSWC
INDIAN HEAD, MARYLAND

	Incremental Lifetime Carcinogenic Risk (ILCR)			Estimated Non-Carcinogenic Hazard Quotient (HQ)		
Chemical	Concentration (maximum) (mg/kg)	RBC[1] (mg/kg)	Estimated ILCR	Primary Target Organs	RBC[1] (mg/kg)	Estimated HQ
Arsenic	11.5	3.8	3.0E-06	Skin, Vascular	613	0.02
		Total Carcinogenic Risk	**3.0E-06**		**Total HI**	**0.02**

Target Organ HIs

Total Skin HI =	0.02
Total Vascular HI =	0.02

1 Risk-Based Concentration (RBC) Table (USEPA Region III, 2002). Industrial RBCs. The noncarcinogenic RBC is not presented in the USEPA Region III Risk Based Concentration Table and was calculated as per the methodology detail in Appendix I.

FINAL

Work Plan for Remedial Investigation at Site 28

Naval Surface Warfare Center
Indian Head Division
Indian Head, Maryland

Contract Task Order 0111

April 2003

Prepared for

Department of the Navy
Engineering Field Activity, Chesapeake
Naval Facilities Engineering Command

Under the

LANTDIV Clean II Program
Contract N62470-95-D-6007

Prepared by

Herndon, Virginia

Executive Summary

This Remedial Investigation (RI) Work Plan for Site 28, located at the Indian Head Division, Naval Surface Warfare Center (IHDIV-NSWC), Indian Head, Maryland, was prepared in response to Contract Task Order 0111, under the Comprehensive Long-Term Environmental Action Navy, contract number N62470-95-D-6007. It addresses all work activities required to conduct the RI and provides the framework and process that will be used to complete the tasks.

The specific site covered by this Work Plan—Site 28, also referred to as the Original Burning Ground, Slavins Dock Area, and Wildlife Area—is located on the main installation of IHDIV-NSWC. The site encompasses a former zinc recovery furnace, Artesian Well 14, and the Shoreline Burning Cage.

During World War I, the Navy initiated a metal recycling program, which continues to the present day. As part of the recycling program, the Zinc Recovery Furnace (Building 415) was erected in 1928 and used until it was demolished in the early 1950s. Artesian Well 14 was installed in 1918 and at one time was used as a potable well. It became an observation well in 1988 and remains an observation well today. A small burning cage used to burn debris, such as wooden crates, existed to the south of Artesian Well 14. In 1990, surface debris was removed from several sites at Indian Head, including Site 28.

An Initial Assessment Study (IAS) in 1982 found that smokeless powder and other contaminated wastes were burned at the site. The finding was based on materials manufactured when the site was in operation, circa 1890s to 1942. The IAS concluded that there was not enough information to characterize the potential hazard at the site; therefore, the site was not recommended for a Navy Assessment and Control of Installation Pollutants (NACIP) confirmation study. Soil samples collected in August 1993, May 2000, and July 2000 contained levels of zinc as high as 7,350 parts per million (ppm). A sediment sample collected in October 2000 during a Toxicity Identification Evaluation (TIE) in Mattawoman Creek offshore of Site 28 contained pore water concentrations of zinc as high as 25,000 ppb.

There are currently insufficient data to characterize the impact of metals from the site on sediment, surface water, soil, and groundwater. To address these data gaps, this investigation will focus on the collection of geological, hydrogeological, and chemical data to characterize the nature and extent of metals and other potential contaminants in soil, sediment, surface water, and groundwater at Site 28. For this investigation the site will be divided into Zones A and B. Zone A encompasses the portion of Site 28 where the zinc recovery furnace was likely located, and Zone B encompasses the probable location of the shoreline burning cage. The first phase of the investigation will consist of collecting surface and subsurface soil samples, in situ groundwater samples, surface water samples, and sediment samples in Zone A; surface and subsurface soil samples in Zone B; and sediment samples from Mattawoman Creek. The data generated during this phase of the investigation will be used to determine the location of monitoring wells that will be installed during a second phase. Data obtained for the various media will be used to assess ecological and human health risks. Table ES-1 summarizes the tasks covered in this Work Plan.

Table ES-1
Summary of Site 28 Remedial Investigation Work Plan Tasks
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

Site Location	Media	Work Plan Summary	Number of Primary Samples	Ecological Risk Assessment	Human Health Risk Assessment
Zone A	Surface Soil	Characterize the vertical and lateral extent of organics and metals in soil. Collect surface soil samples from various locations.	29*	yes	yes
	Subsurface Soil	Characterize the vertical and lateral extent of organics and metals in soil. Collect subsurface soil samples from various locations.	29*	yes	yes
	In Situ Groundwater	Qualitative assessment of groundwater to aid in the placement of monitoring wells. Collected at various locations around Zone A	12	no	no
	Groundwater from Monitoring Wells	Quantitative assessment of groundwater quality. Collected from wells installed at locations determined by the *in situ* groundwater samples.	4	yes	yes
	Surface Water	Assess surface water quality. Collect surface water samples from corresponding sediment locations along the swales.	3	yes	yes
	Sediment	Characterize the lateral extent of organics and metals in sediments. Collect sediment samples from various locations along the swales.	3	yes	yes
Zone B	Surface Soil	Characterize the vertical and lateral extent of organics and metals in soil. Collect surface soil samples from various locations.	10*	yes	yes
	Subsurface Soil	Characterize the vertical and lateral extent of organics and metals in soil. Collect subsurface soil samples from various locations.	10*	yes	yes
Mattawoman Creek	Sediment	Characterize the vertical and lateral extent of metals in sediment of Mattawoman Creek adjacent to Site 28. Collect sediment samples from Mattawoman Creek in a grid pattern adjacent to Site 28.	30	yes**	yes

Notes
* Two field discretionary samples are included in these totals.
**The 15 surface sediment samples (0-6 inches) will be evaluated in the ecological risk assessment.

Contents

Executive Summary ..... **II**

Acronyms and Abbreviations ..... **VI**

1 Introduction **1-1**
- 1.1 Objectives and Scope 1-1
- 1.2 Document Organization 1-2
- 1.3 Project Organization 1-2

2 Background Information **2-1**
- 2.1 IHDIV-NSWC Facility 2-1
  - 2.1.1 Facility Description and Setting 2-1
  - 2.1.2 Historical and Current Uses of IHDIV-NSWC 2-1
  - 2.1.3 Surrounding Land Uses 2-2
  - 2.1.4 Physiography and Geology 2-2
  - 2.1.5 Surface Water and Drainage 2-3
  - 2.1.6 Climatic Conditions 2-3
  - 2.1.7 Ecological Communities 2-4
- 2.2 Site 28 2-5
  - 2.2.1 History and Description 2-5
  - 2.2.2 Previous Investigations 2-5

3 Remedial Investigation Technical Approach **3-1**
- 3.1 Field Activities 3-1
  - 3.1.1 Mobilization/Demobilization and Decontamination 3-1
  - 3.1.2 Zone A 3-2
  - 3.1.3 Zone B 3-4
  - 3.1.4 Sediment Sampling in Mattawoman Creek 3-5
  - 3.1.5 Surveying 3-5
  - 3.1.6 Investigation-Derived Waste 3-6
- 3.2 Sample Handling 3-6
  - 3.2.1 Sample Identification System 3-6
  - 3.2.2 Sample Packaging and Shipping 3-7
- 3.3 Data Quality Objectives 3-8
  - 3.3.1 Step 1: State the Problem 3-8
  - 3.3.2 Step 2: Identify the Decision 3-8
  - 3.3.3 Step 3: Identify Inputs to the Decision 3-8
  - 3.3.4 Step 4: Define the Boundaries of the Study 3-8
  - 3.3.5 Step 5: Develop a Decision Rule 3-8
  - 3.3.6 Step 6: Specify Limits on Decision Errors 3-9
  - 3.3.7 Step 7: Optimize the Design 3-9
- 3.4 Human Health Risk Assessment 3-9
- 3.5 Ecological Risk Assessment 3-11

4 References **4-1**

Tables

ES-1 Summary of Site 28 Remedial Investigation Work Plan Tasks

2-1 Rare Flora Found at NSWC Indian Head Division
2-2 Rare Fauna Found at NSWC Indian Head Division

3-1 Summary of Sampling Program, Site 28
3-2 Bottleware, Preservation, and Holding Time Requirements, Site 28

Figures

1-1 Project Organization Chart

2-1 IHDIV-NSWC Vicinity Map
2-2 Location of Site 28
2-3 Site 28

3-1 Site 28 Zones A and B
3-2 Site 28 Sample Locations
3-3 Site 28 Mattawoman Creek Sediment Sample Locations

Acronyms and Abbreviations

B&RE	Brown & Root Environmental
BERA	Baseline Ecological Risk Assessment
bgs	below ground surface
CLEAN	Comprehensive Long-term Environmental Action Navy
CLP	Contract Laboratory Program
CNO	Chief of Naval Operations
COC	Chemical of Concern
COPC	Chemical of Potential Concern
CTO	Contract Task Order
DO	Dissolved Oxygen
DPT	Direct Push Technology
ERA	Ecological Risk Assessment
EPC	Exposure Point Concentration
FTL	Field Team Leader
HASP	Health and Safety Plan
HHRA	Human Health Risk Assessment
HRS	Hazard Ranking System
HQ	Hazard Quotient
IAS	Initial Assessment Study
IDW	Investigation-Derived Wastes
IHDIV-NSWC	Indian Head Division, Naval Surface Warfare Center
IR	Installation Restoration
MCL	Maximum Contaminant Level
MDE	Maryland Department of the Environment
MDNR	Maryland Department of Natural Resources
mg/L	milligrams per liter
MS/MSD	Matrix Spike and Matrix Spike Duplicate
msl	mean sea level
NACIP	Navy Assessment and Control of Installation Pollutants
NAVFAC	Naval Facilities Engineering Command
NEESA	Naval Energy and Environmental Support Activity
NOAEL	no-observed-adverse-effect level
NOS	Naval Ordnance Station
NPL	National Priorities List
NWI	National Wetlands Inventory
ORP	Oxidation/Reduction Potential
ppm	parts per million

QA/QC	Quality Assurance and Quality Control
QAPP	Quality Assurance Project Plan
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RPM	Remedial Project Manager
SDWA	Safe Drinking Water Act
SPAWARS	Space and Naval Warfare Systems Command
SERA	Screening Ecological Risk Assessment
SVOC	Semivolatile Organic Compound
SOP	Standard Operating Procedure
TAL	Target Analyte List
TCL	Target Compound List
TCLP	Toxicity Characteristic Leaching Procedure
TIE	Toxicity Identification Evaluation
TOC	Total Organic Carbon
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compound

1 Introduction

This Remedial Investigation (RI) Work Plan for Site 28, located at the Indian Head Division, Naval Surface Warfare Center (IHDIV-NSWC), Indian Head, Maryland, was prepared in response to Contract Task Order (CTO) 0111, under the Comprehensive Long-term Environmental Action Navy (CLEAN), contract number N62470-95-D-6007. It addresses all work activities required to conduct the RI and provides the framework and process that will be utilized to complete the tasks.

This RI Work Plan is a supplement to the following master planning documents:

- Master Work Plan, prepared by Brown & Root Environmental (B&RE), April 1997
- Master Field Sampling Plan, prepared by B&RE, April 1997
- Standard Operating Procedures (SOPs), prepared by B&RE, April 1997
- Master Quality Assurance Project Plan (QAPP), prepared by B&RE, April 1997
- Health and Safety Guidance Document, prepared by B&RE, April 1997
- Addendum to B&RE Master Work Plans, prepared by CH2M HILL, March 2000
- Addendum to Health and Safety Plan, to be prepared by CH2M HILL

The above-referenced master planning documents will provide the methods and procedures that will be used to perform the environmental investigative work proposed herein for Site 28. Unless otherwise noted, all SOPs referenced in this Work Plan are contained in the Master Work Plan.

1.1 Objectives and Scope

The objective of this Work Plan is to present historical information for Site 28, evaluate that information, determine the need for further investigation, and propose a plan for further investigation. Further, the RI objectives at Site 28 are to:

- Verify the presence or absence of contamination in soil, groundwater, surface water, and sediment resulting from past activities at the site
- Define the extent of contamination
- Evaluate the need for remediation based on the critical information developed in the human health and ecological risk assessments

These objectives were established based on a review and evaluation of site historical information.

These objectives will be accomplished through the following field and laboratory activities: (1) collecting and analyzing surface and subsurface soil samples; (2) collecting and analyzing in situ groundwater samples; (3) collecting and analyzing surface water and sediment in the swales and collection of sediment samples in Mattawoman Creek; and (4) installing and sampling permanent monitoring wells during a second phase of the field effort.

1.2 Document Organization

This RI Work Plan is organized as follows: Section 1 presents the objectives, document organization, and project organization; Section 2 presents a general description of the facility and the site, a summary of the site history, and a description of previous investigations; and Section 3 presents a description of the field investigation program. Figures and tables are provided at the end of each section.

1.3 Project Organization

CH2M HILL will conduct this remedial investigation with support from the Navy. The Navy RPM will be Mr. Jeff Morris.

Mr. Jeff Morris, Code CH20C
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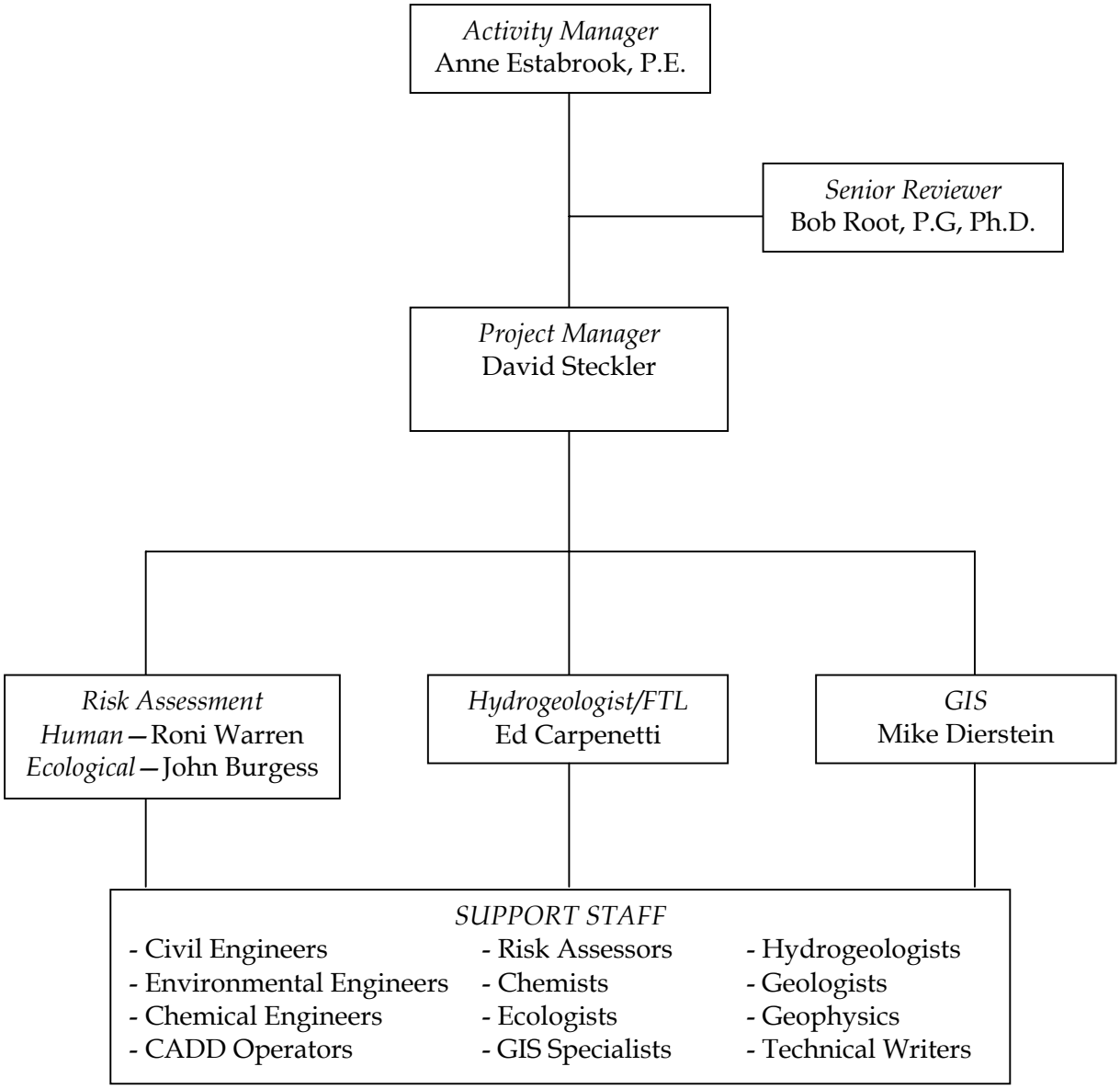
(301) 744-4180 (FAX)
Email: MorganHA@ih.navy.mil

The CH2M HILL Project Organization is shown in Figure 1-1.

FIGURE 1-1
Project Organization Chart



2 Background Information

This section of the Work Plan describes background information associated with IHDIV-NSWC and Site 28. Section 2.1 contains a description of the facility, operations, land use, and geological setting of the IHDIV-NSWC facility as well as the ecological communities present. Section 2.2 contains the history, site description, and results of previous investigations. Similar information on IHDIV-NSWC and other sites at the facility is provided in other documents (NEESA, 1983, 1988, 1992, and B&RE, 1997).

2.1 IHDIV-NSWC Facility

2.1.1 Facility Description and Setting

IHDIV-NSWC is a military facility located in northwestern Charles County, Maryland, approximately 25 miles southwest of Washington, D.C. (Figure 2-1). The facility provides services, research, development, testing, and evaluation in energetics (B&RE, 1997).

IHDIV-NSWC consists of the main installation on the Cornwallis Neck Peninsula and the Stump Neck Annex. The main installation covers approximately 2,500 acres. The Stump Neck Annex, located across Mattawoman Creek, covers 1,084 acres. The main installation is bounded by the Potomac River to the northwest, west, and south; Mattawoman Creek to the south and east; and the town of Indian Head to the northeast. The main installation includes Marsh Island and Thoroughfare Island, which are located in Mattawoman Creek. Elevations range from sea level to 111 feet above mean sea level (msl) on Cornwallis Neck.

Both the main installation (Cornwallis Neck Peninsula) and the Stump Neck Annex are on the National Priorities List (NPL). The main installation and Stump Neck Annex are separated by Mattawoman Creek (noncontiguous), have separate United States Environmental Protection Agency (USEPA) identification numbers, and perform dissimilar operations.

2.1.2 Historical and Current Uses of IHDIV-NSWC

IHDIV-NSWC was established in 1890 and is the Navy's oldest continuously operating ordnance station. At various times during its operation, IHDIV-NSWC has served as a gun and armor proving ground, a powder factory, a propellant plant, and a research facility. The U.S. Government purchased Stump Neck Annex in 1901. The property provided a safety buffer for the testing of larger naval guns that were tested by firing into the Potomac River, and at Stump Neck.

The Indian Head installation was enlarged by another 1,160 acres of adjacent land in 1918, during World War I. This expansion included the purchase of Hopewell Farm and Hog Island, which was at that time an islet in Mattawoman Creek and has since become attached to the Cornwallis Neck peninsula. When the Dahlgren Naval Proving Ground was established as a separate command in 1932, IHDIV-NSWC was redesignated the Naval Powder Factory (Parsons, 2000).

The production of gunpowder and development of new explosives at the onset of World War II resulted in the construction of several new facilities at Indian Head, as well as the construction of Route 210 as a Defense Access Road in 1943. Development and improvements at Indian Head continued throughout the 1950s and 1960s; in 1966, IHDIV-NSWC was renamed the Naval Ordnance Station (NOS), and Rum Point, an 80-acre promontory in Mattawoman Creek near Stump Neck, was acquired. Bullitt Neck was obtained in five small acquisitions in 1965 and 1966 in order to meet safety and security needs arising from explosive magazines on the Indian Head station (Parsons, 2000).

After the Vietnam conflict, the mission of IHDIV-NSWC shifted from primarily a production facility to a highly technical engineering support operation. In 1987, the NOS was established as a Center for Excellence to promote technological excellence in the following specialized fields: energetic chemicals; guns, rockets, and missile propulsion; ordnance devices; explosives; safety and environmental protection; and simulators and training (Parsons, 2000). Current military land use includes operations and training; production; maintenance and utilities; research, development, testing, and evaluation; explosive storage; supply and nonexplosive storage; administration; community facilities and services; housing; and open space.

Forest stands make up approximately 47 percent, or 1,603 acres, of IHDIV-NSWC and include pine, pine-hardwood, and hardwood forest cover types. Recreation areas at Indian Head include approximately 1,150 acres of designated hunting areas, approximately 2 miles of shoreline fishing areas, and 1.5 miles of nature trails.

2.1.3 Surrounding Land Uses

IHDIV-NSWC is generally surrounded by commercial, residential, and state park land to the east and south of the main installation and Stump Neck Annex. The town of Indian Head is located just east of IHDIV-NSWC, where most residential developments are located. Indian Head Highway (Route 210) extends eastward from IHDIV-NSWC's main gate, attracting businesses and providing access to residential areas off the main highway. The Potomac River borders the main installation to the north and west, and Stump Neck borders it to the west. Mason Neck National Wildlife Refuge is located across the Potomac River, north of the main installation. The Mattawoman Natural Environment Area is state-owned property located along the southern edge of Mattawoman Creek east of the main installation.

The Stump Neck Annex is bordered to the north by Mattawoman Creek, to the east by General Smallwood State Park and Sweden Point Marina, and to the south by Chicamuxen Creek, agricultural lands, and low-density residential development. The Chicamuxen Wildlife Management Area is located adjacent to and south of the Stump Neck Annex.

2.1.4 Physiography and Geology

IHDIV-NSWC lies within the Atlantic Coastal Plain physiographic province and is underlain by unconsolidated sand, gravel, and clay from the Pleistocene and Cretaceous Periods. The soil in this area consists of silty and sandy loams, with minor amounts of gravel. The soils tend to have low permeability and low shrink-swell potential. Four dominant soil associations are found at Indian Head (USDA SCS, 1974):

- **Beltsville-Gravelly Land-Bourne**—The soils within this association are level to moderately sloping, moderately well-drained and loamy, and moderately deep. They also include dense, root-inhibiting fragipans and steep, gravelly soil materials.
- **Beltsville-Exum-Wickham**—This association is characterized by level to moderately sloping, moderately well-drained and well-drained loamy soils. Soils within this association are moderately deep and include dense, root-inhibiting fragipans and steep, gravelly soil materials.
- **Evesboro-Keyport-Elkton**—This association is characterized by level to moderately sloping, excessively drained, sandy soils and moderately well-drained and poorly drained level-to-gently-sloping loamy soils with clayey subsoil.
- **Bibb-Tidal Marsh-Swamp**—This association is characterized by level or nearly level, poorly drained, and generally located on floodplains and in miscellaneous unclassified wetlands.

2.1.5 Surface Water and Drainage

Major water bodies at Indian Head include the Potomac River, Mattawoman Creek, and Chicamuxen Creek. The Potomac River flows almost 400 miles from its headwaters in the Allegheny Mountains of West Virginia. Near Indian Head, the Potomac broadens and becomes saltier from the increasing influence of the Chesapeake Bay. Near IHDIV-NSWC, salinity ranges from 0.01 to 3.0 parts per thousand, with the highest salinity values recorded during dry summer months. Mattawoman and Chicamuxen Creeks are tidal tributaries to the lower Potomac River. Chicamuxen Creek is more saline than Mattawoman Creek because it is more strongly influenced by the estuarine waters of the lower Potomac River.

The Potomac River bounds Cornwallis Neck to the north and northwest. Owing to the peninsula's topography, most of the surface water on Cornwallis Neck drains into Mattawoman Creek, which forms its southeastern boundary. The Stump Neck Peninsula is bounded by Mattawoman Creek to the north, the Potomac River to the northwest, and partially by Chicamuxen Creek to the southeast.

The Patapsco Formation aquifer supplies IHDIV-NSWC with the majority of groundwater required for production. It is recharged chiefly through precipitation, and the water filters through the soil and is held primarily in sandy/gravelly formations (Parsons, 2000). A single production well, Well 16A, serves IHDIV-NSWC and is screened in the deeper Patuxent aquifer.

2.1.6 Climatic Conditions

IHDIV-NSWC lies in the humid temperate continental climatic zone of the eastern United States. This zone has hot, humid summers and relatively mild winters. Because of its proximity to the Potomac River and its tributaries, IHDIV-NSWC experiences less extreme temperatures, higher precipitation, and higher humidity than do inland areas. The average daily maximum temperature is 67.5°F, and the average daily minimum temperature is 45°F. The warmest part of the year is in late July, and the coldest is in late January and early February. The growing season is approximately 190 days, from mid-April through mid-October (USDA SCS, 1974).

2.1.7 Ecological Communities

2.1.7.1 Terrestrial Systems

IHDIV-NSWC comprises approximately 2,500 acres of terrestrial ecological communities on Cornwallis Neck and about 1,084 acres at Stump Neck. Terrestrial habitats in these areas are classified as forested uplands, open uplands, and terrestrial cultural uplands. The forested areas on IHDIV-NSWC are dominated by oak, hickory, tulip tree (*Liriodendron tulipifera*), and pine. Flowering dogwood (*Cornus florida*), redbud (*Cercis canadensis*), and American holly (*Ilex opaca*) are typical of the upland understory. The forests are heavily fragmented by buildings, roads, and other structures. Terrestrial cultural uplands consist of areas that have been created, maintained, or modified by human activities. These areas are characterized as either mowed grass/landscaped areas, wildlife food plots, or successional fields and roadsides.

2.1.7.2 Wetland Systems

National Wetland Inventory (NWI) maps identify approximately 290 acres of wetlands on IHDIV-NSWC. Of this acreage, tidal estuarine systems total 234 acres; forested wetlands, 42 acres; emergent marshes and shrub swamps, 5.5 acres; and lacustrine systems, the remaining acreage. There are approximately 17 miles of riverine systems in this area.

At Indian Head, the tidal estuarine systems are associated with the Potomac River, Mattawoman Creek, and Chicamuxen Creek. Mattawoman Creek marshes are typically dominated by wild rice (*Zizania aquatica*), big cordgrass (*Spartina cynosuriodes*), cattail (*Typha* spp.), rose-mallow (*Hibiscus moscheutos*), tickseed sunflowers (*Bidens* spp.), pickerelweed (*Pontederia cordata*), and arrow arum (*Peltandra virginica*). Intertidal shoreline fringe marshes are extremely rare and are dominated by water willow (*Justica americana*) or American threesquare (*Scirpus pungens*). The broad expansive marsh of Chicamuxen Creek contains an extremely diverse flora. An informal survey of this marsh conducted in 1988 identified more than 80 species of plants (MDNR, 1992).

2.1.7.3 Fauna

The diverse ecological communities at Indian Head support many wildlife species. The Integrated Natural Resources Management Plan for IHDIV-NSWC provides a list of fauna inhabiting the base (Parsons, 2000). Fifteen species of damselflies, 26 species of dragonflies, 48 species of butterflies, 29 species of mammals, 23 species of reptiles, 20 species of amphibians, and 119 species of birds have been observed at the base.

2.1.7.4 Rare, Threatened, and Endangered Species

The Maryland Natural Heritage Program conducted a survey of rare, threatened, and endangered species in 1991 and 1992 (MDNR, 1992). The survey focused on areas with a high potential for supporting rare, threatened, and endangered species. Tables 2-1 and 2-2 list the rare, threatened, and endangered flora and fauna, respectively, identified on IHDIV-NSWC during the survey. The species lists presented in the tables were revised based on data available on the MDNR website (MDNR, 2001). Of these listed species, the bald eagle (*Haliaeetus leucocephalus*) is the only known federally listed threatened species identified on IHDIV-NSWC.

The 1991–1992 survey also identified 10 areas of ecological significance at Indian Head (totaling 614 acres) that have the potential to support the long-term protection of the rare, threatened, and endangered species. These protection areas include Bullitt Neck Point, Cornwallis Neck Marshes, Hog Island Cove, Thoroughfare Island, Chicamuxen Creek Marsh, Magnolia Seep, Porter Woods, Rum Point, Stump Neck Beaver Marsh, and West Stump Neck Shoreline.

2.2 Site 28

2.2.1 History and Description

Site 28, also referred to variously as the "Original NOS Burning Ground," the "Slavins Dock Area," and the "Wildlife Area," is located on the main installation of IHDIV-NSWC (Figure 2-2). The site encompasses the former site of a zinc recovery furnace, Artesian Well 14, and the Shoreline Burning Cage (Figure 2-3). During World War I, the U.S. Navy initiated a metal-recycling program, which was vital during World War II and continues to present day. In 1928, the Zinc Recovery Furnace, designated as Building 415, was erected. The last station map the building appears on is dated October 31, 1952, indicating that the building was demolished in the early 1950s (Dolph, 2001). Artesian Well 14 was installed in 1918 to a depth of 430 feet using cable drilling (Public Works of the Navy, Potable Well Inventory and Well Number Changes, date unknown). Until 1988, it was used as a potable well; afterward it became an observation well. A small burning cage to the south of Artesian Well 14 was used to burn debris, such as wooden crates. The exact location of the former burning cage is unknown. The burning ground is shown outside of the existing perimeter fence on at least one historical map; however, burned debris, glass, and slaglike materials were observed inside the fence in an area adjacent to the mouth of Swale 4.

2.2.2 Previous Investigations

In June 1982, Naval Energy and Environment Support Activity (NEESA) conducted an Initial Assessment Study (IAS) to evaluate sites at IHDIV-NSWC and to determine if a potential threat to human health or the environment existed. The findings for Site 28 are provided in the IAS report; in it the 1.8-acre site was referred to as the "original NOS burning ground." File searches did not provide information on the types of materials that were burned. That smokeless powder was burned at the site was concluded on the basis of materials manufactured when the site was in operation, circa 1890s to 1942. Various contaminated wastes were also burned openly. During IAS site reconnaissance, no visible signs of burned materials were observed. The conclusion was that there was not enough information to characterize the potential hazard to the site. Similarly, the site was not recommended for a Navy Assessment and Control of Installation Pollutants (NACIP) Confirmation Study.

Several soil-sampling events were conducted following the IAS. In August 1993, a soil sample from Site 28, referred to then as the "Slavins Dock area," was collected about 20 feet southwest of Artesian Well 14 and analyzed for soil texture, pH, and fertility. The pH for the sandy loam soil was 6.7. The soil test results indicated that copper, magnesium, sulphate, and zinc were present in amounts of 25, 30, 22.7, and 14,700 pounds per acre, respectively. For zinc, this translates into 7,350 ppm.

In May 2000, the analytical results of total lead and total zinc in a soil sample (soil sample 1) collected from Site 28 near "Wildlife Area Well 14" indicated concentration levels of 9.37 and 515 ppm, respectively. In July 2000, a soil sample (IR2855-000712) was collected and analyzed for various metals. The analysis detected cadmium (1.2 ppm), lead (3.8 ppm), and selenium (1.8 ppm) in the sample.

In October 2000, a sediment sample was collected in Mattawoman Creek just off the shoreline of Site 28 for a Toxicity Identification Evaluation (TIE) associated with Site 42 (SAIC, 2001). The sediment sample had a measured pore water concentration of zinc of 25,000 µg/L.

TetraTech NUS is conducting an ongoing study of the Mattawoman Creek that includes using the Rapid Sediment Screening technology developed by Space and Naval Warfare Systems Command (SPAWARS). A review of the data collected for the Mattawoman Creek study indicated that additional site-specific data are required to evaluateSite 28's effect on the environment. Accordingly, additional sampling is proposed (see Section 3).

Table 2-1
Rare Flora Found at NSWC Indian Head Division
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

Common Name	Scientific Name	Federal Status	State Status	Global/State Rank
Tickseed sunflower	Bidens coronata	NS	NS	G5/S2S3
Narrow melicgrass	Melica mutica	NS	T	G5/S1
Large-seeded forget-me-not	Myosotis macrosperma	NS	NS	G5/S2S3
Smallflower baby blue eyes	Nemophila aphylla	NS	NS	G5/S1

Sources:
Maryland Department of Natural Resources (MDNR), Natural Heritage Program
Rare, Threatened,and Endangered Animal Species and Area Survey for the Naval Surface Warfare Center, Indian Head Division 1991 - 1992 , 1992.
MDNR, *Current and Historical Rare, Threatened, and Endangered Plant Species of Charles County, Maryland* , July 5, 2001. Last Updated November 7, 2002

*Although listed in the state Threatened and Endangered Species List as endangered extirpated, state regulations provide that such species be afforded the same protection as an endangered species upon the discovery of a viable, naturally occurring population.

**Source: Virginia Tech, 1995.

Federal Codes
E = Endangered
NS = No status

State Codes
E = Endangered
EE = Endangered extirpated
T = Threatened

Global Ranks
G4 = Apparently secure globally, though it may be quite rare in parts of its range.
G5 = Demonstrably secure globally, though it may be rare in parts of its range.

State Ranks
S1 = Critically imperiled in the state because of extreme rarity, equivalent to being ranked as state rare.
S2 = Imperiled in the state because of rarity; equivalent to being ranked state rare.
S3 = Rare or uncommon in the state; equivalent to being ranked as watch list.
S4 = Apparently secure in state, with many occurrences.
SH = Of historical occurrence in the state but not verified in the past 20 years.
SU = Possibly in peril in the state, but status uncertain.

Table 2-2
Rare Fauna Found at IHDIV-NSWC
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

Common Name	Scientific Name	Federal Status	State Status	Global/State Rank
Birds				
Bald eagle	Haliaeetus leucocephalus	LT	T	G4/S2S3B
Invertebrates				
Carolina satyr	Hermeuptychia sosybius	NS	NS	G5/S1S3
Frosted elfin	Incisalia irus	NS	E	G3/S1
Treetop emerald	Somatochlora provocans	NS	NS	G3G4/S1

Sources:
Maryland Department of Natural Resources (MDNR), Natural Heritage Program
Rare, Threatened,and Endangered Animal Species and Area Survey for the Naval Surface Warfare Center, Indian Head Division 1991 - 1992 , 1992.
MDNR, *Current and Historical Rare, Threatened, and Endangered Animal Species of Charles County, Maryland* , July 5, 2001. Last Updated November 7, 2002

Federal Codes
LT = Threatened
NS = No status
LE = Endangered

State Codes
E = Endangered
I = In need of conservation
T = Threatened
NS = No status

Global Ranks
G1 = Highly globally rare.
G2 = Globally rare.
G3 = Either very rare and local throughout its range or found locally in a restricted range.
G4 = Apparently secure globally, though it may be quite rare in parts of its range.
G5 = Demonstrably secure globally, though it may be rare in parts of its range.
T3 = Infraspecific taxon is being ranked differently than the full species.

State Ranks
S1 = Critically imperiled in the state because of extreme rarity, equivalent to being ranked as state rare.
S2 = Imperiled in the state because of rarity; equivalent to being ranked state rare.
S3 = Rare or uncommon in the state; equivalent to being ranked as watch list.
SH = Of historical occurrence in the state but not verified in the past 20 years.

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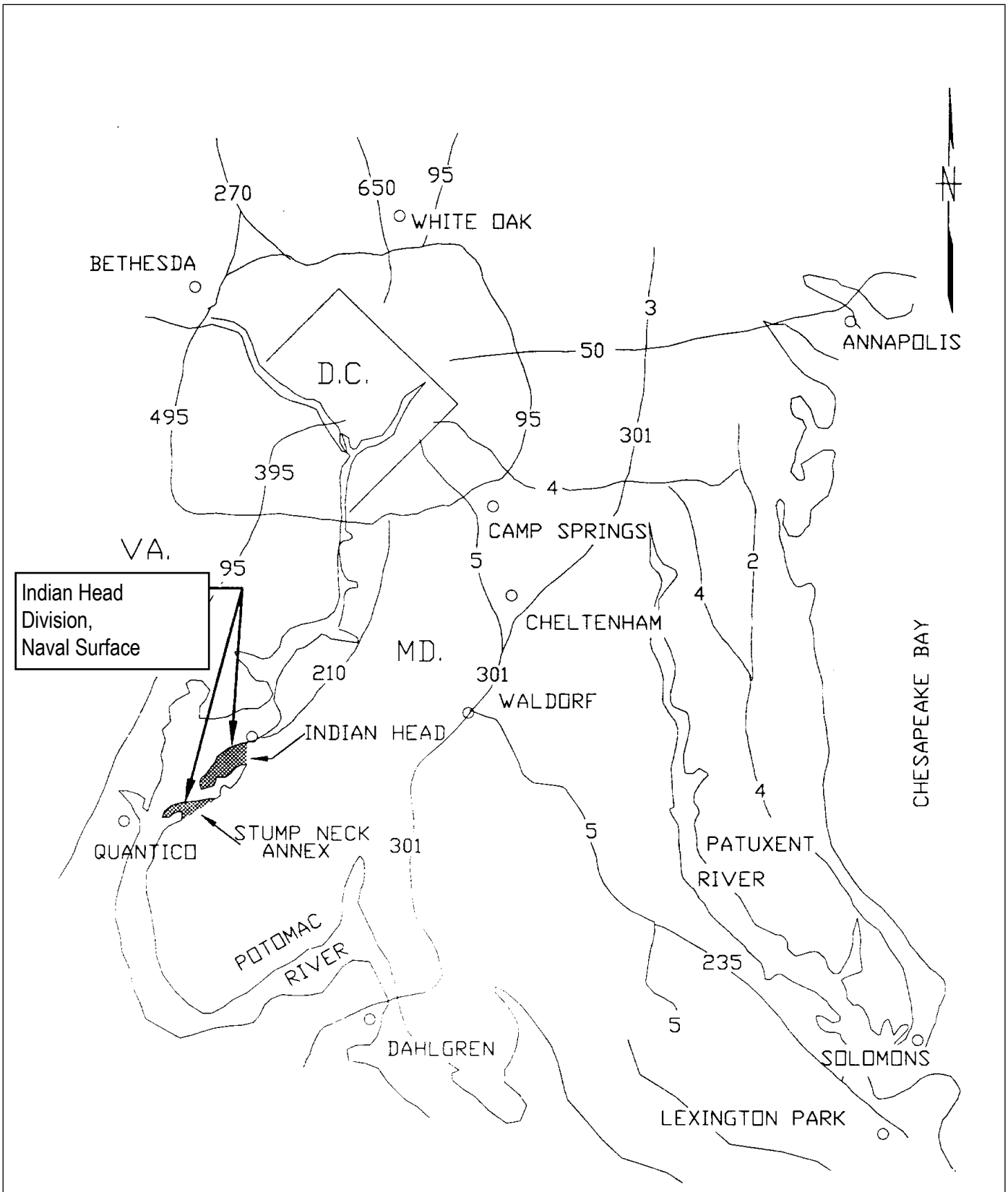

Figure 2-1
VICINITY MAP
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

CH2MHILL

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Figure 2-2
LOCATION OF SITE 28
SITE 28 RI WORK PLAN
IHDIV-NSWC
INDIAN HEAD, MARYLAND

CH2MHILL

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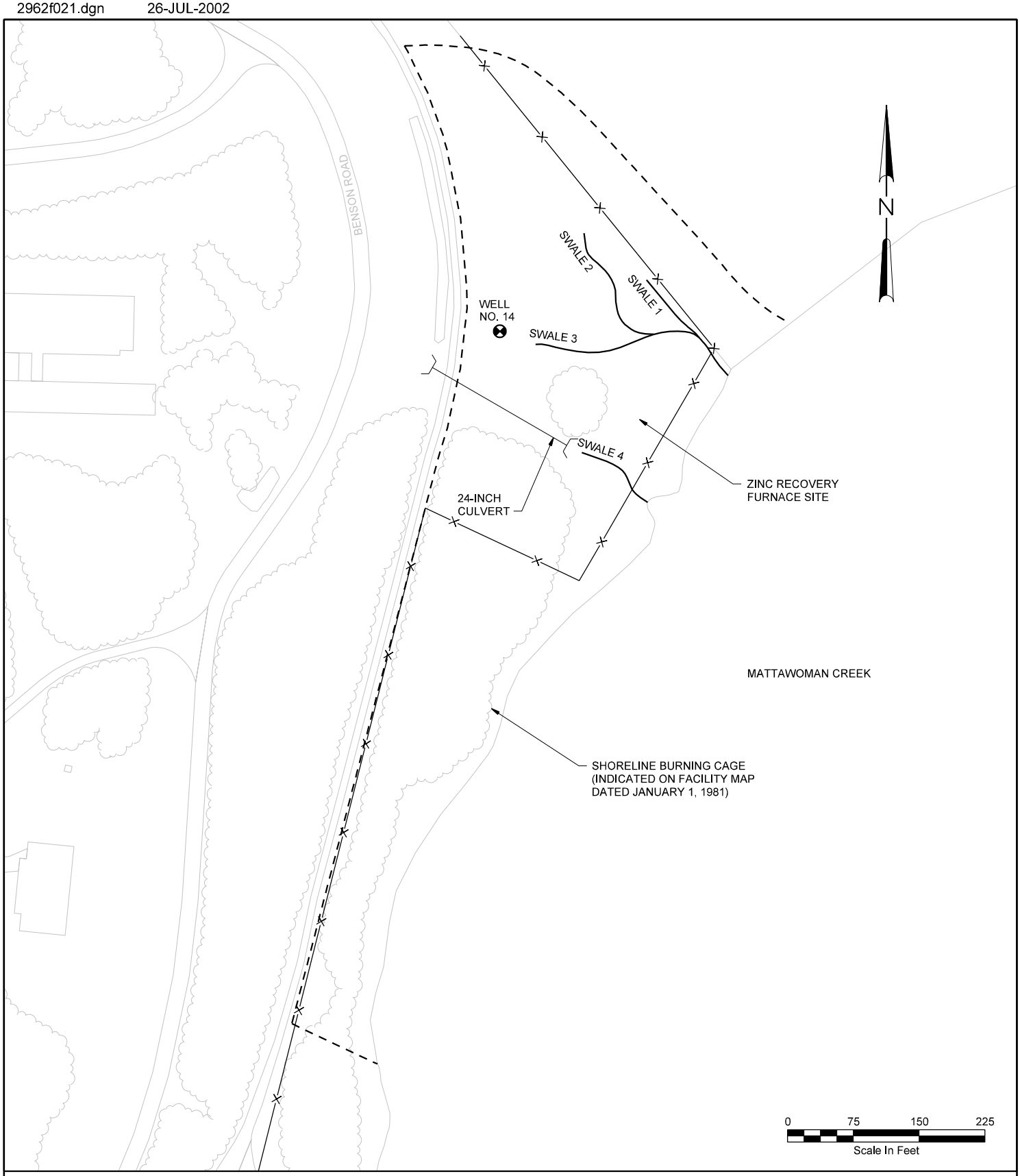

LEGEND

FENCE LINE

APPROXIMATE SITE BOUNDARY FOR RI

NOTE: SWALE LOCATIONS ARE APPROXIMATE.

FIGURE 2-3
SITE 28
SITE 28 RI WORK PLAN
IHDIV-NSWC
INDIAN HEAD, MARYLAND

CH2MHILL

3 Remedial Investigation Technical Approach

This section discusses the technical approach for the work to be performed in support of the Site 28 RI. There is currently insufficient data to characterize the impact of inorganics in soil, groundwater, surface water, and sediment at Site 28. To address these data gaps, this investigation will focus on the collection of geological, hydrogeological, and chemical data to characterize the nature and extent of contaminants at the site. The first phase of the investigation will consist of collecting surface and subsurface soil samples, in-situ groundwater samples, surface water samples, and sediment samples at the site. Groundwater data will be analyzed and evaluated to determine installation locations for monitoring wells that will be installed and sampled during the second phase of the investigation.

Figure 3-1 shows Zones A and B proposed for the investigation. It should be noted that as a result of past site activities, results of previous investigations, and site visits conducted by CH2M HILL, the Site 28 was expanded to include areas beyond the IHDIV-NSWC fence line (though still within the property boundaries).

3.1 Field Activities

This section provides information on the field investigation methods and protocol for collecting surface soil, subsurface soil, groundwater, surface water, and sediment samples.

3.1.1 Mobilization/Demobilization and Decontamination

The field crew will consist of a Field Team Leader (FTL), qualified technician(s), and specialized subcontractor(s). Prior to mobilization, all field team members will review the project plans, including the site-specific Health and Safety Plan (HASP) provided in the Master Work Plan addendum (CH2M HILL, March 2000), the CH2M HILL IHDIV-NSWC Safety Improvement Plan (May 9, 2001), and the IHDIV-NSWC Hazard Control Briefing.

All equipment required for field operations will be brought to the site by the CH2M HILL field team and its subcontractors. Demobilization will entail following proper decontamination procedures for all site personnel and equipment. All sampling equipment used for collecting samples will be decontaminated prior to beginning field sampling, between collection of each sample, and at the end of the sampling event. All down-hole equipment required for drilling and or DPT will be decontaminated prior to beginning drilling or pushing, between holes, and at the end of the drilling or DPT operations. Decontamination procedures are discussed in IHDIV-NSWC SOP SA-13. The investigation-derived waste (IDW) will be handled in accordance with IHDIV-NSWC SOP SA-13, and field records will be kept as directed in IHDIV-NSWC SOP SA-12.

3.1.2 Zone A

3.1.2.1 Description

Zone A comprises the area between the north and south fence lines, the area outside of the fence line to the north, and shoreline to the east. Within Zone A is the location of the former zinc recovery furnace building and the former burning cage (Figure 3-1). The parameters proposed are based on past site activities.

3.1.2.2 Surface and Subsurface Soil Sampling

Surface and subsurface soil samples will be collected on a stratified grid pattern to determine the lateral and vertical extents of inorganic and organic constituents in Zone A (Figure 3-2). The grid, in general, consists of a series of 100-ft^2 and 50-ft^2 sections in the area where the zinc recovery furnace was most likely located, as well as where loading operations would have taken place between the furnace and railroad tracks, which are currently the gravel road west of Site 28.

Surface and subsurface soil samples will be collected from 27 locations (Figure 3-2). Additionally, samples will be collected from up to two locations at the discretion of the field team on the basis of stressed vegetation or other visual evidence of contamination. Two site-specific background surface and subsurface soil samples will be collected across the road to the west of Site 28 (Figure 3-2). Surface soil samples will be collected from 0 to 6 in. below ground surface (bgs), and subsurface soil samples will be collected from 1 to 3 ft bgs. Both surface and subsurface soil samples will be collected with a track-mounted DPT rig using a macrocore sampler wherever possible. In locations where DPT-rig access is restricted (e.g., outside the Base fence line) , samples will be collected manually with trowels and hand augers. Locations outside of the fence line will be accessed by traversing the shoreline of Mattawoman Creek, or by boat from Slavins Dock, north of Site 28.

Surface and subsurface soil samples will be analyzed at an offsite laboratory for Target Compound List (TCL) volatile organic compounds (VOCs), TCL semivolatile organic compounds (SVOCs), Target Analyte List (TAL) metals, explosives (including nitroguanidine [NG], nitroglycerin [NQ], pentaerythritol tetranitrate [PETN], and perchlorate). Surface soil samples will also be analyzed for pH, total organic carbon (TOC), and grain-size distribution. Associated quality assurance and quality control (QA/QC) samples, consisting of matrix spike and matrix spike duplicates (MS/MSDs), field duplicates, field blanks, equipment rinsate blanks, and trip blanks, will be collected. Samples will be analyzed in accordance with the Navy guidance for Level D. Sampling activities (collection, handling, and decontamination of sampling equipment) will be performed in accordance with existing SOPs. Table 3-1 summarizes the sampling and analysis program; Table 3-2 provides the sample bottleware, preservation, and holding-time requirements.

3.1.2.3 *3.1.2.2 In Situ* Groundwater Sampling

Approximately 12 *in situ* groundwater samples will be collected from the locations shown in Figure 3-2. Two site-specific background groundwater samples will be collected across the road to the west of Site 28 (Figure 3-2). The *in situ* groundwater samples will be collected at

a depth just below the water table at each location using a track-mounted direct-push rig fitted with a screened grab sampler and a peristaltic pump with disposable tubing.

The samples will be analyzed at an offsite laboratory for TCL VOCs, TCL SVOCs, TAL dissolved metals, and explosives (including NG, NQ, PETN, and perchlorate). Because these data will not be validated, the associated QA/QC samples will consist of only one field duplicate sample only. Analysis of the samples will be performed in accordance with the Navy guidance. Sampling activities (collection, handling, and decontamination of sampling equipment) will be performed in accordance with existing SOPs. Table 3-1 summarizes the sampling and analysis program; Table 3-2 provides the sample bottleware, preservation, and holding-time requirements.

3.1.2.4 Sediment Sampling

There are four well-defined swales in Zone A (Figure 3-2). The path of these swales may change slightly depending on the erosion and groundwater seepage that take place between extreme weather events. On the basis of site topography, it is likely that significant standing water in Swales 1 through 3 is rare. Because the swales are runoff channels/gullies, sediment samples collected in Swales 1 through 3 will be considered surface soil, rather than sediment, from an exposure perspective, and will be treated as such in the risk assessment. On the basis of the November 2001 site visit by a CH2M HILL ecologist, Swale 4 was the only swale with flowing water. Substrate samples collected from Swale 4 will be considered sediment. Swale 4 runs through an area with groundwater seeps and wetland vegetation. In addition to groundwater discharge and site runoff, Swale 4 also receives runoff via a 24-inch culvert from Benson Road and the hillside above the site. Therefore, approximately three sediment samples will be collected in the swales at the locations marked on Figure 3-2. No site-specific background samples will be collected for surface water or sediment. Sediment samples will be collected from 0 to 6 in. bgs at the surface water locations. Sediment samples collected from the swales will be analyzed at an offsite laboratory for TCL VOCs, TCL SVOCs, TAL metals, explosives (including NG, NQ, PETN, and perchlorate), pH, TOC, and grain-size distribution. Associated QA/QC samples, consisting of MS/MSDs, field duplicates, field blanks, equipment rinsate blanks, and trip blanks will be collected for sediment samples.

3.1.2.5 Surface Water Sampling

Surface water samples will be collected by using a peristaltic pump and disposable tubing due to the likely shallowness of the surface water in the swales. The samples collected for dissolved metals analysis will be filtered at the time of collection using an inline 45 micron filter. Approximately three surface water samples will be collected in the swales at the marked locations on Figure 3-2. Care will be taken not to stir sediment when and if surface water is sampled. Thus, surface water will be collected first followed by sediment sampling. Surface water samples will be analyzed at an offsite laboratory for TCL VOCs, TCL SVOCs, explosives (including NG, NQ, PETN, and perchlorate), TAL metals (total and dissolved), dissolved organic carbon, and hardness. Field measurements will include specific conductivity, oxidation/reduction potential (ORP), dissolved oxygen (DO), pH, and temperature. Associated QA/QC samples, consisting of MS/MSDs, field duplicates, field blanks, equipment rinsate blanks, and trip blanks will be collected for surface water samples. Analysis of the samples will be performed in accordance with the Navy guidance

for Level D. Sampling activities (collection, handling, and decontamination of sampling equipment) will be performed in accordance with existing SOPs. Table 3-1 summarizes the sampling and analysis program, while Table 3-2 provides the sample bottleware, preservation, and holding time requirements.

3.1.2.6 Permanent Monitoring Well Installation and Sampling

A Phase II RI will be conducted if the analytical results of the in situ groundwater samples collected during Phase I indicate that inorganic or organic concentrations exceed regulatory screening criteria. Phase II will consist of installing shallow monitoring wells (number to be determined in an addendum to this Work Plan to be prepared at a later date) at Site 28. These monitoring wells will provide groundwater data for the human health risk assessment (HHRA) and ecological risk assessment (ERA), since only data generated from monitoring well samples can be validated to support HHRAs and ERAs. Groundwater will be collected from these wells and analyzed for TCL VOCs, TCL SVOCs, TAL metals, and explosives (including NG, NQ, PETN, and perchlorate).

3.1.3 Zone B

3.1.3.1 Description

Zone B is reported as the "Burning Ground" in the IAS and as the "Shoreline Burning Cage" by a naval historian (Dolph, 2001). This area, outside of the IHDIV-NSWC fence line but within navy property, is to the south of Zone A (Figure 3-1). The area proposed for sampling extends approximately 600 feet south from the southern Zone A fence line. Zone B will be accessed by traversing the shoreline of Mattawoman Creek, or by boat, from Slavins Dock, just north of Site 28.

3.1.3.2 Surface and Subsurface Soil Sampling

Surface and subsurface soil samples will be collected from the eight locations shown in Figure 3-2. Additionally, samples will be collected from two locations at the discretion of the field team on the basis of stressed vegetation or visual evidence of contamination. Two site-specific background surface and subsurface soil samples will be collected across the gravel road to the west of Site 28 (Figure 3-2). Surface soil samples will be collected from 0 to 6 in. bgs, and subsurface soil samples will be collected from 1 to 3 ft bgs. Since Zone B is inaccessible with a DPT rig, the samples will be collected with trowels and hand augers.

Surface and subsurface soil samples in Zone B will be analyzed at an offsite laboratory for TCL VOCs, TCL SVOCs, TAL metals, and explosives (including NG, NQ, PETN, and perchlorate). Surface soil samples will also be analyzed for pH, TOC, and grain size (distribution). Associated QA/QC samples, consisting of MS/MSDs, field duplicates, field blanks, equipment rinsate blanks, and trip blanks will be collected. The samples will be analyzed according to Navy guidance for Level D. Sampling activities (collection, handling, and decontamination of sampling equipment) will be performed in accordance with existing SOPs. Table 3-1 summarizes the sampling and analysis program; Table 3-2 provides the sample bottleware, preservation, and holding-time requirements.

3.1.4 Sediment Sampling in Mattawoman Creek

An investigation into the lateral and vertical extent of possible inorganic contamination in the sediment of Mattawoman Creek adjacent to Site 28 is planned because a previous investigation related to Site 42 (SAIC, 2001) found elevated zinc concentrations in the pore water of a sediment sample collected just offshore of Site 28. A review of the available data from the Mattawoman Creek Study (TTNUS, 2002) and the SPAWARS rapid screening pilot study (SPAWARS, undated) revealed that no VOCs, pesticides, or PCBs were detected in any of the sediment samples collected from the creek in the vicinity of Site 28. Therefore, it was determined that analyzing for these chemical parameters in future sampling efforts in Mattawoman Creek in relation to the Site 28 investigation was not warranted (CH2M HILL, 2003). The available data suggest that certain metals, primarily cadmium, copper, lead, and zinc, are elevated in the sediments of Mattawoman Creek adjacent to the site. Therefore, the initial sampling effort will be focused on evaluating the spatial and vertical extent of metal concentrations in the area of the creek adjacent to Site 28. However, in an effort to ensure a conservative approach, sediment samples collected from three sampling locations will also be analyzed for SVOCs and explosives (including NG, NQ PETN, and perchlorate).

Sediment will be collected at 15 locations (Figure 3-3). Two samples will be collected at each location: surface (0 to 6 inches below the surface water–sediment interface) and subsurface (6 to 12 inches below the surface water–sediment interface). Five sample locations are planned for the near-shore area adjacent to Site 28, five sample locations are planned for the creek channel, and five sample locations are planned for the near-shore area of the sandbar across the channel from Site 28. Sediment samples will be collected using a gravity corer with disposable core liners and core catchers, wherever possible. A petite Ponar dredge will be used as a back-up sampling method if adequate core samples cannot be collected.

The sample collected from 0 to 6 inches will be used to support the ecological risk assessment for Site 28; the sample collected from 6 to 12 inches will be used to aid in remediation and risk management decisions. As noted above, all samples will be analyzed for TAL metals. In addition, six of the samples, collected from three locations, will be analyzed for TCL SVOCs and explosives (including NG, NQ, PETN, and perchlorate). The sampling locations for these samples will be determined during the field effort and will be based upon the observed locations of greatest deposition in each sampling area (i.e., one sample location along the near-shore area adjacent to the site, one sample location in the creek channel, and one location from the near-shore area of the sandbar across the channel from Site 28). The samples collected from 0 to 6 inches samples will be analyzed for grain size, as well.

3.1.5 Surveying

All sampling station locations will be surveyed for horizontal coordinates to the nearest 1 foot using a portable backpack Global Positioning System (GPS). A registered surveyor will survey the monitoring wells for elevation to the nearest 0.01-foot.

3.1.6 Investigation-Derived Waste

Investigation-derived waste (IDW) will consist of soil cuttings, purged groundwater, and decontamination water generated during the field activities. All IDW will be handled in accordance with IHDIV-NSWC SOP SA-13 and will be disposed of following laboratory analysis to determine if it is hazardous or nonhazardous waste. A staging area for the IDW will be coordinated with base personnel prior to initiating field activities. All IDW drums will be marked with the following information:

Investigation-Derived Waste
Soil Cuttings / Purge Water / Decontamination Water
IHDIV-NSWC, Site 28
Onsite Contact: Heidi Morgan x2265

IDW composite samples will be collected for solid and liquid media and analyzed for toxicity characteristic leaching procedure (TCLP), ignitability, corrosivity, and reactivity for disposal purposes.

3.2 Sample Handling

Sample handling includes the field-related considerations regarding the selection of sample containers and preservatives, allowable holding times, and the analyses required. These topics are discussed above and are presented in Table 3-2. The sample identification system to be applied to the samples and the shipping requirements are discussed below.

3.2.1 Sample Identification System

Each sample will be designated by an alphanumeric code that identifies the site and matrix sampled and contains a sequential sample number. Site-specific procedures are elaborated below.

The following is a general guide for sample identification:

First Segment of Sample Number: Naval Installation Abbreviation	Second Segment of Sample Number: Site Number	Third Segment of Sample Number		
		Sample Type	Sample Location	Additional Qualifiers (Sample Depth, Date)
A	ANN	AA	NN	NNNN

Symbol definition:

"A" = Alphabetic
"N" = Numeric

Naval installation abbreviation:

A = One-letter abbreviation identifying the Naval Installation where the sample was collected (e.g., Indian Head = I)

Site number:

ANN = One letter and two numbers identifying the site on the facility where the sample was collected (e.g., S28 = Site 28)

Sample type:

SS = Surface soil sample
SB = Subsurface soil sample
SD = Sediment sample
SW = Surface water sample
GW = Grab groundwater sample
MW = Monitoring well sample
WS = Waste (solid)
TB = Trip blank
EB = Equipment blank
FB = Field blank

Sample Location:

MM = QC samples—2-digit month of sampling event
NN = Primary samples—2-digit number indicating sample location

Additional Qualifiers:

MMYY = Monitoring well, surface water, and waste samples—2-digit month and 2-digit year of sampling event (e.g., May 2003 = 0503)
BDED = Surface soil, subsurface soil, sediment, and grab groundwater samples—2-digit begining depth and 2-digit end depth rounded up to nearest foot (e.g., 2'– 3' = 0203)
DDYY = QC Samples—2-digit day and 2-digit year of sampling event

Examples of this numbering approach are:

IS28SS040001	The fourth surface soil sample collected from 0 ft to 1 ft
IS28MW020302	The groundwater sample collected from IS28MW02 in May 2003
IS28WS010503	The first waste sample collected from drums in May 2003

Examples of this numbering approach for QA/QC samples are:

IS28FB051503	Field blank collected at Site 28 on May 15, 2003
IS28TB051503	Trip blank collected at Site 28 on May 15, 2003
IS28EB051503	Equipment blank collected at Site 28 on May 15, 2003

Sample Packaging and Shipping

Samples will be packaged in accordance with IHDIV-NSWC SOP SA-11, *Non-Radiological Sample Handling*. The sample will be tightly packed in a cooler with bubble wrap packaging material and ice as a preservative. The samples will be either picked up at the site by the analytical laboratory or shipped to the laboratory via Federal Express. The FTL is responsible for completion of the following forms:

- Sample labels and chain-of-custody seals

- Chain-of-custody forms
- Appropriate labels and forms required for shipment

Custody of the samples will be maintained and documented at all times. Chain-of-custody will begin with the collection of the samples in the field and will continue through the analysis of the sample at the analytical laboratory.

3.3 Data Quality Objectives

3.3.1 Step 1: State the Problem

As noted in the introduction, land use activities at Site 28 included the burning of smokeless powder and other contaminated wastes and the operation of a zinc recovery furnace. Sampling conducted following the IAS and as part the TIE study identified high levels of zinc in Site 28 soils and sediment in Mattawoman Creek.

3.3.2 Step 2: Identify the Decision

This RI will define the nature and extent of contamination, identify contaminant transport mechanisms, and quantify the risk to human health and the environment from the site. Further, if risks are identified at the site, the data generated during the RI will be used to evaluate remediation alternatives.

3.3.3 Step 3: Identify Inputs to the Decision

Current information about the site consists of literature reviews and analytical data generated following the IAS and during the Mattawoman Creek and TIE studies. Additionally, site visits have been conducted to examine current conditions. It should be noted that the precise location of the zinc recovery furnace and former burning cage are not known.

3.3.4 Step 4: Define the Boundaries of the Study

Site 28 is bounded to the east by Mattawoman Creek (although Mattawoman Creek will be investigated as part of this RI); to the west by an unnamed road; to the north the site boundary extends approximately 75 feet past the northern fence line; and to the south the site boundary extends approximately 600 feet past the southern fence line.

3.3.5 Step 5: Develop a Decision Rule

The analytical results will be the basis for many project decisions, including risk management decisions and the development of remedial alternatives; therefore, the analysis of soil, sediment, groundwater and surface water samples will require a high level of QC at the laboratory. Further, complete analytical data packages and third-party data validation will be required.

A PID will be used in the field to screen soils and for health and safety monitoring. The instruments will be calibrated daily. The person calibrating the instrument will enter the calibration information in the field log book.

The QC requirements specified in this Indian Head Basewide QAPP and the SOPs attached to the base-wide Field Sampling Plan (FSP; Brown and Root, 1997) will be followed to establish analytical quality.

3.3.6 Step 6: Specify Limits on Decision Errors

The probability of sampling and measurement errors that exist at any site under investigation necessitates the development of sampling guidelines and the collection of quality control samples. Sampling techniques are discussed (or referenced) in detail in the FSP.

QC samples will be used to verify the accuracy and precision of the data generated during the RI. When data are suspect because a QC sample is outside of a laboratory's established control limits, the data user will be notified through the laboratory report's case narrative and the data validator's report. Data validation is an important step in determining how the data can be used by the risk assessors and for the development of remedial alternatives. All data used for risk assessment will be validated following Region III modifications to the USEPA National Functional Guidelines for Validating Inorganic Data (USEPA, 1993) and the USEPA National Functional Guidelines for Validating Organic and Data (USEPA, 1994).

3.3.7 Step 7: Optimize the Design

The specific objectives of the RI are to: 1) verify the presence or absence of contamination in soil, groundwater, surface water, and sediment resulting from past activities at the site; 2) define the extent of contamination; and 3) evaluate the need for remediation. The RI is designed to collect enough data to meet these objectives while avoiding any unnecessary sample collection.

Human Health Risk Assessment

A human health risk assessment will be performed for Site 28 in accordance with Section 3 of the Master WP (B&RE, 1997) and current USEPA guidance documents. Surface and subsurface soil, shallow groundwater, surface water, and sediment samples will be collected and the analytical results used to evaluate whether the concentrations of site contaminants pose a significant threat to human health. This section presents an outline of the evaluation process of the human health risk assessment, which includes the screening methods for selecting chemicals of potential concern (COPCs) and exposure scenarios.

The proposal in this Work Plan is to collect *in situ* groundwater samples during Phase I. The *in situ* groundwater samples will be evaluated to determine the optimal number and locations or permanent monitoring wells to be installed in a second phase of the investigation. The *in situ* groundwater data will not be used in the human health risk evaluation. Groundwater data from monitoring wells will be used in the human health evaluation.

COPCs will be selected on the basis of a comparison of maximum detected concentrations of constituents in the various media to Region III risk-based concentrations (RBCs). RBCs that are based on noncarcinogenic effects will be divided by 10 to account for cumulative exposure (i.e., a hazard quotient of 0.1). RBCs based on carcinogenic effects will be used as presented in the most current RBC table (EPA, 2002). Constituents having a maximum

detected concentration less than the RBC will not be retained as COPCs for the HHRA. Lead concentrations in groundwater will be compared to the Safe Drinking Water Act (SDWA) action level of 15 ppb. If the lead concentration exceeds the screening value, it will be discussed qualitatively in the toxicity assessment section in the risk assessment report. Lead concentrations in soil will be compared to 400 mg/kg. Constituents such as magnesium, calcium, potassium, and sodium that are essential human nutrients will not be considered for quantitative evaluation in the risk assessment if they are detected at concentrations that are not considered toxic (i.e., at or near naturally occurring levels). Data collected from Mattawoman Creek will be used in risk calculations. In addition to screening the data against the RBCs to select the COPCs, a table will be provided to identify those constituents that are COPCs based solely on industrial use of the site.

Site 28 is located in an area of the facility that is expected to be used recreationally (e.g., for bird watching) but not residentially. Navy policy, however, requires the evaluation of a hypothetical conservative scenario of future residential use. Therefore, the exposure scenarios that will be evaluated in the Site 28 HHRA are exposure to:

- Soil by the industrial worker, adult or adolescent trespasser, adult or child recreational user, adult or child resident, and construction worker through inhalation of fugitive dust, incidental ingestion, and dermal contact while at the site
- Groundwater by the residential adult through ingestion of the water and inhalation of volatiles while showering
- Groundwater by the residential child through ingestion of the water and dermal contact while bathing
- Groundwater by the construction worker through inhalation of volatiles from an open excavation and incidental ingestion of, and dermal contact with, groundwater during excavation activities
- Surface water by the recreational adult or child through incidental ingestion and dermal contact while wading in the drainage swale or Mattawoman Creek
- Sediment by the recreational adult or child through incidental ingestion and dermal contact while wading in the drainage swale or Mattawoman Creek

The analytical results from the soil from Zone A and Zone B will be evaluated to determine if they represent two distinct areas. If the data vary, the two zones will be evaluated in the HHRA as two separate source areas. If the data are similar in concentrations of constituents detected, however, the two zones will be evaluated as a single area in the human health evaluation.

The Exposure Point Concentrations (EPCs) for groundwater for the future scenario will be determined using data from only the most contaminated wells. This will include the evaluation of the groundwater data to determine if there is an identifiable groundwater plume or multiple plumes. The groundwater data from the plume(s) will be conservatively used for determining the EPC for the residential scenario.

3.5 Ecological Risk Assessment

A Screening Ecological Risk Assessment (SERA) (Steps 1 and 2) and the first step of the Baseline Ecological Risk Assessment (BERA; Step 3A) will be performed for Site 28 in general accordance with Navy (CNO 1999; NAVFAC 2001) and USEPA (USEPA 1997) ERA guidance. Surface soil, sediment, surface water, and groundwater will be collected, and the analytical results will be used to assess if concentrations of site contaminants may pose risk to the ecosystem. Further, data generated during the Mattawoman Creek Study (TTNUS, 2002) deemed relevant to Site 28 will be included in the assessment, as will site specific data generated during the TIE study (SAIC, 2001).

This section presents a brief summary of the ecological setting of Site 28 and an overview of the process that will be incorporated for Steps 1 through 3A of the Site 28 ERA.

Site 28 is located between Benson Road and Mattawoman Creek (Figure 3-1) in an area of generally declining topography eastward. The site is divided into Zones A and B. Zone A includes a former zinc recovery furnace location, Artesian Well 14, and a portion of a former shoreline burning cage. The rest of this former burning area is believed to extend into Zone B as well. Site 28 includes a mixture of habitats. At the northern end of Zone A, there is a field with patchy herbaceous vegetation. The substrate is a mosaic of soil, gravel, rocks, and debris (e.g., metal parts). A series of three runoff gullies are also located in this area of Zone A. These gullies collect episodic storm water run-off and discharge to adjacent Mattawoman Creek. A fourth drainage feature collects water via a culvert that runs from west of the dirt road at Site 28, downgradient to Swale 4. This drainage also receives runoff from the site, and possibly groundwater discharge. The presence of water during a November 2001 site reconnaissance by CH2M HILL, during a dry period, and the presence of obligate wetlands vegetation suggests that water may be permanently present in this drainage. The drainage discharges to Mattawoman Creek. The remainder of the site (i.e., the southern portion of Zone A and most of Zone B) is a mixed-hardwood-forested area. The tree cover in this area is primarily deciduous (e.g., oak, maple, and sweet gum), with a few conifer species. The shoreline between Site 28 and Mattawoman Creek is tidally influenced. The shoreline is relatively bare of vegetation and is of sandy to muddy composition. The water level fluctuates according to tidal conditions.

In Step 1 of the ERA process for Site 28, the screening-level problem formulation will be conducted. This step will begin by accounting for existing habitats and biota (i.e., potential receptors) and compiling and reviewing existing data for the nature and extent of contamination at the site. In this step, a preliminary conceptual model will be developed that includes a qualitative evaluation of potential sources, fate and transport mechanisms, mechanisms of toxicity, potential receptors, and exposure pathways. Finally, preliminary assessment endpoints, measurement endpoints, and risk hypotheses will also be developed for the selected ecological receptor group.

In Step 2, direct exposure and food chain exposure estimates and risk calculations will be performed for each receptor group. The exposure estimate will be based on conservative media concentrations (e.g., maximum concentration, or the maximum detection limit for undetected chemicals) and conservative exposure parameters (i.e., maximum ingestion rates and minimum body weights). Risk calculations will result in hazard quotients (HQs). HQs

will be derived by dividing the maximum chemical concentration in the medium being evaluated by the corresponding medium-specific screening value, or by dividing the maximum exposure dose by the corresponding ingestion screening value (i.e., No Observed Adverse Effect Level). Chemicals with HQs greater than or equal to 1 will be considered COPCs). The list of Step 2 COPCs will also include detected chemicals that could not be evaluated due to lack of a medium-specific screening value or appropriate no-observed-adverse-effect-levels (NOAELs). If any COPCs are identified following Step 2, the risk assessment process continues into Step 3A.

In Step 3A, exposure assumptions will be refined and risk estimates, or HQs will be recalculated for all COPCs from Step 2. Refinements will include the use of central tendency estimates for media concentrations (i.e., mean concentration, or one half the mean detection limit for undetected chemicals) and exposure parameters (i.e., ingestion rates a body weights). If re-calculation with less conservative exposure assumptions supports an acceptable risk determination (i.e., HQs less than 1), then the site may exit the ecological risk assessment process following Step 3A (CNO 1999). If recalculation yields an HQ greater than or equal to 1 for a particular chemical, that chemical may be selected as a chemical of concern (COC). Risks from potential COCs will be characterized in context of the site setting and other factors (e.g., frequency of detection, background, toxicological information, chemical form considerations). If COCs are selected , the ERA process will need to continue with a revision of the problem formulation (Step 3B) and a baseline ecological risk assessment work plan.

Table 3-1
Summary of Sampling Program
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

			Analyses							
Medium	**Sample ID**	**Sample Depth/Location**	**TCL VOC**	**TCL SVOC**	**TAL Metals**	**pH**	**TOC**	**Grain Size distribution**	**Explosives ***	**Hardness**
Surface Soil	IS28SS010001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS020001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS030001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS040001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS050001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS060001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS070001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS080001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS090001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS100001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS110001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS120001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS130001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS140001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS150001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS160001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS170001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS180001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS190001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS200001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS210001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS220001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS230001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS240001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS250001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS260001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS270001	0-6 inches bgs in Zone A	x	x	x	x	x	x	x	
	IS28SS280001	0-6 inches bgs (discretionary sample within Zone A)	x	x	x	x	x	x	x	
	IS28SS290001	0-6 inches bgs (discretionary sample within Zone A)	x	x	x	x	x	x	x	
	IS28SS300001	0-6 inches bgs (background sample for Zone A)	x	x	x	x	x	x	x	
	IS28SS310001	0-6 inches bgs (background sample for Zone A)	x	x	x	x	x	x	x	
	IS28SS320001	0-6 inches bgs in Zone B	x	x	x	x	x	x	x	
	IS28SS330001	0-6 inches bgs in Zone B	x	x	x	x	x	x	x	
	IS28SS340001	0-6 inches bgs in Zone B	x	x	x	x	x	x	x	
	IS28SS350001	0-6 inches bgs in Zone B	x	x	x	x	x	x	x	
	IS28SS360001	0-6 inches bgs in Zone B	x	x	x	x	x	x	x	
	IS28SS370001	0-6 inches bgs in Zone B	x	x	x	x	x	x	x	
	IS28SS380001	0-6 inches bgs in Zone B	x	x	x	x	x	x	x	
	IS28SS390001	0-6 inches bgs in Zone B	x	x	x	x	x	x	x	
	IS28SS400001	0-6 inches bgs (discretionary sample within Zone B)	x	x	x	x	x	x	x	
	IS28SS410001	0-6 inches bgs (discretionary sample within Zone B)	x	x	x	x	x	x	x	
	IS28SS420001	0-6 inches bgs (background sample for Zone B)	x	x	x	x	x	x	x	
	IS28SS430001	0-6 inches bgs (background sample for Zone B)	x	x	x	x	x	x	x	

Table 3-1
Summary of Sampling Program
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

			Analyses							
Medium	**Sample ID**	**Sample Depth/Location**	**TCL VOC**	**TCL SVOC**	**TAL Metals**	**pH**	**TOC**	**Grain Size distribution**	**Explosives ***	**Hardness**
Subsurface Soil	IS28SB010103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB020103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB030103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB040103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB050103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB060103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB070103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB080103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB090103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB100103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB110103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB120103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB130103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB140103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB150103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB160103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB170103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB180103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB190103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB200103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB210103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB220103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB230103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB240103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB250103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB260103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB270103	1-3 feet bgs in Zone A	x	x	x				x	
	IS28SB280103	1-3 feet bgs (discretionary sample within Zone A)	x	x	x				x	
	IS28SB290103	1-3 feet bgs (discretionary sample within Zone A)	x	x	x				x	
	IS28SB300103	1-3 feet bgs (background sample for Zone A)	x	x	x				x	
	IS28SB310103	1-3 feet bgs (background sample for Zone A)	x	x	x				x	
	IS28SB320103	1-3 feet bgs in Zone B	x	x	x				x	
	IS28SB330103	1-3 feet bgs in Zone B	x	x	x				x	
	IS28SB340103	1-3 feet bgs in Zone B	x	x	x				x	
	IS28SB350103	1-3 feet bgs in Zone B	x	x	x				x	
	IS28SB360103	1-3 feet bgs in Zone B	x	x	x				x	
	IS28SB370103	1-3 feet bgs in Zone B	x	x	x				x	
	IS28SB380103	1-3 feet bgs in Zone B	x	x	x				x	
	IS28SB390103	1-3 feet bgs in Zone B	x	x	x				x	
	IS28SB400103	1-3 feet bgs (discretionary sample within Zone B)	x	x	x				x	
	IS28SB410103	1-3 feet bgs (discretionary sample within Zone B)	x	x	x				x	
	IS28SB420103	1-3 feet bgs (background sample for Zone B)	x	x	x				x	
	IS28SB430103	1-3 feet bgs (background sample for Zone B)	x	x	x				x	

Table 3-1
Summary of Sampling Program
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

			Analyses							
Medium	**Sample ID**	**Sample Depth/Location**	**TCL VOC**	**TCL SVOC**	**TAL Metals**	**pH**	**TOC**	**Grain Size distribution**	**Explosives ***	**Hardness**
Sediment (in Swales)	IS28SD010000	0-6 inches bgs in swale in Zone A	x	x	x	x	x	x	x	
	IS28SD020000	0-6 inches bgs in swale in Zone A	x	x	x	x	x	x	x	
	IS28SD030000	0-6 inches bgs in swale in Zone A	x	x	x	x	x	x	x	
Sediment (in Mattawoman Creek)**	IS28SD040000	0-6 inches bgs in Mattawoman Creek		x	x		x	x	x	
	IS28SD050000	0-6 inches bgs in Mattawoman Creek		x	x		x	x	x	
	IS28SD060000	0-6 inches bgs in Mattawoman Creek		x	x		x	x	x	
	IS28SD070000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD080000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD090000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD100000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD110000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD120000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD130000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD140000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD150000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD160000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD170000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD180000	0-6 inches bgs in Mattawoman Creek			x			x		
	IS28SD040001	6-12 inches bgs in Mattawoman Creek		x	x				x	
	IS28SD050001	6-12 inches bgs in Mattawoman Creek		x	x				x	
	IS28SD060001	6-12 inches bgs in Mattawoman Creek		x	x				x	
	IS28SD070001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD080001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD090001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD100001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD110001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD120001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD130001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD140001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD150001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD160001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD170001	6-12 inches bgs in Mattawoman Creek			x					
	IS28SD180001	6-12 inches bgs in Mattawoman Creek			x					

Table 3-1
Summary of Sampling Program
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

			Analyses							
Medium	**Sample ID**	**Sample Depth/Location**	**TCL VOC**	**TCL SVOC**	**TAL Metals**	**pH**	**TOC**	**Grain Size distribution**	**Explosives ***	**Hardness**
***In Situ* Groundwater**	IS28GW01MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW02MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW03MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW04MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW05MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW06MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW07MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW08MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW09MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW10MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW11MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW12MMYY	Just below water table in Zone A	x	x	x				x	
	IS28GW13MMYY	Just below water table (background sample for Zone A)	x	x	x				x	
	IS28GW14MMYY	Just below water table (background sample for Zone A)	x	x	x				x	
Groundwater from Monitoring Wells	IS28MW01MMYY	Monitoring Well IS28MW01	x	x	x	x	x	x	x	x
	IS28MW02MMYY	Monitoring Well IS28MW02	x	x	x	x	x	x	x	x
	IS28MW03MMYY	Monitoring Well IS28MW03	x	x	x	x	x	x	x	x
	IS28MW04MMYY	Monitoring Well IS28MW04	x	x	x	x	x	x	x	x
Surface Water	IS28SW01MMYY	Swale in Zone A	x	x	x	x	x	x	x	x
	IS28SW02MMYY	Swale in Zone A	x	x	x	x	x	x	x	x
	IS28SW03MMYY	Swale in Zone A	x	x	x	x	x	x	x	x

Notes

MMYY = Two digit month and two digit year when sampled

Analytical methods for surface soil, subsurface soil, and sediments: TCL VOCs (OLM04), TCL SVOCs (OLM04), TAL Inorganics (ILM04), pH (SW-846 9045C), TOC (SW-846 9060), and Grain

Analytical methods for surface water and groundwater: TCL VOCs (OLM04), TCL SVOCs (OLM04), TAL Total and Dissolved Inorganics (ILM04), Total and Dissolved TOC (SW-846 9060),

Field Parameters for surface water using Horiba U-22 water quality meter: pH, specific conductivity, oxidation/reduction potential, dissolved oxygen, and temperature

* Explosives include PETN, perchlorate, nitroguanidine, and nitroglycerin

** Six of the samples (3 locations, 2 depths) will be analyzed for TAL Metals, TCL SVOCs, Explosives, TOC, and Grain Size. (locations will be determined during sampling based on visual observation of areas of greatest deposition)

Table 3-2
Bottleware, Preservation, and Holding Time Requirements
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

Media	Analysis	Containers Per Sample	Container Type	Preservation	Holding Times
Surface Soil	TCL VOCs	3	Soil: 2x5-gram + 1x25-gram Encore™ Sampling receptacle	4 degrees C	48 hours
	TCL SVOCs	1	8-oz bottle, Teflon cap	4 degrees C	7 days to extraction; 40 days from extraction to analysis
	Grain size	1	16-oz bottle, Teflon cap	4 degrees C	28 days
	Explosives*	2	1-liter amber glass jars, Teflon cap	4 degrees C	7 days
	Perchlorate	1	4-oz glass jar, Teflon cap	4 degrees C	7 days
	TOC	1	8-oz bottle, Teflon cap	4 degrees C	28 days
	TAL Inorganics	1	4-oz bottle, Teflon cap	4 degrees C	6 months
Subsurface Soil	TCL VOCs	1	Soil: 2x5-gram + 1x25-gram Encore™ Sampling receptacle	4 degrees C	48 hours
	TCL SVOCs	1	8-oz bottle, Teflon cap	4 degrees C	7 days to extraction; 40 days from extraction to analysis
	Explosives*	2	1-liter amber glass jars, Teflon cap	4 degrees C	7 days
	Perchlorate	1	4-oz glass jar, Teflon cap	4 degrees C	7 days
	TAL Inorganics	1	4-oz bottle, Teflon cap	4 degrees C	6 months
Sediment	TCL VOCs	1	4-oz bottle, Teflon cap	4 degrees C	48 hours
	Grain size	1	16-oz bottle, Teflon cap	4 degrees C	28 days
	TOC	1	8-oz bottle, Teflon cap	4 degrees C	28 days
	Explosives*	2	1-liter amber glass jars, Teflon cap	4 degrees C	7 days
	Perchlorate	1	4-oz glass jar, Teflon cap	4 degrees C	7 days
	TCL SVOCs	1	8-oz bottle, Teflon cap	4 degrees C	7 days to extraction; 40 days from extraction to analysis
	TAL Inorganics	1	4-oz bottle, Teflon cap	4 degrees C	6 months
Groundwater	TCL VOCs	3	40-ml vial	HCl to pH less than or equal to 2; 4 degrees C	14 days
	TCL SVOCs	2	1-liter amber glass jars, Teflon cap	4 degrees C	7 days to extract; 40 days to analysis
	Explosives*	2	1-liter amber glass jars, Teflon cap	4 degrees C	7 days
	Perchlorate	1	4-oz glass jar, Teflon cap	4 degrees C	7 days
	Dissolved TAL Inorganics	1	1-liter polyethylene bottle	HNO3 to pH less than or equal to 2; 4 degrees C	6 months
Surface Water	TCL VOCs	3	40-ml vial	HCl to pH less than or equal to 2; 4 degrees C	14 days
	TCL SVOCs	2	1-liter amber glass jars, Teflon cap	4 degrees C	7 days to extract; 40 days to analysis
	Total TAL Inorganics	1	1-liter polyethylene bottle	HNO3 to pH less than or equal to 2; 4 degrees C	6 months
	Dissolved TAL Inorganics	1	1-liter polyethylene bottle	HNO3 to pH less than or equal to 2; 4 degrees C	6 months
	Explosives*	2	1-liter amber glass jars, Teflon cap	4 degrees C	7 days
	Perchlorate	1	4-oz glass jar, Teflon cap	4 degrees C	7 days
	Dissolved TOC	1	500-ml polyethylene bottle	HCl to pH less than or equal to 2; 4 degrees C	28 days
	Hardness	1	250-ml HDPE	HNO3 to pH less than or equal to 2; 4 degrees C	6 months

*Explosives include Nitroglycerin, Nitroguanidine, and PETN

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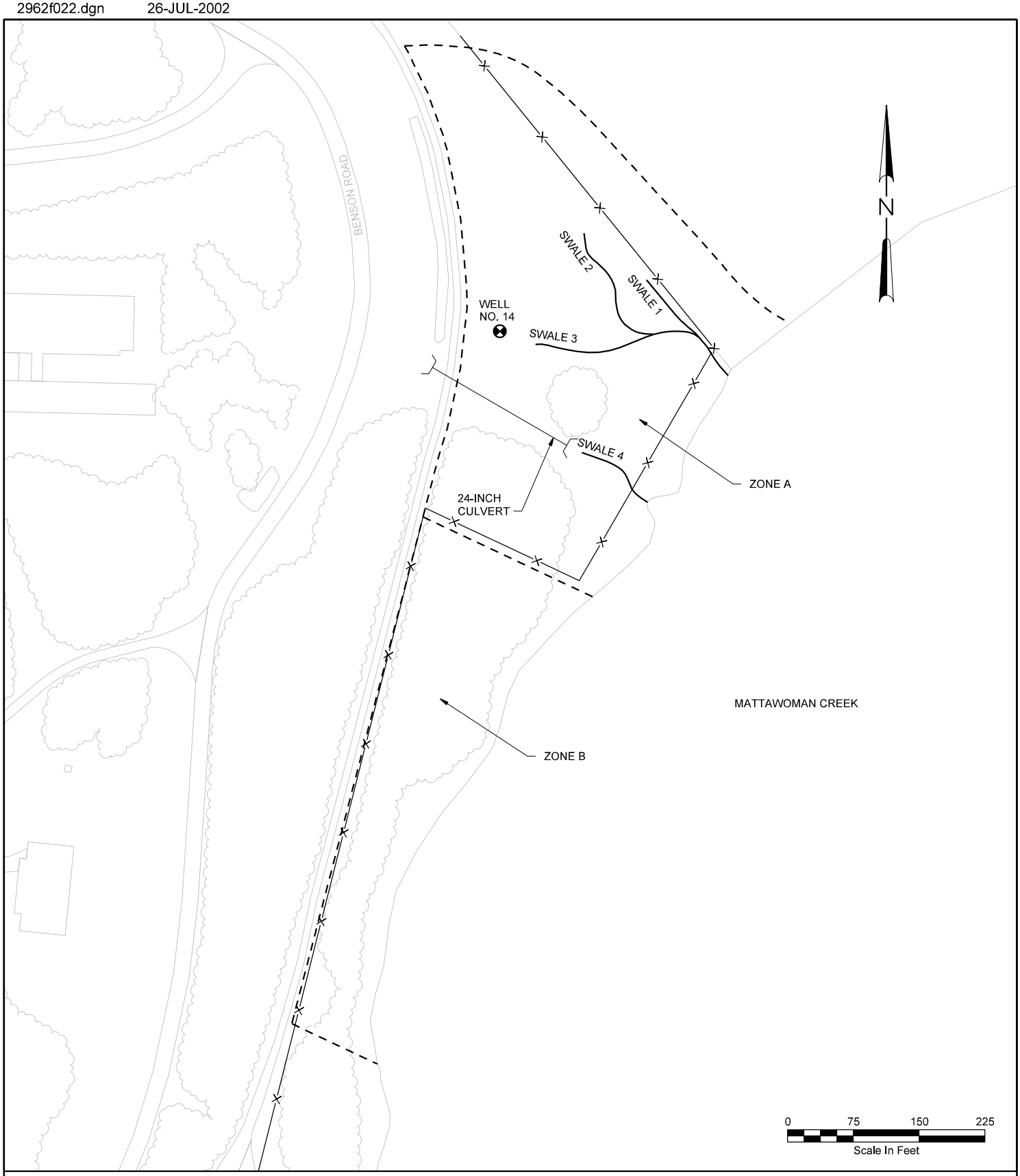

LEGEND

FENCE LINE

ZONE BOUNDARY

NOTE: SWALE LOCATIONS ARE APPROXIMATE.

FIGURE 3-1
SITE 28 ZONES A AND B
SITE 28 RI WORK PLAN
IHDIV-NSWC
INDIAN HEAD, MARYLAND

CH2MHILL

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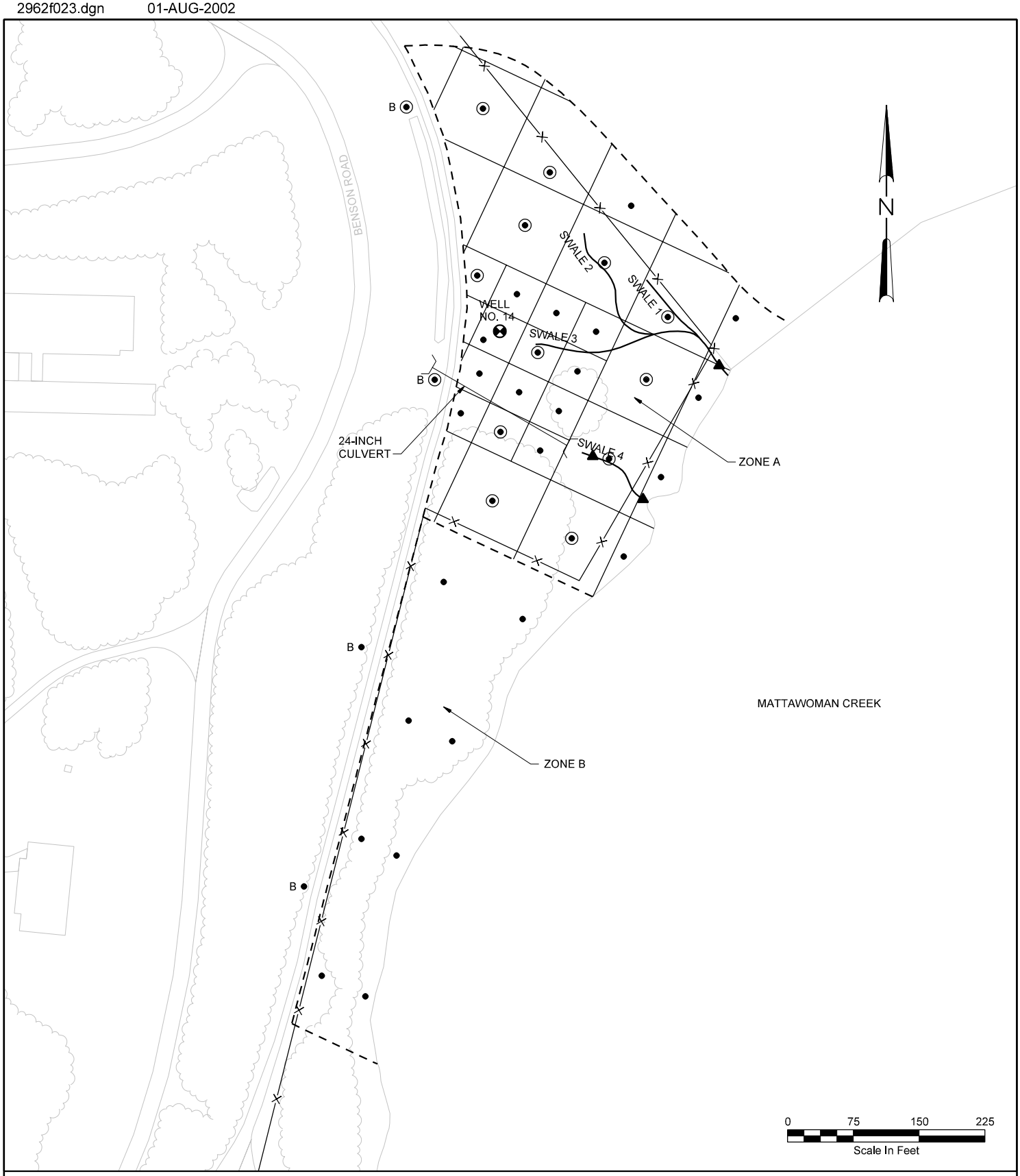

LEGEND

- FENCE LINE
- ZONE BOUNDARY
- GRID LINE
- SURFACE AND SUBSURFACE SOIL SAMPLE LOCATION
- B BACKGROUND SAMPLE
- SURFACE AND SUBSURFACE SOIL SAMPLE AND DIRECT PUSH GROUNDWATER SAMPLE LOCATION
- SURFACE WATER AND SEDIMENT LOCATION

NOTE: SWALE LOCATIONS ARE APPROXIMATE.

FIGURE 3-2
SITE 28 SAMPLING LOCATIONS
SITE 28 RI WORK PLAN
IHDIV-NSWC
INDIAN HEAD, MARYLAND

CH2MHILL

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LEGEND

- Sediment Sample Location
- IR Sites

N

0 250 500 Feet

Figure 3-3
Mattawoman Creek Sediment Sampling Locations
Site 28 RI Work Plan
IHDIV-NSWC
Indian Head, Maryland

CH2MHILL

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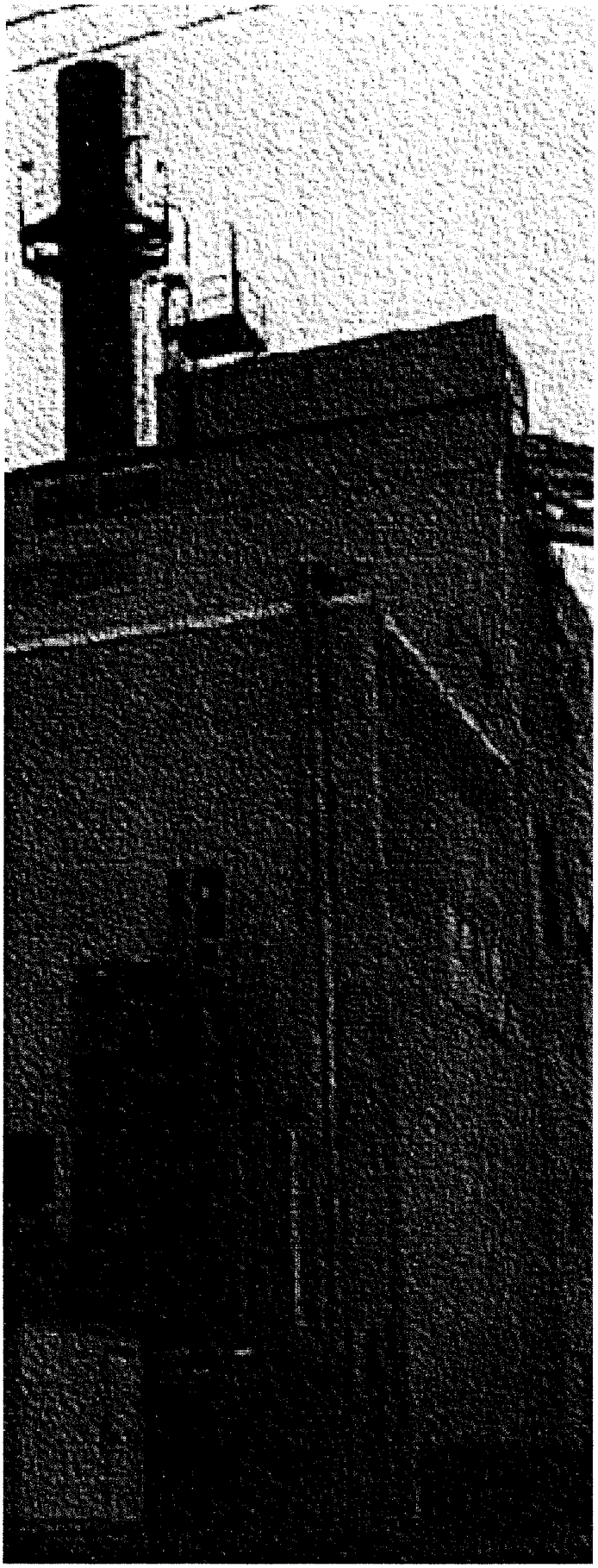


Water System Improvements

Naval Surface Warfare Center
Indian Head, Maryland

100% RFP Documents

Contract No. N62477-02-C-0115
Specification No. 21020115

Prepared for:
EFA Chesapeake

Prepared by:
ADTEK Engineers, Inc.

WATER SYSTEM IMPROVEMENTS

Naval Surface Warfare Center
Indian Head, Maryland

100% Submission

DESIGN/BUILD REQUEST FOR PROPOSAL CONTRACT DOCUMENTS

PREPARED BY:

ADTEK ENGINEERS, INC.
3251 Old Lee Highway, Suite 405
Fairfax, Virginia 22030
703-691-4040

ADTEK ENGINEERS, INC.
Civil and Structural

SAMAHA ASSOCIATES, P.C.
Architectural

MUELLER ASSOCIATES
Mechanical, Electrical, Plumbing

AEROSOL MONITORING & ANALYSIS INC.
Environmental

FORELLA ASSOCIATES
Cost Estimating

DEWBERRY & DAVIS, LLC
Surveying

RFP SUBMITTED BY: Mahendra Shah
ADTEK Engineers, Inc., Mahendra Shah, PE

Date: April 11, 2003

RFP APPROVED BY: _____
EFACHES, Heinz R. Trechsel, R.A.

Date: _____

DESIGN/BUILD REQUEST FOR PROPOSAL

Table of Contents

Part No.:	Title:	Section No.:
Part 1	**List of Drawings**	00102
Part 2	**Design/Build General Requirements**	00911
Part 3	**General Requirements**	
	Summary of Work	01110
	Work Restrictions	01140
	Price and Payment Procedures	01200
	Administrative Requirements	01310
	Construction Progress Documentation	01320
	Submittal Procedures	01330
	Sources for Reference Publications	01420
	Quality Control	01450
	Temporary Facilities and Controls	01500
	Safety and Occupational Health Requirements	01525
	Construction Waste Management	01572
	Temporary Environmental controls	01575
	Project Identification	01580
	Closeout Procedures	01770
	Operation and Maintenance Data	01781
Part 4	**Prescriptive Technical Specifications**	
	Transportation And Disposal Of Hazardous Materials	02120A
	Site Demolition	02220
	Geographic Information System (GIS)	02222
	Geographic Information System (GIS)	02223
	Elevated Steel Water Tank	13210A
	Engineering Control of Asbestos Containing Materials	13281N
	Lead in Construction	13282N
Part 5	**Performance Technical Specifications**	
	Foundations	Section A10
	Superstructure	Section B10
	Exterior Closure	Section B20
	Roofing	Section B30

Final Inspection

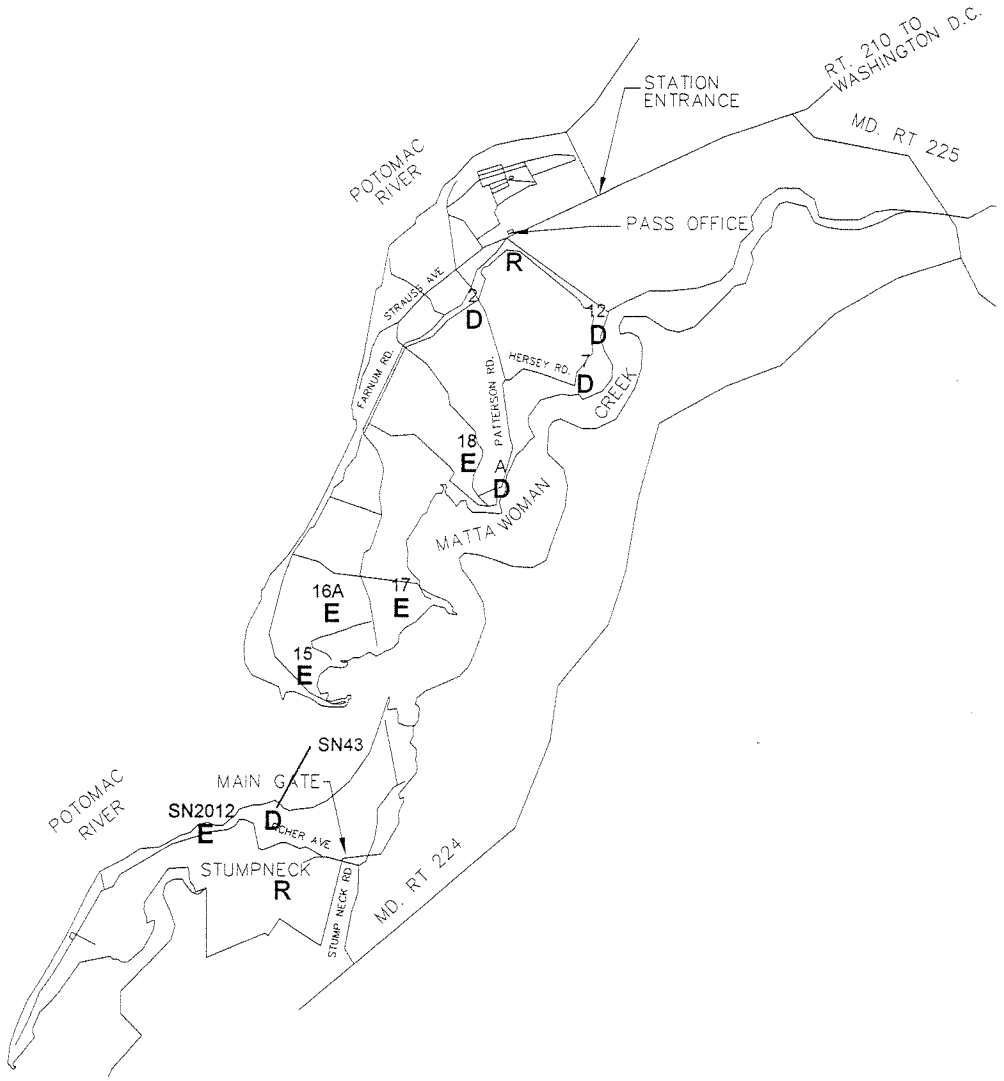
Table of Contents (continued)

Mechanical / Electrical (continued)
SKM-4 New Work-Mechanical
SKM-5 Automatic Temperature Controls-Mechanical
SKM-6 Water Treatment System-Mechanical
SKM-7 Water Treatment Schematic-Mechanical
SKE-1 Aerial Fiber Optic Cable Service For Buildings # 20 & 1601
SKE-2 Aerial Fiber Optic Cable Service For Building # D-339
SKE-3 Aerial Fiber Optic Cable Service For Building # 559
SKE-4 Aerial Fiber Optic Cable Service For Building # 600
SKE-5 Aerial Fiber Optic Cable Service For Building # 601
SKE-6 Aerial Fiber Optic Cable Service For Building # 620, 867 & 868
SKE-7 Aerial Fiber Optic Cable Service For Building # 703
SKE-8 Aerial Fiber Optic Cable Service For Building # 712
SKE-9 Aerial Fiber Optic Cable Service For Building # 714
SKE-10 Aerial Fiber Optic Cable Service For Building # 739
SKE-11 Aerial Fiber Optic Cable Service For Building # 765
SKE-12 Aerial Fiber Optic Cable Service For Building # 864
SKE-13 Aerial Fiber Optic Cable Service For Building # 897
SKE-14 Aerial Fiber Optic Cable Service For Building # 902 & 1752
SKE-15 Aerial Fiber Optic Cable Service For Building # 992
SKE-16 Aerial Fiber Optic Cable Service For Building # 1915
SKE-17 Aerial Fiber Optic Cable Service For Building # 2
SKE-18 Aerial Fiber Optic Cable Service For Building # 2008 & 2015
SKE-19 Aerial Fiber Optic Cable Service For Building # 2100
SKE-20 Aerial Fiber Optic Cable Service For Building # 2108
SKE-21 Fiber Optic Ring Network

Photographs of the Sites/Buildings

Asbestos-Containing Materials and Hazardous Chemical Survey Report

--End of RFP Table of Contents--



Notes/Legend:

1. Locations are conceptual and approximate.

R Replacement well for MILCON P160.

E Existing well that will continue to be used.

D Well to be demolished.

Well Locations

Water System MILCON P160

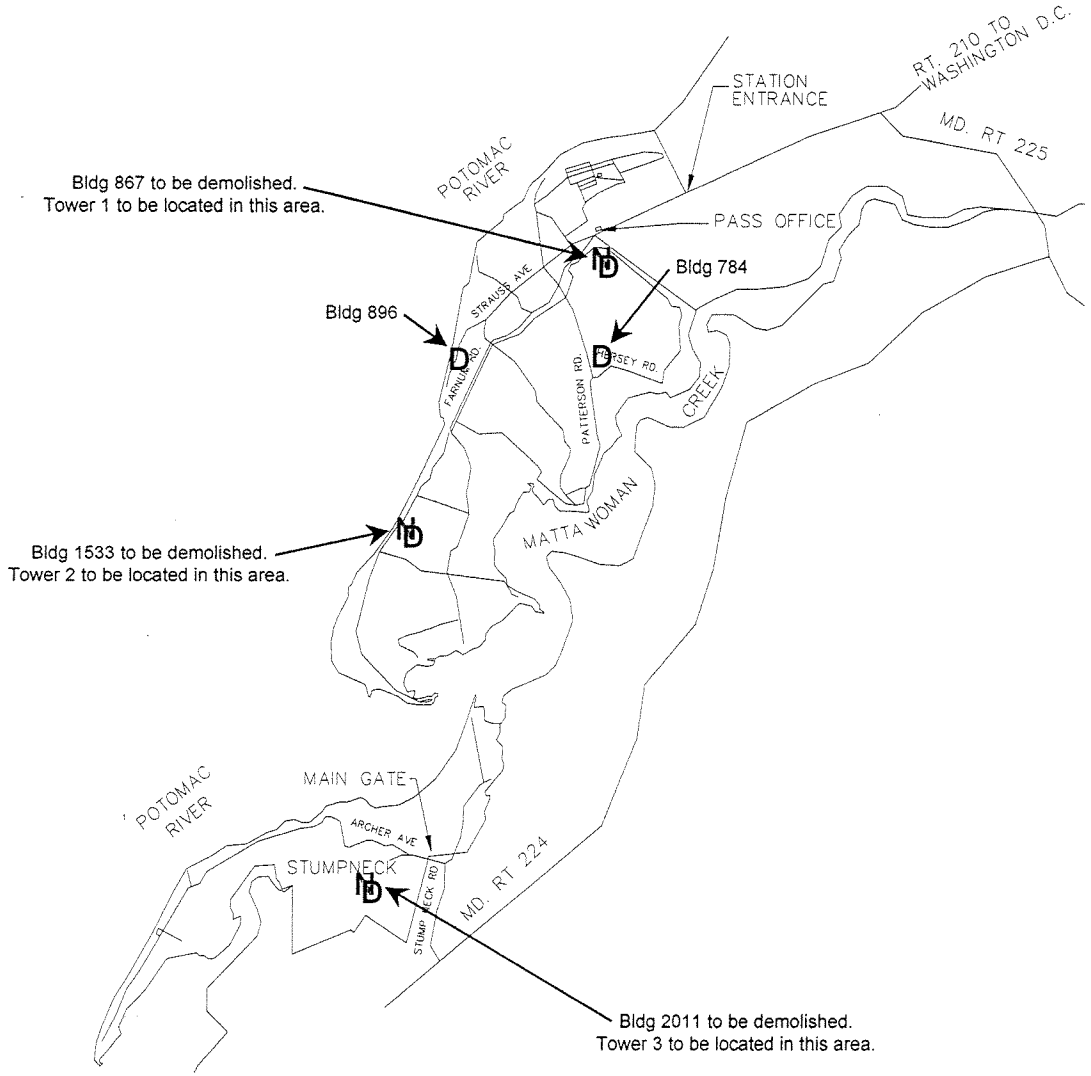
Naval Surface Warfare Center – Indian Head Division

Drawing: **W-1**

Revision: 2 November 2001 by A. Thepvongs, ERG

NAVSEA INDIAN HEAD Surface Warfare Center Division

ERG



Notes/Legend:

1. Locations are conceptual and approximate.

N New elevated water storage tank for MILCON P160.

D Existing elevated water storage tank (designated by building number) to be demolished.

Elevated Water Tank Locations

Water System MILCON P160

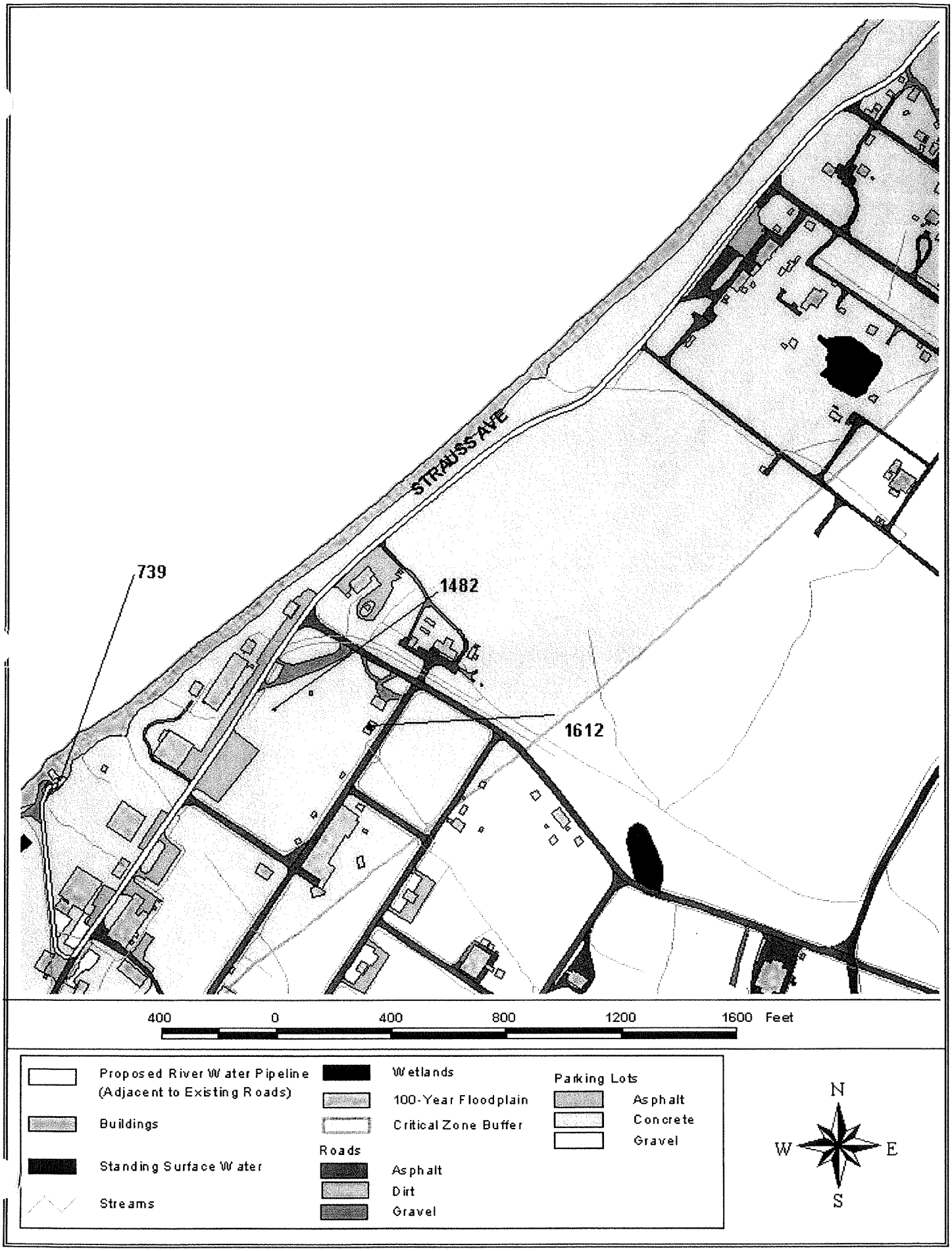
Naval Surface Warfare Center – Indian Head Division

Drawing: **WT-1**

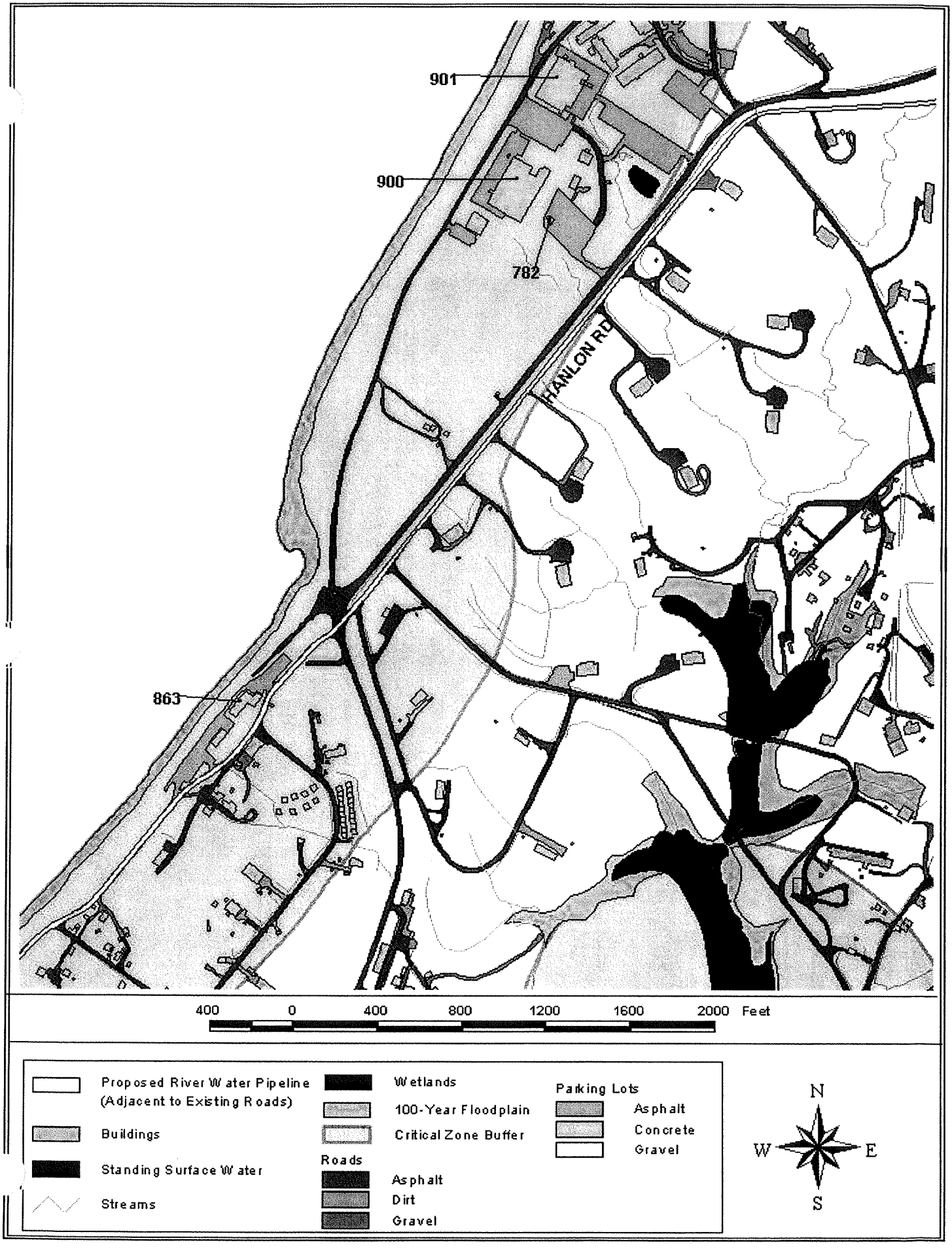
Revision: 2 November 2001 by A. Thepvongs, ERG

NAVSEA INDIAN HEAD Surface Warfare Center Division

ERG



Detailed Drawing H - Water Resources



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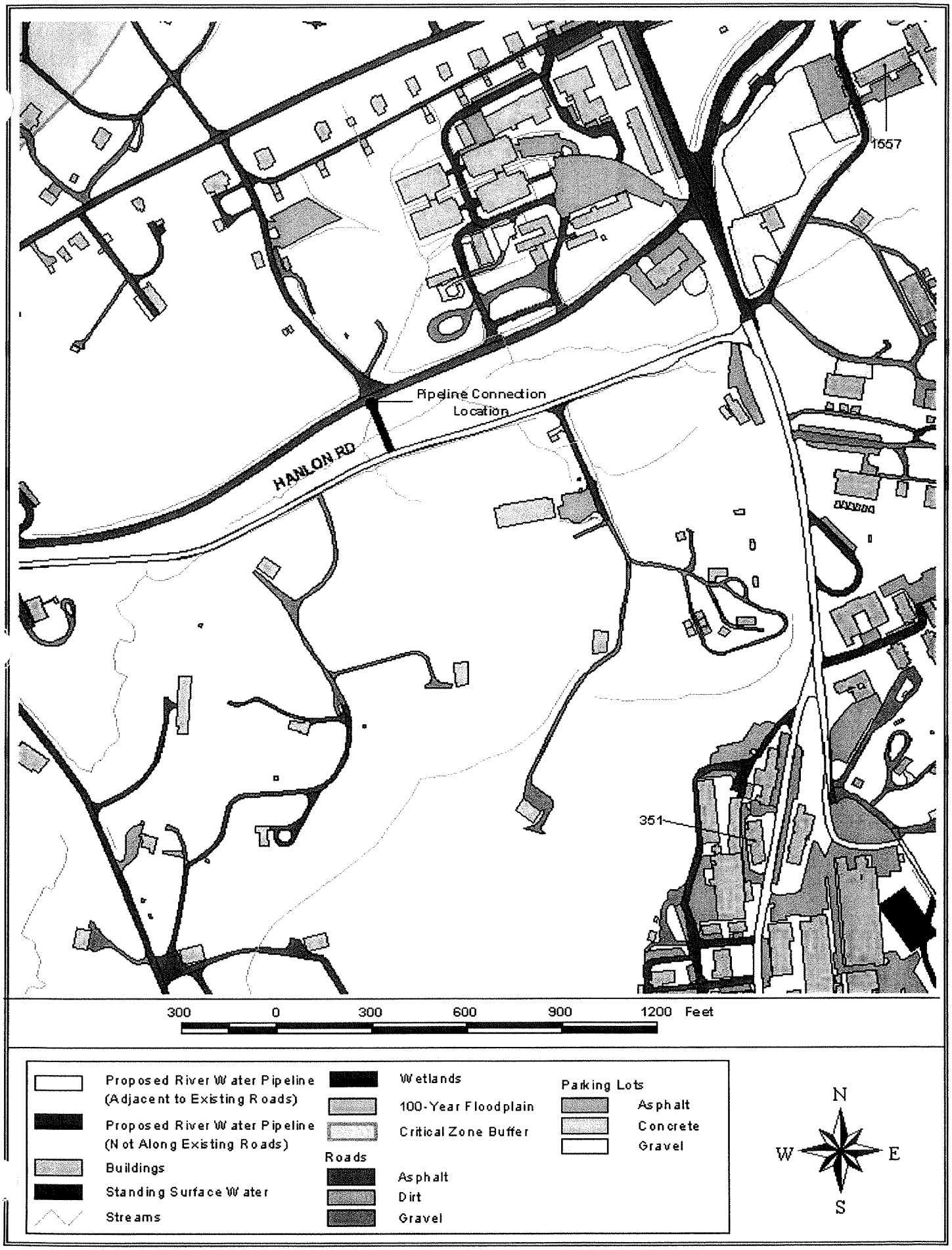
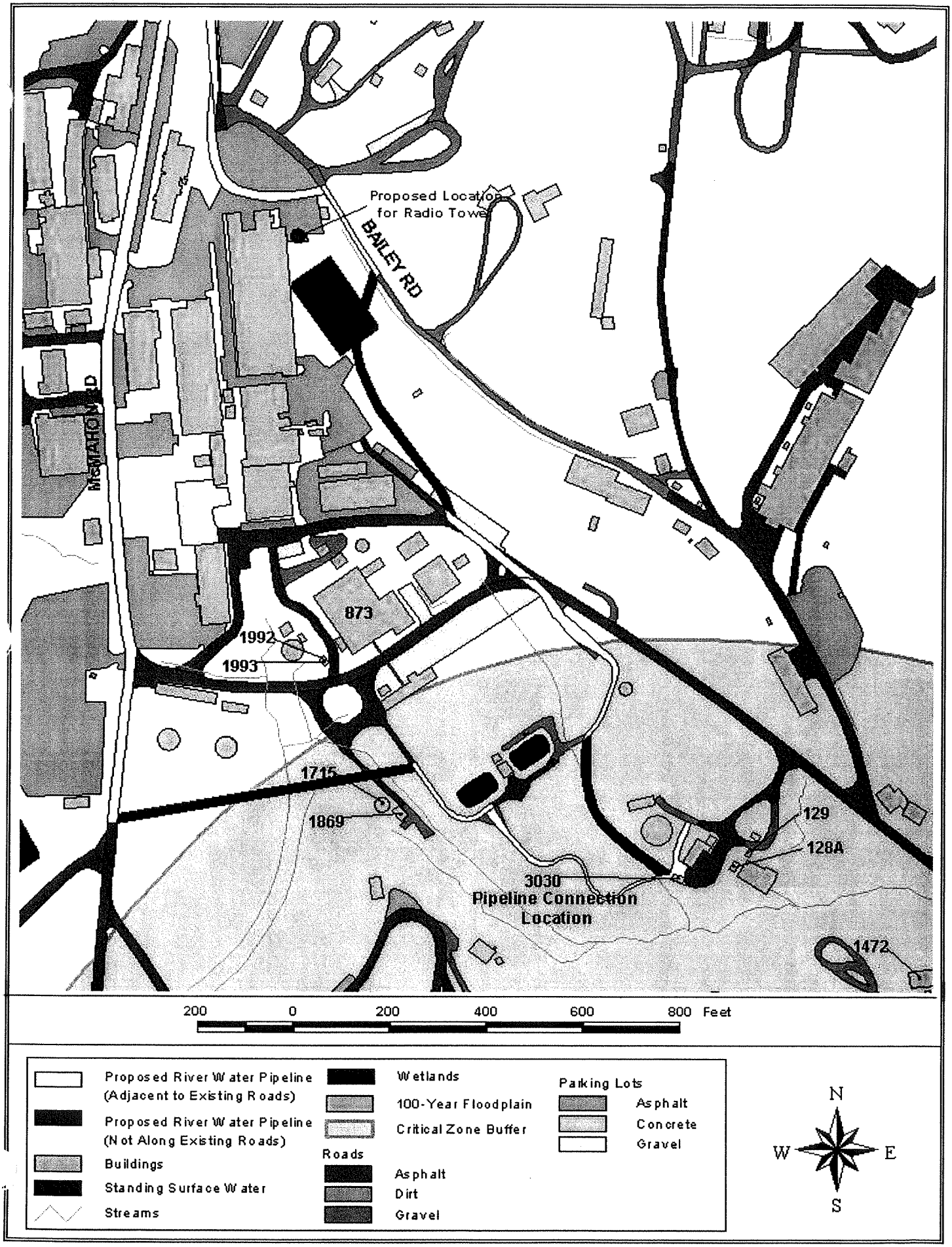


Detailed Drawing E - Water Resources



Detailed Drawing F - Water Resources

Site Management Plan
for
Installation Restoration Program
Indian Head Division
Naval Surface Warfare Center
Indian Head, Maryland

Engineering Field Activity, Chesapeake
Naval Facilities Engineering Command

For Fiscal Years
2003 - 2004

REVISED:
May 2003

SITE MANAGEMENT PLAN
FOR
INSTALLATION RESTORATION PROGRAM
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Prepared by:
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For Fiscal Years

2003 - 2004

Revised:

May 2003

TABLE OF CONTENTS

SECTION **PAGE NO.**

ACRONYMS ..... **vii**

EXECUTIVE SUMMARY **ES-1**

1.0 INTRODUCTION **1-1**
1.1 DESCRIPTION OF THE INSTALLATION 1-1
1.2 ENVIRONMENTAL HISTORY 1-2
1.2.1 IHDIV-NSWC MAIN AREA 1-3
1.2.2 STUMP NECK ANNEX 1-7
1.3 PURPOSE OF THE SITE MANAGEMENT PLAN 1-10
1.4 FORMAT OF THE SITE MANAGEMENT PLAN 1-11

2.0 SITE DESCRIPTIONS **2-1**
2.1 SITE DESCRIPTION – MAIN AREA 2-2

IR Sites

SITE 1 - THORIUM SPILL 2-3
SITE 2 - WASTE CRANK CASE OIL APPLIED TO TORRENCE ROAD 2-4
SITE 3 - NITROGLYCERIN EXPLOSION, NITRATION BUILDING AREA 2-5
SITE 4 - LLOYD ROAD OIL SPILL SITES 2-6
SITE 5 - X-RAY BUILDING 731, OPEN DRAIN 2-7
SITE 6 - HYPO SPILL, RADIOGRAPHIC FACILITY ACCELERATOR 2-9
SITE 7 - HMX SPILL, SLURRY MIX BUILDING 2-10
SITE 8 - MERCURY DEPOSITS IN MANHOLE, BIAZZI PLANT 2-11
SITE 9 - PATTERSON AVENUE, OIL SPILL 2-13
SITE 10 - SINGLE-BASE PROPELLANT GRAINS SPILL AREA 2-14
SITE 11 - CAFFEE ROAD LANDFILL 2-15
SITE 12 - TOWN GUT 2-17
SITE 13 - PAINT SOLVENTS DISPOSAL GROUND 2-19
SITE 14 - WASTE ACID DISPOSAL PIT 2-20
SITE 15 - MERCURY DEPOSITS IN MANHOLE, FLUORINE LAB 2-21
SITE 16 - LABORATORY CHEMICAL DISPOSAL 2-22
SITE 17 - DISPOSED METAL PARTS ALONG SHORELINE 2-23
SITE 18 - HOG ISLAND 2-25
SITE 19 - CATCH BASINS AT CHIP COLLECTION HOUSES 2-26
SITE 20 - SINGLE-BASE POWDER FACILITIES 2-27
SITE 21 - BRONSON ROAD LANDFILL 2-28
SITE 22 - NG SLUMS BURNING SITE 2-30
SITE 23 - HYDRAULIC OIL DISCHARGES FROM EXTRUSION PLANT 2-31
SITE 24 - ABANDONED DRAIN LINES 2-32
SITE 25 - HYPO DISCHARGES FROM X-RAY BUILDING NO. 2 2-33
SITE 26 - THERMAL DESTRUCTOR 2 2-35
SITE 27 - THERMAL DESTRUCTOR 1 2-36
SITE 28 - ORIGINAL BURNING GROUND 2-37
SITE 29 - THE VALLEY 2-38
SITE 39 - ORGANICS PLANT - SILVER CONTAMINATION IN SEDIMENTS 2-39
SITE 40 - PALLADIUM CATALYST IN SEDIMENTS 2-41
SITE 41 - SCRAP YARD 2-42
SITE 42 - OLSON ROAD LANDFILL 2-44

TABLE OF CONTENTS (Continued)

SECTION **PAGE NO.**

SITE 43 - TOLUENE DISPOSAL 2-46
SITE 44 - SOAK OUT AREA 2-47
SITE 45 - ABANDONED DRUMS 2-49
SITE 46 - CADMIUM SANDBLAST GRIT AREA 2-50
SITE 47 - MERCURIC NITRATE DISPOSAL AREA 2-51
SITE 48 - NG PLANT DISPOSAL AREA 2-53
SITE 49 - CHEMICAL DISPOSAL PIT 2-54
SITE 50 - BUILDING 103 CRAWL SPACE 2-56
SITE 51 - BUILDING 101 DRY WELL 2-58
SITE 52 - BUILDING 102 DRY WELL 2-59
SITE 53 - MERCURY CONTAMINATION OF THE SEWAGE SYSTEM 2-60
SITE 54 - BUILDING 101 2-62
SITE 55 - BUILDING 102 2-64
SITE 56 - IW87 LEAD CONTAMINATION 2-66
SITE 57 - TCE BUILDING 292 AREA 2-67

IR Sites AOCs

SWMU 4,5 - UNDERGROUND STORAGE TANKS (BUILDING 290 AND 520) 2-69
SWMU 6 - USED BATTERY ACCUMULATION AREA 2-70
SWMU 27 - WASTE OIL STORAGE AREA 2-71
SWMU 38 - CAFEE ROAD WASTE OIL STORAGE AREA 2-73
SWMUs 40 to 46 - WASTEWATER COLLECTION/TREATMENT TANKS (MOSER) 2-74
SWMUs 47 to 51 - SPENT ACID STORAGE/TREATMENT TANKS (MOSER) 2-75
SWMUs 64 to 66 - WASTE WATER STORAGE TANKS (BUILDING 1596) 2-76
SWMU 69 - TEMPORARY ACCUMULATION DUMPSTERS FOR EXPLOSIVE SCRAP 2-77
SWMU 70 - TEMPORARY ACCUMULATION AREA FOR DRUMMED EXPLOSIVE SCRAP 2-78
SWMU 72 - OIL/WATER SEPARATORS 2-79
AOC G - SAND BLASTING SAND STORAGE AREA 2-80
AOC H - DRUM AT FUEL STORAGE AREA 2-81
SWMU 20 - SAFETY BURN POINT 2-82
SWMU 21 - CAFFEE ROAD DECONTAMINATION BURN POINT 2-83

2.2 SITE DESCRIPTIONS – STUMP NECK ANNEX 2-84

IR Sites

SITE 30 - STUMP NECK IMPACT AREA (SWMU 22) 2-85
SITE 31 - OLD DEMOLITION RANGE (SWMU 23) 2-86
SITE 32 - SUSPECTED TOOL BURIAL AREA (SWMU 11) 2-87
SITE 33 - SCRAP METAL PIT (SWMU 7) 2-88
SITE 34 - TOOL BURIAL SITE (SWMU 8) 2-89
SITE 35 - TORPEDO BURIAL SITE (SWMU 9) 2-90
SITE 36 - INACTIVE DISPOSAL SITE (SWMU 10) 2-91
SITE 37 - CAUSEWAY (SWMU 24) 2-92
SITE 38 - RUM POINT LANDFILL (SWMU 1) 2-94
SITE 58 - RANGE 3 BURN POINT (SWMU 2) 2-95
SITE 59 - CHICAMUXEN CREEK'S EDGE SITE A (SWMU 3) 2-96

TABLE OF CONTENTS (Continued)

SECTION **PAGE NO.**

SITE 60 - CHICAMUXEN CREEK'S EDGE SITE B (SWMU 4) 2-97
SITE 61 - RANGE 6 (SWMU 5) 2-98
SITE 62 - AIR BLAST POND (SWMU 6) 2-99
SITE 63 - AREA 8 (SWMU 25) 2-100
SITE 64 - IED (SWMU 26) 2-101
SITE 65 - IOD (SWMU 27) 2-102

IR Sites AOCs

SWMU 12 - WASTE OIL STORAGE SITE 2-103
SWMU 13 - PINK WATER TREATMENT TANK 2-104
SWMU 15 - SPENT PHOTOGRAPHIC SOLUTION STORAGE 2-106
SWMU 16 - THERMAL TREATMENT TANK 2-107
SWMU 17 - BUILDING 2015 - CHEM LAB ACCUMULATION AREA 2-108
SWMU 18 - WASTE PILE 2-109
SWMU 19 - DISPOSAL AREA #1 2-110
SWMU 20 - DISPOSAL AREA #2 2-111
SWMU 21 - DRUM STORAGE AREA 2-112
SWMU 28 - SKEET RANGE 2-113
SWMU 29 - OLD PISTOL RANGE 2-114
SWMU 14 - PHOTOGRAPHIC LAB SEPTIC TANK SYSTEM 2-115
SWMU 30 - BUILDING 2015 DRY WELL 2-116

3.0 SITE LOCATION SUMMARY 3-1

4.0 SCHEDULES 4-1

REFERENCES R-1

APPENDICES

A IHDIV - MAIN AREA SITE FIGURES
B IHDIV – STUMP NECK ANNEX SITE FIGURES
C PHOTO LOG

TABLES

NUMBER

1-1 Site Summary - Main Area Installation Restoration (IR) Sites and Solid Waste Management Units (SWMUs)
1-2 Summary of Desk-Top Audit Main Area Areas of Concern (AOCs)
1-3 Summary of Desk-Top Audit Stump Neck Areas of Concern (AOCs)

FIGURES

NUMBER

1-1 Facility Location Map
1-2 CERCLA Process VS. RCRA Process
3-1 Site Locations Main Area
3-2 Site Locations Stump Neck Annex
4-1 Schedule for FY02 and FY03

LIST OF ACRONYMS

ACM	Asbestos Containing Material
AOCs	Areas of Concern
BNA	base-neutral acids
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
CRQL	Contract Required Quantitation Limits
DERA	Defense Environmental Restoration Account
DOD	Department of Defense
EE/CA	Engineering Evaluation/Cost Analysis
EOD	Explosive Ordnanace Disposal
EPA	United States Environmental Protection Agency
EPTox	Extraction Procedure Toxicity
FDWS	Federal Drinking Water Standards
FFA	Federal Facilities Agreement
FS	Feasibility Study
GC/FID	Gas Chromatograph/flame ionization detector
GPR	Ground Penetrated Radar
HMX	A chemical (C4H8N8O8) component of plastic explosives
HSWA	Hazardous and Solid Waste Amendments
IAS	Initial Assessment Study
IAS	Initial Assessment Study
IHDIV-NSWC	Indian Head Division, Naval Surface Warfare Center
IR	Installation Restoration
IW	Industrial Wastewater
IWTP	Industrial Wastewater Treatment Plant
MCL	Maximum Contaminant Levels
MDE	Maryland Department of the Environment
NACIP	Naval Assessment for the Control of Industrial Pollutants
NAVEODTECHDIV	Naval Explosives Ordnance Technology Division
NAVSCOLEOD	Naval School Explosive Ordnance Disposal
NC	Nitrocellulose
NEESA	Naval Energy and Environmental Support Activity
NG	Nitroglycerin
NOS	Naval Ordnance Station
NPL	National Priorities List

PA	Preliminary Assessment
PA/SI	Preliminary Assessment/Site Inspection
PBX	Plastic Bonded Explosives
PCB	Polychlorinated Biphenyl
PCE	Tetrachloroethene
PR	Preliminary Review
PSPAS	Point-Source Pollution Abatement Study
RAC	Removal Action Contractor
RCRA	Resource Concentration and Recovery Act
RD/RA	Remedial Design/Remedial Action
RFA	RCRA Facilities Assessment
RFI	RCRA Facilities Investigation
RI	Remedial Investigation
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SI	Site Investigation
SMP	Site Management Plan
SSP	Site Screening Process
STP	Sewage Treatment Plant
SWMU	Solid Waste Management Unit
TAL	Target Analyte List
TCE	Trichloroethene
TCL	Target Compound List
TPH	Total Petroleum Hydrocarbons
UDMH	Unsymmetrical Dimethyl Hydrazine
UST	Underground Storage Tank
VI	Verification Investigation
VOC	Volatile Organic Compound
VSI	Visual State Inspection

EXECUTIVE SUMMARY

This Site Management Plan (SMP) was updated by Engineering Field Activity Chesapeake to present the activities that were conducted and those that are planned for sites at the Indian Head Division, Naval Surface Warfare Center (IHDIV-NSWC). This SMP addresses 48 Installation Restoration (IR) sites and 15 Areas of Concern (AOCs) on the Main Area of IHDIV-NSWC, and 17 IR sites and 13 AOCs at the Stump Neck Annex. Previous SMPs for IHDIV-NSWC did not include the Stump Neck Annex because the Annex was being addressed by a separate program under a Resource Conservation and Recovery Act (RCRA) Corrective Action Permit. However, upon finalization of the Federal Facilities Agreement (FFA) between the Department of the Navy and United States Environmental Protection Agency (EPA) the RCRA sites at the Stump Neck Annex were included under the Comprehensive Environmental Response, Compensation and Liability act of 1980 (CERCLA) program of the Main Area.

The schedules in this SMP were prepared to include the traditional steps for addressing contaminated sites under CERCLA. Existing documentation published in connection with past investigations and studies were used to describe completed activities and recommendations for future work. This SMP should be considered a "living document" because the information and schedules that are provided will be updated periodically as the work progresses at each site and more definitive information becomes available.

As a result of previous investigations and recommendations for sites within the Main Area of IHDIV-NSWC, 25 of the 48 IR sites have been included in the category of Remedial Investigation/Feasibility Study (RI/FS). Twenty of these sites are currently undergoing the RI/FS process, and four (Sites 43, 46, 48, and 56) are scheduled for future RI/FS work. One site (Site 28) continues in the RI/FS process and has been included in the Munitions Response Program. Twenty IR sites within the Main Area fall under the Site Screening Process (SSP), three of which (Sites 10, 22, and 29) are included in the MRP. In addition, two sites (Sites 12 and 41) are in the Remedial Action phase. Lastly, a final remedy has been completed for Site 44 and no further action is required. As indicated above, the Main Area also includes 15 AOCs. These AOCs have undergone a desktop audit. As a result of the desktop audit, two of the sites will be incorporated into ongoing Remedial Investigations (RIs). A third site will be subjected to its own remedial investigation. One of the AOC sites will be designated as a new IR site, and the remaining 11 sites are expected to be closed with a No Action decision document.

As a result of previous investigations and recommendations for the sites within the Stump Neck Annex, all of the 17 IR sites have been included in the category of SSP. 6 of these sites are included in the Munitions Response Program. Two sites (Sites 36 and 37) are recommended to move into the RI/FS process and no further action has been recommended for the remaining 2 sites (Sites 32 and 34). The

Stump Neck Annex also includes 13 AOCs. During a desktop audit, these AOCs were categorized to either remain AOCs (3 sites), remain RCRA facilities (1 site), be closed with a No Further Action decision document (5 sites), or undergo an RI (2 sites) or an SSP (2 sites). Furthermore, 2 of the AOCs are included in the Munitions Response Program.

With the finalization of the FFA, these areas are addressed under the CERCLA Program, and the SMP provides the schedules for these areas.

1.0 INTRODUCTION

This Site Management Plan (SMP) for the Indian Head Division Naval Surface Warfare Center (IHDIV-NSWC), Indian Head, Maryland, was prepared by Engineering Field Activity Chesapeake. The purpose of this SMP is to provide site-specific background information, present the activities that are currently being conducted or are planned at IHDIV-NSWC during Fiscal Years 2003 through 2005, and project the long-term progress of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA) program at the IHDIV-NSWC in accordance with the Department of Navy Installation Restoration (IR) Program.

1.1 DESCRIPTION OF THE INSTALLATION

IHDIV-NSWC, formerly called the Naval Ordnance Station (NOS), the Naval Propellant Plant, the Naval Powder Factory, and the Naval Proving Grounds, is located in Charles County, Maryland, 30 miles south of Washington, D.C. The site is positioned along the Potomac River at the confluence of Mattawoman Creek, as shown on Figure 1-1. The site comprises of about 3,500 acres. The Main Area, on the Cornwallis Neck Peninsula, is approximately 2,500 acres. The Stump Neck Annex is approximately 1,000 acres and is separated from the Main Area by Mattawoman Creek. IHDIV-NSWC has been active since 1890 and assumed its current name in 1992.

IHDIV-NSWC operations are primarily located on the Main Area. The principal mission on the Main Area of the Station is to

- Provide services in energetics for all warfare centers through engineering, fleet and operational support, manufacturing technology, limited production, and industrial base support.

- Provide research, development, testing, and evaluation of energetic materials, ordnance devices and components, and other related ordnance engineering standards, including chemicals, propellants and their propulsion systems, explosives, pyrotechnics, warheads, and simulators.

- Provide support to all warfare centers, military departments, and the ordnance industry for special weapons, explosive safety, and ordnance environmental issues.

The Stump Neck Annex of IHDIV-NSWC is primarily occupied by tenant commands. Until recently, the Stump Neck Annex was occupied by two tenant commands, the Naval School Explosive Ordnance Disposal (NAVSCOLEOD) and the Naval Explosive Ordnance Disposal Technology Division (NAVEODTECHDIV). The mission of NAVSCOLEOD was the training of active military personnel in

performing explosive ordnance disposal (EOD) operations. In 1998, most operations at NAVSCOLEOD were relocated to Pensacola, Florida. Currently, NAVEODTECHDIV is the primary tenant command at the Stump Neck Annex. The mission of NAVEODTECHDIV is as follows:

?? Provide EOD technology and logistics management.

?? Develop war-essential elements of intelligence, equipment, and procedures to counter munitions, both United States and foreign, as required to support Department of Defense (DOD) components and the peacetime security needs of other agencies.

1.2 ENVIRONMENTAL HISTORY

Environmental studies at IHDIV-NSWC and all other Naval facilities are conducted under the DOD IR Program. The IR Program was authorized by the Chief of Naval Operations under Instruction, OPNAVINST 5090.1, dated May 2, 1983. Funding to pay for these environmental studies is allocated for DOD sites under the Environmental Restoration, Navy Account.

The IR Program parallels CERCLA (see Figure 1-2). Under CERCLA, abandoned waste sites that potentially contained hazardous constituents undergo several phases of environmental study that would ultimately determine the need for a remedy and, if necessary, the selection and implementation of the remedy for the site. The phases of investigation include the Preliminary Assessment/Site Inspection (PA/SI), Remedial Investigation/Feasibility Study (RI/FS), Record of Decision (ROD), and Remedial Design/Remedial Action (RD/RA). CERCLA also provides for removal actions if a site poses an immediate threat to human health or the environment.

The IHDIV-NSWC IR Program includes a total list of 65 sites. Sites numbered 1 through 29 and 39 through 57 are located on the Main Area of the facility. Sites numbered 30 through 38 and 58 through 65 are located on the Stump Neck Annex (see Figure 1-1).

Between 1990 and 2001, the sites at the Stump Neck Annex were managed under a Resource Conservation and Recovery Act (RCRA) Corrective Action Permit that provided for a process similar to CERCLA for site investigation and remediation. However, in 1998 the United States Environmental Protection Agency (EPA) Region III made the determination that the Stump Neck Annex was included under the National Priorities Listing of IHDIV-NSWC. As a result of the finalization of the Federal Facilities Agreement (FFA) between the Department of the Navy and EPA, the RCRA sites at the Stump Neck Annex are now included under the CERCLA program of the Main Area. Section 1.2.1 below describes the environmental history of the IR Program at the main area of the facility. Section 1.2.2

describes the environmental history of the Stump Neck Annex sites. Table 1-1 provides a list of all of the IR sites and Areas of Concern (AOCs) at the Main Area and the Stump Neck Annex.

1.2.1 IHDIV-NSWC MAIN AREA

Initial Assessment Study (IAS) (Sites 1-29)

The first IR Program objective is the collection and evaluation of data and historical evidence of hazardous constituents that might have contaminated the facility or that pose an imminent health hazard on or off the facility. The Navy completed an IAS of IHDIV-NSWC in May 1983 (NEESA, 1983). The IAS is equivalent to the Preliminary Assessment (PA) in the CERCLA process. The IAS examined a total of 38 potentially contaminated sites. Sites numbered 1 through 29 are located on the Main Area of the facility. Sites numbered 30 through 38 are located on the Stump Neck Annex. The 29 identified Main Area sites are listed below. Stump Neck Sites 30 through 38 are discussed in Section 1.2.2.

Site 1	Thorium Spill
Site 2	Waste Crankcase Oil applied to Torrense Road
Site 3	Nitroglycerin Explosion, Nitration Building Area
Site 4	Lloyd Road Oil Spill
Site 5	X-ray Building, Building 731
Site 6	Radiographic Facility, Building 1349
Site 7	HMX Spill, Slurry Mix Building
Site 8	Mercury Deposits, Building 766
Site 9	Patterson Avenue, Oil Spill
Site 10	Single-Base Propellant Grains Spill Area
Site 11	Caffee Road Landfill
Site 12	Town Gut Landfill
Site 13	Paint Solvents Disposal Area
Site 14	Waste Acid Disposal Pit
Site 15	Mercury Deposits in Manhole, Fluorine Lab
Site 16	Laboratory Chemical Disposal
Site 17	Disposed Metal Parts along Shoreline
Site 18	Hog Island
Site 19	Catch Basins at Chip Collection Houses
Site 20	Single Base Powder Facilities
Site 21	Bronson Road Landfill
Site 22	NG Slums Burning Site
Site 23	Hydraulic Oil Discharges from Extrusion Plant

Site 24	Abandoned Drain Lines
Site 25	Hypo Discharges from X-Ray Building No. 2
Site 26	Thermal Destructor 2
Site 27	Thermal Destructor 1
Site 28	Original Burning Ground
Site 29	The Valley

Of the 38 sites, the IAS recommended further study at Sites 5, 8, and 12 based on the available historical information. Because historical operations at Sites 6 and 25 were similar to those at Site 5, the IAS also recommended additional study at these two sites if further investigation of Site 5 indicated a problem.

The Navy completed a Confirmation Study at IHDIV-NSWC in September 1985. The Confirmation Study was designed to evaluate the presence or absence of contamination at Sites 5, 8, and 12. The results of the study are documented in the Naval Assessment for the Control of Industrial Pollutants (NACIP) Confirmation Study, Naval Ordnance Station, Indian Head, MD. Sites 5 and 8 were determined to have extensive levels of silver and mercury, respectively. Contamination in the pond adjacent to Site 12, however, was not found to be attributable to the landfill and is suspected to be the result of contamination from farther upstream.

The Navy completed removal actions at Sites 5 and 8 and continued investigations at Site 12. The removal actions involved the excavation of contaminated soils to prevent further transport and migration of the contamination, and risk to ecologically sensitive receptors. At Site 5, the Navy removed silver-contaminated soil from one swale on the site in 1992 and additional contaminated soil from another swale on the site in 1995. The soils from the first excavation were encapsulated and placed in the base of a large earthen explosion barrier expansion (the soils represent less than 4 percent of the total volume of the expansion). The soils from the second excavation were used to reclaim a gravel borrow pit on the Stump Neck Annex at IHDIV-NSWC. At Site 8, the Navy removed mercury-contaminated soil in 1984 and 1995. The soils removed in 1984 were disposed off-site, and soils removed in 1995 were disposed by encapsulating them in the earthen berm of Building 606 and covering them with a 1-foot thick layer of clay.

The Navy conducted a five-year biomonitoring program, which demonstrated that contamination is not migrating from the landfill to the adjacent pond. A Remedial Investigation (RI) was completed in 1999. The RI recommended the preparation of a Feasibility Study (FS) to evaluate methods for mitigating environmental risks and to address regulatory concerns connected with landfill closure requirements. An FS for Site 12 was completed in January 2001. Subsequently, a Proposed Plan and fact sheet were published for the installation of a 2-foot thick soil cover over the Town Gut Landfill, and a public meeting

was held on January 23, 2001. The final design for the remediation of Site 12 was completed in February 2002 and construction began in September 2002.

In 1996, after further review of the original 29 IAS sites of the Main Area, the Navy, EPA and Maryland Department of the Environment (MDE) decided to subject Sites 6, 11, 13, 15, 16, 17, 21 and 25 to RIs because of the potentially higher risks associated with these sites. RIs for all of those sites except Site 13 are currently ongoing. An RI is also being conducted for Sites 8 and 28. Site 28 has also been included in the Munitions Response Program. No further action has been recommended for Sites 5, 13, and 14. The remainder of the original 29 IAS sites will enter the Site Screening Process (SSP), which will provide for a second evaluation, potentially including some additional sampling, to confirm the presence or absence of contamination at the sites and the need for further action. Three of these sites (Sites 10, 22, and 29) have been included in the MRP.

Supplemental Preliminary Assessment (PA) (Sites 39 –55)

The Navy completed a Supplemental PA Report for IHDIV-NSWC in January 1992. The PA was an addendum to the IAS and examined an additional 17 sites located on the Main Area. The 17 additional sites are listed below. All but Sites 51 and 52 were recommended for further action (i.e., additional investigation, contaminant removal, etc.).

Site 39	Silver Release to Sediments
Site 40	Palladium Catalyst in Sediment
Site 41	Scrap Yard
Site 42	Olsen Road Landfill
Site 43	Toluene Disposal
Site 44	Soak-Out Area
Site 45	Abandoned Drums
Site 46	Cadmium Sandblast Grit
Site 47	Mercuric Nitrate Disposal Area
Site 48	NG Plant Disposal Area
Site 49	Chemical Disposal Pit
Site 50	Building 103 Crawl Space
Site 51	Building 101 Dry Well
Site 52	Building 102 Dry Well
Site 53	Mercury Contamination of the Sewage System
Site 54	Building 101
Site 55	Building 102

As a follow-up to the Supplemental PA, the Navy conducted a Site Investigation (SI) on Sites 39 through 50 and Sites 53 through 55 in two phases. SI Phase I focused on Site 42, Olsen Road Landfill and SI Phase II focused on the remainder of the sites. Based on the results of the SI, all the sites were recommended for further study to determine the nature and extent of contamination and to identify the appropriate remedial action.

The Navy completed work plans for the RI of these sites in 1997. RI Reports for Sites 41, 42 and 44 were completed in 1999. At Site 41, the RI recommended an FS to evaluate methods for mitigating human health and environmental risks posed by the contaminated surface soil at the site. The FS for Site 41 was completed in January 2001. Subsequently, a Proposed Plan and fact sheet were published for removing contaminated soil and removing polychlorinated biphenyl (PCB) contamination from the surface of the concrete slab within the Scrap Yard (Site 41), and a public meeting was held on February 20, 2001. The final design for the remediation of Site 41 was completed in mid-2002 and construction began in November 2002. At Site 42, the RI recommended an FS to evaluate methods to address regulatory concerns connected with landfill closure requirements. Additional field investigations were conducted during January and February 2002 to better define the extent of the landfill and to assess the possibility that groundwater contamination may have migrated downgradient from the landfill. Consequently, the FS was completed in June 2002. The RI for Site 44 recommended no further action, and no FS was prepared. Following the final RI for Site 44, a Proposed Plan and fact sheet for no action were published, and a public meeting was held on February 20, 2001. The No Further Action ROD for Site 44 was signed and completed in September 2002. RODs for Sites 12 and 41have been prepared and are under review by the Navy and regulatory agencies. At Site 49, the chemical disposal pit was removed in May 2001 and no further action is expected.

Site screening investigations were conducted at Sites 51 and 52 during January and February 2002. RIs continue for the remainder of the 1992 PA sites.

Additional Sites (56- 57)

Since the 1992 PA, two additional sites have been discovered on the Main Area of IHDIV-NSWC.

Site 56	IW-87 Lead Outfall
Site 57	Building 292 TCE Contamination

Based on site sampling, the Navy performed Engineering Evaluations/Cost Analyses (EE/CAs) in 1994 and 1997 respectively to evaluate the removal action options at Site 56 and Site 57. The Navy conducted a removal action at Site 56 in 1996 that involved the removal of lead-contaminated sediments at IW–87 and from approximately 750 feet of outfall pipe. These soils were properly disposed off-site. The pipe

was then relined to prevent potential lead-contaminated shallow groundwater from infiltrating the pipe, which could deposit lead downgradient of the site. In 1998, the Navy completed a removal action at Site 57 to address infiltration of trichloroethene (TCE) contaminated groundwater into a storm sewer leading to outfall IW-80. Approximately 700 feet of storm sewer were lined to inhibit the accelerated migration of TCE. The Navy completed the RI at Site 57 in July 2000. During August 2001, a field investigation was conducted at Site 57 to collect field data to aid in the evaluation of remedial alternatives during the preparation of an FS. Preparation of the FS is ongoing at this writing and various pilot studies for the treatment of TCE are being considered. In May 2003, an HRC (hydrogen-releasing compound) pilot study was performed at the site. Previously, a pilot-scale soil vapor extraction (SVE) study was conducted in 1997 to determine if SVE was an appropriate method for removing TCE from the site. The study is mentioned in the RI Report of July 2000 (Section 4.2.3, page 4-5), and states on page 4-6 that "Therefore, it was concluded that the subsurface conditions at Site 57, as experienced during this pilot study, are not well suited to the application of the SVE technology." The results of the study are contained in the Findings Report Pilot-Scale Soil Vapor Extraction Study (B&R Environmental, 1997b).

Areas of Concern (AOC)

In addition to the 48 sites discussed in this section, 15 AOCs in the Main Area are also being evaluated under the IR Program. These AOCs were originally identified as RCRA solid waste management units (SWMUs) and they are currently inactive. These AOCs have undergone a desktop audit, which involves a thorough review and evaluation of all existing or easily obtainable documentation on the identified areas. Based on this evaluation, the Navy, EPA Region III, and MDE decided which AOCs should proceed to the SSP, and which AOCs will require no action and can be closed out. A summary of the results of the desktop audit appears in Table 1-2.

1.2.2 STUMP NECK ANNEX

In November 1980, IHDIV-NSWC submitted a RCRA Part A permit application to the EPA for designation of specific Stump Neck operations as hazardous waste management facilities with interim status. On October 6, 1981, EPA advised Naval Explosive Ordnance Technology Center (now NAVEODTECHDIV) that, pursuant to Section 3005 of RCRA regulations, the application did not demonstrate that the facility was required to have a permit under Section 3005 of the Act, and the application was returned. However, the EPA did issue an identification (EPA I.D. No. MD4170090001) and the state of Maryland subsequently issued an interim permit (No. A223A).

The 1983 IAS of 38 sites at IHDIV-NSWC had identified nine sites (Sites 30 through 38). These nine sites are listed below, are addressed as site screening areas and will continue under the SSP. The SSP will provide for a second evaluation, potentially including some additional sampling, to confirm the

presence or absence of contamination at the sites and the need for further action. Sites 30, 31, 33, 35, and 38 are currently part of an ongoing site screening field investigation. Sites 36 and 37 have progressed to the RI/FS phase and no further action has been recommended for Sites 32 and 34. Sites 30, 31, 35, and 37 have also been included in the Munitions Response Program.

Site 30	Stump Neck Impact Area
Site 31	Old Demolition Range
Site 32	Suspected Tool Burial Site
Site 33	Scrap Metal Pit
Site 34	Tool Burial Site
Site 35	Torpedo Burial Site
Site 36	Closed Landfill
Site 37	Causeway
Site 38	Rum Point Landfill

Because the facility was identified as a RCRA operating facility, the 1984 Hazardous and Solid Waste Amendments (HSWA) to RCRA authorized EPA to require corrective action for releases of hazardous waste or hazardous constituents from SWMUs and other AOCs. The first phase of the corrective action program, as established by EPA, is to conduct a RCRA Facilities Assessment (RFA). The RFA includes a preliminary review (PR) of all available relevant documents, and a visual site inspection (VSI). The EPA Office of RCRA Programs conducted a RCRA SWMU Investigation of the NAVEODTECHDIV at the NSWC-IHDIV and issued a final RCRA Facilities Assessment in April 1990. The RFA identified 24 SWMUs at the Stump Neck Annex:

SWMU 1	Rum Point Landfill
SWMU 2	Range 3 Burn Point
SWMU 3	Chicamuxen Creek's Edge Site A
SWMU 4	Chicamuxen Creek's Edge Site B
SWMU 5	Range 6
SWMU 6	Air Blast Pond
SWMU 7	Scrap Metal Pit
SWMU 8	Tool Burial Site
SWMU 9	Torpedo Burial Site
SWMU 10	Inactive Disposal Site
SWMU 11	Suspected Tool Burial Site
SWMU 12	Waste Oil Storage Site
SWMU 13	Pink Water Treatment Tank

SWMU 14	Photographic Lab Septic Tank System
SWMU 15	Spent Photographic Solution Storage
SWMU 16	Thermal Treatment Tank
SWMU 17	Building 2015 - Chem Lab Accumulation Area
SWMU 18	Waste Pile
SWMU 19	Disposal Area No. 1
SWMU 20	Disposal Area No. 2
SWMU 21	Drum Storage Area
SWMU 22	Stump Neck Impact Area
SWMU 23	Old Demolition Range
SWMU 24	Causeway

In December 1990, EPA issued a RCRA Permit for Corrective Action (effective January 24, 1991 and expiring on January 23, 2001). Of the 24 SWMUs, the following six SWMUs were required by permit conditions to undergo further investigation. SWMU 1 had previously been designated as Site 38 during the IAS. SWMUs 2 through 6 were assigned IR site numbers 58 through 62. Site 62 has also been included in the Munitions Response Program. The permit required verification investigations (VIs) at Sites 38, 60, and 62 and RCRA Facilities Investigations (RFI) at Sites 58, 59, and 61. Draft reports for these investigations were completed in January 1998. These sites are addressed as site screening areas, and information and conclusions from these draft reports will be used in the SSP.

Site 38	SWMU 1	Rum Point Landfill
Site 58	SWMU 2	Range 3 Burn Point
Site 59	SWMU 3	Chicamuxen Creek's Edge Site A
Site 60	SWMU 4	Chicamuxen Creek's Edge Site B
Site 61	SWMU 5	Range 6
Site 62	SWMU 6	Air Blast Pond

Pursuant to the requirements of the RCRA Corrective Action Permit, IHDIV-NSWC notified the EPA Region III RCRA Programs Branch in 1991 of three additional SWMUs that were not originally identified in the RFA but warranted further investigation. These three sites are listed below. These SWMUs were associated with operations of the Naval School Explosive Ordnance Disposal. The three “school” sites included Sites 63, 64, and 65 (SWMUs 25, 26, and 27), which became inactive with the relocation of the school in 1998. The Navy completed a VI report on the three sites in June 1996. The Navy will address these three sites as site screening areas, and will continue under the SSP. Sites 63 and 65 have also been included in the Munitions Response Program.

Site 63 SWMU 25 Area 8
Site 64 SWMU 26 IED
Site 65 SWMU 27 IOD

Areas of Concern (AOC)

In 1991, the Navy discovered a fourth SWMU (SWMU 30), which was associated with a dry well that was connected to a laboratory located in Building 2015. SWMU 30 and 10 of the 24 originally identified SWMUs were evaluated under the IR Program as AOCs. These ten SWMUs are listed below.

SWMU 12 Waste Oil Storage Site SWMU 13 Pink Water Treatment Tank
SWMU 14 Photographic Lab Septic Tank System,
SWMU 15 Spent Photographic Solution Storage
SWMU 16 Thermal Treatment Tank
SWMU 17 Building 2015 - Chem Lab Accumulation Area
SWMU 18 Waste Pile
SWMU 19 Disposal Area No. 1
SWMU 20 Disposal Area No. 2
SWMU 21 Drum Storage Area
SWMU 30 Building 2015 Dry Well

In 1992, IHDIV-NSWC notified EPA of two additional sites at the Stump Neck Annex, which later became SWMUs 28 and 29. Both of these units have been included in the Munitions Response Program.

SWMU 28 Old Skeet and Trap Range
SWMU 29 Small Arms Range (Pistol Range)

All 12 of the above AOCs were subjected to a desktop audit on November 28, 2001. The audit involved a thorough review of all existing or easily obtainable documentation/information on the identified areas. A total of 13 Stump Neck AOCs were included in the desktop audit.

The FFA officially incorporated the Stump Neck SWMUs from the RCRA Program into the IHDIV-NSWC CERCLA Program. This results from an FFA clause requiring that any cleanups needed for RCRA SWMUs due to past releases will be addressed under the FFA and CERCLA, but, otherwise, the SWMUs will be handled under RCRA. At this point, 2 SWMUs at the Stump Neck Annex are being addressed within the SSP to evaluate if any action needs to be taken at the sites. The remaining SWMUs have been evaluated under the IR Program as AOCs. As with the Main Area, these AOCs were subjected to a desktop evaluation, which involved a thorough review of all existing or easily obtainable

documentation/information on the identified areas. Based on this evaluation, decisions were made by the Project Managers as to which AOCs will proceed to the SSP, and which AOCs will require no action and can be closed out. Table 1-3 provides a summary of the results of the audit.

1.3 PURPOSE OF THE SITE MANAGEMENT PLAN

The SMP is intended to be a living document. It serves as a tool to support planning, scheduling, and budgeting future activities at sites located on the IHDIV-NSWC. The SMP will be updated annually, as required by the FFA.

In addition to providing a record of the milestones achieved in connection with each site, the SMP presents the anticipated milestones for the future work necessary to address the potential adverse impacts of contamination at each site.

1.4 FORMAT OF THE SITE MANAGEMENT PLAN

This SMP document is organized into four sections and three appendices. Section 1.0 presents a brief description of the IHDIV-NSWC, a summary of the facility's overall environmental history, and a description of the purpose of this document. Section 2.0 provides fact sheets for each site and AOC in the program. Each of the fact sheets presents a compilation of historical information and summarized data extracted from previously prepared studies and reports. All the documents supplying information to this SMP are listed in the References section located at the end of this document. Section 3.0 consists of 2 maps of the IHDIV-NSWC showing the approximate location of each of the sites discussed. Section 4.0 provides a schedule of future activities for the sites recommended for further action. The schedules present the sequence of activities anticipated to be necessary for the completion of critical steps in the IRP. Appendices A and B supplement the Site Location Map by presenting figures for each of the sites. Appendix A includes sites at the Main Area and Appendix B includes sites at the Stump Neck Annex. These figures offer a more detailed view of site locations and features in the immediate vicinity of the respective sites. Appendix C is a separately bound photographic log of photographs collected during a visit to the sites by Halliburton NUS personnel during January 1995 and is unchanged from its original publication. This photo log is organized by site number. Photographs are not currently available for all the sites.

TABLE 1-1

INSTALLATION RESTORATION (IR) SITES,
and SOLID WASTE MANAGEMENT UNITS (SWMUs)
MAIN AREA AND STUMP NECK
INDIV-NSWC,INDIAN HEAD, MARYLAND

IR Site ID	SWMU ID	Name of IR Site or Area of Concern	Main Area (MA)/ Stump Neck (SN)	Relative Risk	FFA Group	Status	Comments
		IR SITES					
1		Thorium Spill	MA	Low	SSA	SSP	
2		Waste Crank Case Oil Applied to Torrence Road	MA	Low	SSA	SSP	
3		Nitroglycerin Explosion, Nitration Building Area	MA	Low	SSA	SSP	
4		Lloyd Road Oil Spill Sites	MA	Low	SSA	SSP	
5		X-Ray Building 731	MA	Medium	SSA	NoA	
6		Building 1349, Hypo Spill	MA	High	RI/FS	RI/FS	
7		Building 682, HMX Spill	MA	Medium	SSA	SSP	
8		Building 766, Mercury Deposits	MA	High	SSA	RI/FS	
9		Patterson Avenue, Oil Spill	MA	Low	SSA	SSP	
10		Single-base Propellant Grains Spill	MA	Low	SSA	SSP	Included in MRP
11		Caffee Road Landfill	MA	High	RI/FS	RI/FS	Investigate with Main Area SWMUs 21 & 38
12		Town Gut Landfill	MA	High	RI/FS	RA	
13		Paint Solvents Disposal Ground	MA	High	RI/FS	NoA	
14		Waste Acid Disposal Pit	MA	High	SSA	RI/FS	
15		Mercury Deposits in Manhole, Fluorine Lab	MA	High	RI/FS	RI/FS	
16		Laboratory Chemical Disposal	MA	High	RI/FS	RI/FS	
17		Disposal Metal Parts Along Shoreline	MA	High	RI/FS	RI/FS	
18		Hog Island	MA	Low	SSA	SSP	
19		Catch Basins at Chip Collection Houses	MA	Low	SSA	SSP	
20		Single-base Powder Facilities	MA	Low	SSA	SSP	
21		Bronson Road Landfill	MA	High	RI/FS	RI/FS	
22		NG Slums Burning Site	MA	Low	SSA	SSP	Included in MRP
23		Hydraulic Oil Spill Discharges From Extrusion Plant	MA	Low	SSA	SSP	
24		Abandoned Drain Lines	MA	Medium	SSA	SSP	
25		Hypo Discharge X-Ray Building No. 2	MA	High	RI/FS	RI/FS	
26		Thermal Destructor 2	MA	Low	SSA	SSP	
27		Thermal Destructor 1	MA	Low	SSA	SSP	
28		Original Burning Ground	MA	High Medium	SSA	RI/FS	Included in MRP
29		The Valley	MA	Low	SSA	SSP	Included in MRP
30	22	Stump Neck Impact Area	SN	NE	SSA	SSP	Included in MRP
31	23	Old Demolition Range	SN	NE	SSA	SSP	Included in MRP
32	11	Suspected Tool Burial Site	SN	NE	SSA	NoA	
33	7	Scrap Metal Pit	SN	NE	SSA	SSP	
34	8	Tool Burial Site	SN	NE	SSA	NoA	
35	9	Torpedo Burial Site	SN	NE	SSA	SSP	Included in MRP
36	10	Closed Landfill	SN	NE	SSA	RI/FS	
37	24	Causeway	SN	NE	SSA	RI/FS	Included in MRP
38	1	Rum Point Landfill	SN	Medium	SSA	SSP	
39		Silver Release to Sediments	MA	High	RI/FS	RI/FS	

TABLE 1-1

INSTALLATION RESTORATION (IR) SITES,
and SOLID WASTE MANAGEMENT UNITS (SWMUs)
MAIN AREA AND STUMP NECK
INDIV-NSWC,INDIAN HEAD, MARYLAND
PAGE 2 OF 3

IR Site ID	SWMU ID	Name of IR Site or Area of Concern	Main Area (MA)/ Stump Neck (SN)	Relative Risk	FFA Group	Status	Comments
40		Palladium Catalyst in Sediments	MA	Low	RI/FS	RI/FS	
41		Scrap Yard	MA	High	RI/FS	RA	
42		Olsen Road Landfill	MA	High	RI/FS	RI/FS	
43		Toluene Disposal Site	MA	Low	RI/FS	RI/FS	
44		Soak Out Area	MA	Medium	RI/FS	NoA	
45		Abandoned Drums	MA	Medium	RI/FS	RI/FS	
46		Cadmium Sandblast Grit	MA	Low	RI/FS	RI/FS	
47		Mercuric Nitrate Disposal Area	MA	High	RI/FS	RI/FS	
48		Nitroglycerine Plant Disposal Area	MA	Low	RI/FS	RI/FS	
49		Chemical Disposal Area	MA	High	RI/FS	NoA	
50		Building 103, Crawl Space	MA	High	RI/FS	RI/FS	
51		Building 101, Dry Well	MA	NE		SSP	
52		Building 102, Dry Well	MA	NE		SSP	
53		Mercury Contamination of the Sewage System	MA	High	RI/FS	RI/FS	
54		Building 101	MA	High	RI/FS	RI/FS	
55		Building 102	MA	High	RI/FS	RI/FS	
56		IW87 - Lead Contamination	MA	Low	RI/FS	RI/FS	
57		TCE Building 292 Area	MA	High	RI/FS	RI/FS	
58	2	Range 3 Burn Point	SN	High	SSA	SSP	Investigate with Stump Neck SWMU 16
59	3	Chicamuxen Creek's Edge Site A	SN	High	SSA	SSP	
60	4	Chicamuxen Creek's Edge Site B	SN	Medium	SSA	SSP	
61	5	Range 6	SN	Medium	SSA	SSP	
62	6	Air Blast Pond	SN	Medium	SSA	SSP	Included in MRP
63	25	Area 8	SN	Medium	SSA	SSP	Included in MRP
64	26	IED (+SN SWMU 19)	SN	Medium	SSA	SSP	
65	27	IOD	SN	Medium	SSA	SSP	Included in MRP
		AREAS OF CONCERN					
	6	Used Battery Accumulation Area (Bldg. 766)	MA	NE	AOC	NoA	
	20	Safety Thermal Treatment Point	MA	NE	AOC	RI/FS	Included in MRP
	21	Caffee Road Decontamination Burn Point	MA	NE	AOC	RI/FS	Investigate with Site 11
	27	Waste Oil Storage Area (Goddard Power Plant)	MA	Low	AOC	NoA	
	38	Caffee Road Waste Oil Storage Area	MA	Low	AOC	RI/FS	Investigate with Site 11
	69	Temp Accumulation Dumpster for Explosive Scrap	MA	Low	AOC	NoA	
	70	Temp Accum Areas for Drummed Explosive Scrap	MA	Low	AOC	NoA	
	72	Oil/Water Separators	MA	Low	AOC	NoA	
	74	Unlined Overland Drainage Ditches	MA	Low	AOC	AOC	
	4,5	Underground Storage Tanks (Bldg. 290 and 525)	MA	NE	AOC	NoA	
	40-46	Wastewater Collection/Treatment Tanks (Moser Plant)	MA	Low	AOC	NoA	
	47-51	Spent Acid Storage/Treatment Tanks (Moser Plant)	MA	Low	AOC	NoA	
	64-66	Waste Water Storage Tanks (Bldg. 1596)	MA	Low	AOC	NoA	

TABLE 1-1

INSTALLATION RESTORATION (IR) SITES,
and SOLID WASTE MANAGEMENT UNITS (SWMUs)
MAIN AREA AND STUMP NECK
INDIV-NSWC,INDIAN HEAD, MARYLAND

IR Site ID	SWMU ID	Name of IR Site or Area of Concern	Main Area (MA)/ Stump Neck (SN)	Relative Risk	FFA Group	Status	Comments
	AOC G	Sand Blasting Sand Storage Area	MA	Low	AOC	NoA	
	AOC H	Drum at Fuel Storage Area	MA	Low	AOC	NoA	
	12	Waste Oil Storage Site	SN	NE	AOC	NoA	
	13	Pink Water Treatment Tank	SN	NE	AOC	RCRA	
	14	Photographic Lab Septic Tank System	SN	NE	AOC	AOC	
	15	Spent Photographic Solution Storage	SN	NE	AOC	NoA	
	16	Thermal Treatment Tank	SN	NE	AOC	RI/FS	Investigate with Site 58
	17	Bldg. 2015 – Chem Lab Accumulation Area	SN	NE	AOC	NoA	
	18	Waste Pile	SN	NE	AOC	NoA	
	19	Disposal Area #1	SN	NE	AOC	RI/FS	Investigate with Site 64
	20	Disposal Area #2	SN	NE	AOC	SSP	Investigate with Stump Neck SWMU 28
	21	Drum Storage Area	SN	NE	AOC	NoA	
	28	Old Skeet and Trap Range	SN	NE	AOC	SSP	Investigate with Stump Neck SWMU 20 Included in MRP
	29	Small Arms Range (Pistol Range)	SN	NE	AOC	AOC	Included in MRP
	30	Bldg. 2015 Dry Well	SN	NE	AOC	AOC	

AOC =Area of Concern
IR =Installation Restoration
MRP =Munitions Response Program
NE =Not Evaluated
NoA =No Action
RCRA =Resource Conversation and Recovery Act
RI/FS =Remedial Investigation/Feasibility Study
SSA =Site Screening Assessment
SSI =Site Screening Investigation
SSP =Site Screening Process
RA =Remedial Action

TABLE 1-2

SUMMARY OF DESKTOP AUDIT
MAIN AREA AREAS OF CONCERN (AOCs)
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

AOC	NAME	DECISION
Main Area SWMUs 4 and 5	Underground Storage Tanks (Buildings 290/525)	No action required
Main Area SWMU 6	Used Battery Accumulation Area (Building 290)	No action required
Main Area SWMU 27	Waste Oil Storage Area (Goddard Power)	No action required
Main Area SWMU 38	Caffee Road Waste Oil Storage Area	Investigate with Site 11 remedial investigation
Main Area SWMUs 40 – 46	Wastewater Collection/Treatment Tanks	No action required
Main Area SWMUs 47 –51	Spent Acid Storage/Treatment Tanks	No action required
Main Area SWMUs 64 – 66	Wastewater Storage Tanks (Building 1596)	No action required
Main Area SWMU 69	Temporary Dumpster for Explosive Scrap	No action required
Main Area SWMU 70	Temporary Areas for Drummed Explosive Scrap	No action required
Main Area SWMU 72	Oil/Water Separators	No action required
Main Area SWMU 74	Unlined Overland Drainage Ditches	Retain as an AOC pending further investigation
Main Area AOC G	Sand-Blasting Sand Storage Area	No action required
Main Area AOC H	Drum at Fuel Storage Area	No action required
Main Area SWMU 20	Safety Thermal Treatment Point	Conduct a remedial investigation
Main Area SWMU 21	Caffee Road Decontamination Burn Point	Investigate with Site 11 remedial investigation

TABLE 1-3

SUMMARY OF DESKTOP AUDIT
STUMP NECK ANNEX AREAS OF CONCERN (AOCs)
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

AOC	NAME	DECISION
Stump Neck SWMU 12	Waste Oil Storage Site	No action required
Stump Neck SWMU 13	Pink Water Treatment Tank	Manage under the RCRA program
Stump Neck SWMU 14	Photographic Lab Septic System	Retain as an AOC pending further investigation
Stump Neck SWMU 15	Spent Photographic Solution Storage	No action required
Stump Neck SWMU 16	Thermal Treatment Tank	Investigate with Site 58 remedial investigation
Stump Neck SWMU 17	Building 2015 – Chemical Lab Accumulation Area	No action required
Stump Neck SWMU 18	Waste Pile	No action required
Stump Neck SWMU 19	Disposal Area No. 1	Investigate with Site 64 remedial investigation
Stump Neck SWMU 20	Disposal Area No. 2	Investigate with Stump Neck SWMU 28
Stump Neck SWMU 21	Drum Storage Area	No action required
Stump Neck SWMU 28	Old Skeet and Trap Range	Investigate with the site screening process
Stump Neck SWMU 29	Small Arms Range (Pistol Range)	Retain as an AOC pending further investigation
Stump Neck SWMU 30	Building 2015 Dry Well	Retain as an AOC pending further investigation

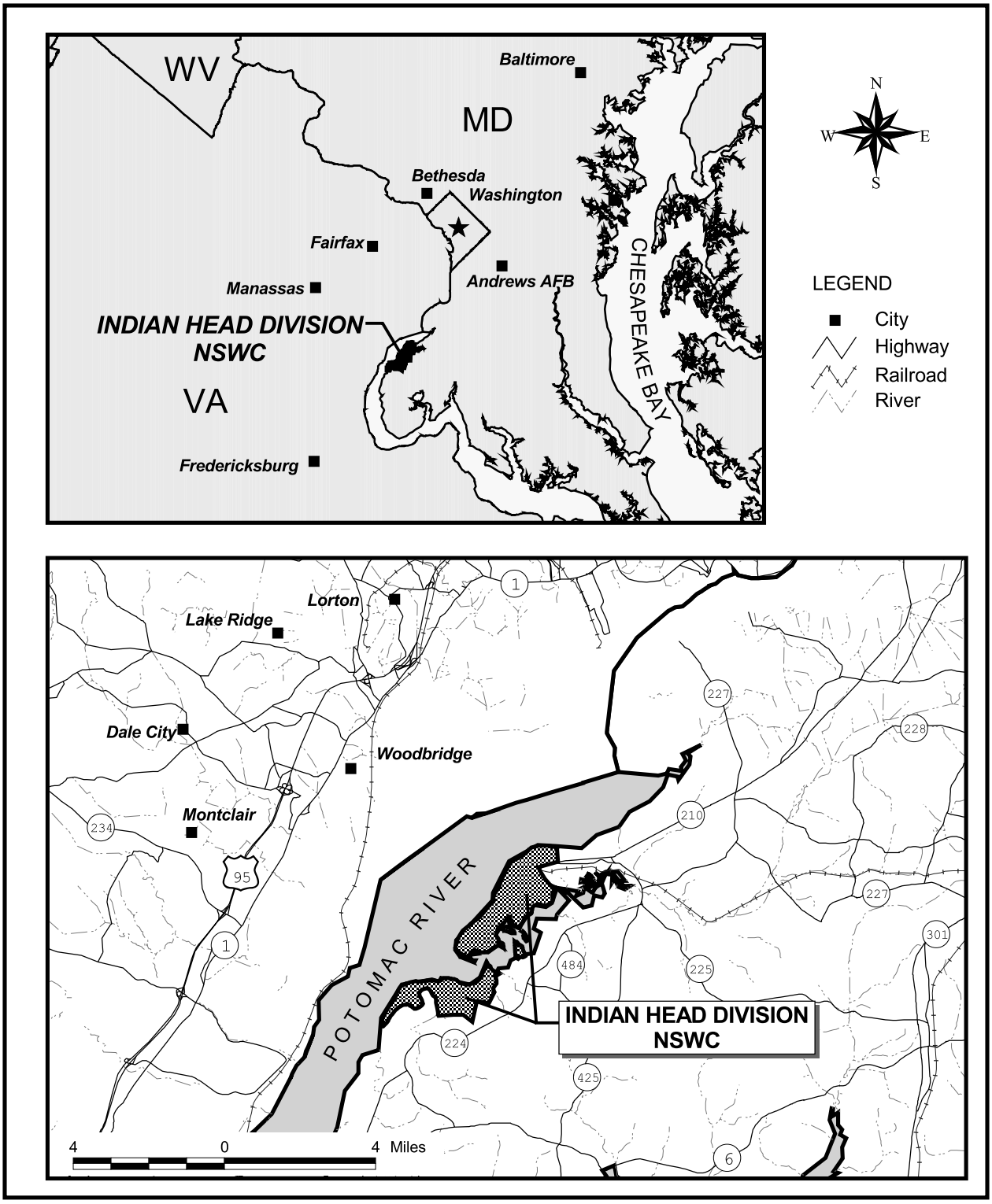

FIGURE 1-1

FACILITY LOCATION MAP
INDIAN HEAD DIVISION NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

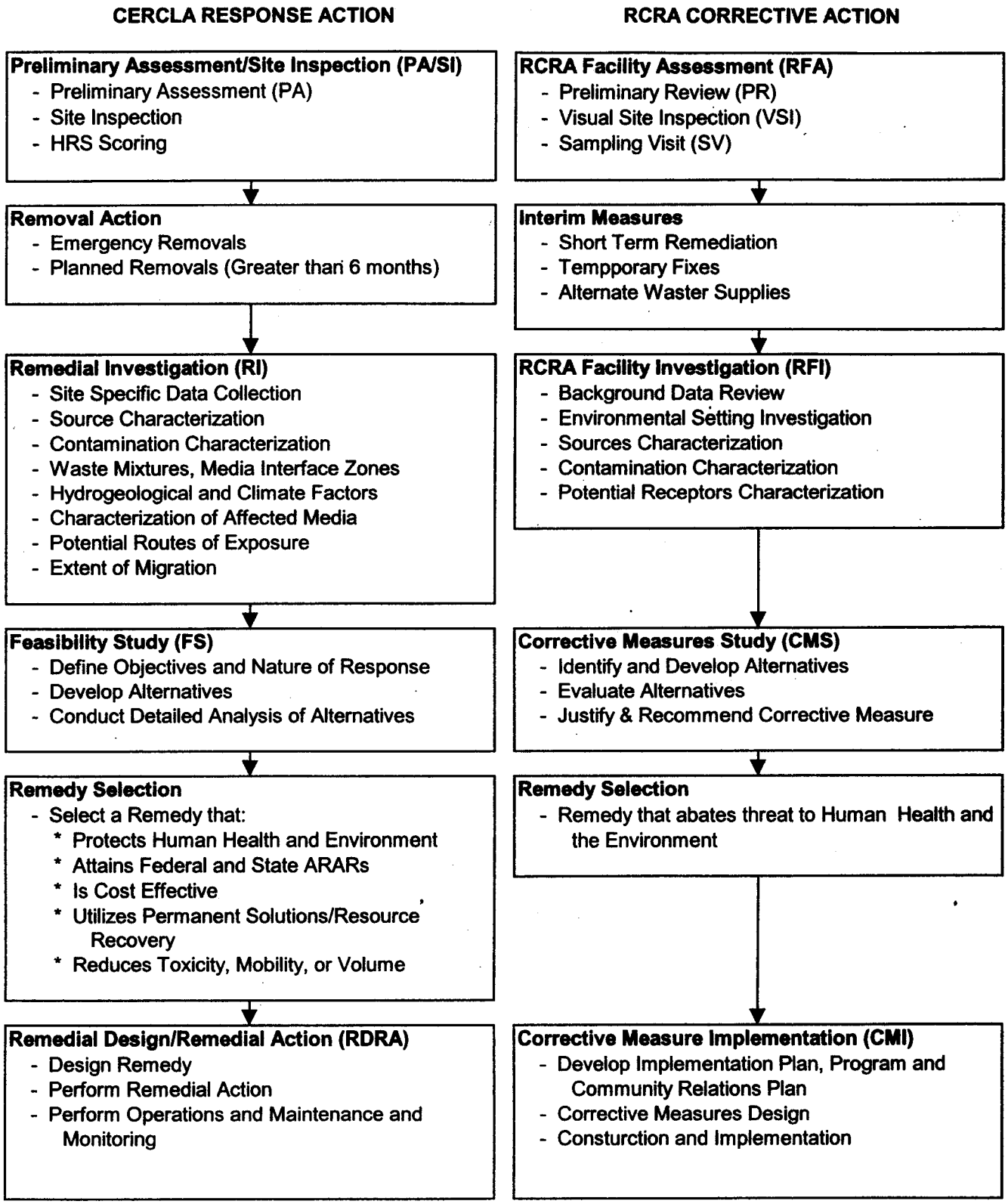

FIGURE 1-2

CERCLA PROCESS VS. RCRA PROCESS
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

2.0 SITE DESCRIPTIONS

Section 2.0 contains a series of fact sheets addressing each site's history, current conditions, recent investigative activity, and recommended future action. Section 2.0 contains limited historical information representing a compilation of historical documents. References from which the fact sheets were developed are listed in the bibliography at the end of this SMP.

Section 2.1 contains descriptions of the IR sites and AOCs located on the Main Area of IHDIV-NSWC. Section 2.2 contains descriptions of the IR sites and AOCs located at the Stump Neck Annex.

2.1 SITE DESCRIPTIONS – MAIN AREA

This section includes the fact sheets for the Main Area IR sites and AOCs.

THORIUM SPILL

(OLD MAP GRID C27)
IR Site 1
Fact Sheet

1. Contamination:

Thorium.

2. Location:

Special Weapons Disposal Building (Building 900).

3. From:

Potential thorium contamination from ordnance training session near Building 900.

4. When:

Date of training session is unknown.

5. Generated By:

Thorium items were used for ordnance training on the ground near Building 900. If these items were not completely removed after the training session, then these items may have contaminated the ground near Building 900.

6. Amount:

Unknown.

7. Work Completed:

The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a thorough survey and Confirmation Study be conducted prior to any excavation or change in land use.

8. Current Status:

Awaiting Initiation of Site Screening Process.

WASTE CRANK CASE OIL APPLIED TO TORRENCE ROAD

(OLD MAP GRID E17)
IR Site 2
Fact Sheet

1. Contamination:

Waste oil.

2. Location:

Torrence Road behind Building 290 (Public Works Department maintenance garage).

3. From:

Waste oil from Transportation Branch buildings was reportedly applied to unpaved roads for dust control.

4. When:

Prior to 1965.

5. Generated By:

Waste oils from the Transportation Branch buildings consisted of crankcase, hydraulic, transmission, and motor oils.

6. Amount:

The Transportation Branch buildings generated approximately 7,700 gallons annually.

7. Work Completed:

The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be conducted for Site 2.

8. Current Status:

Awaiting Initiation of Site Screening Process.

NITROGLYCERIN EXPLOSION , NITRATION BUILDING AREA

(OLD MAP GRID E17)
IR Site 3
Fact Sheet

1. Contamination:

Residual nitroglycerin.

2. Location:

Vicinity of Nitration Building, Building 1543.

3. From:

Explosion in former Nitration Building, Building 675.

4. When:

1971.

5. Generated By:

Explosion in former Nitration Building.

6. Amount:

Unknown

7. Work Completed:

The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be conducted for Site 3.

8. Current Status:

Awaiting Initiation of Site Screening Process.

LLOYD ROAD OIL SPILL SITES

(OLD MAP GRID E37)
IR Site 4
Fact Sheet

1. Contamination:

Waste Oil.

2. Location:

On Lloyd Road near the Public Works Department Maintenance garage area, Building 290.

3. From:

Waste oil spilled from a dumpster that was used to store waste petroleum.

4. When:

Prior to 1981.

5. Generated By:

Waste oil from the Public Works maintenance operations was deposited in a dumpster. Waste oil consisted of fuel oil, motor oil, and kerosene.

6. Amount:

Estimated to be 50 to 100 gallons.

7. Work Completed:

The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be conducted for this site.

8. Current Status:

Awaiting Initiation of Site Screening Process.

X-RAY BUILDING 731

(OLD MAP GRID F6, F7)
IR Site 5
Fact Sheet

1. Contamination:

Silver from spent fixer and developer.

2. Location:

Drainage swales behind Building 731 that flow to Mattawoman Creek.

3. From:

Discharge of spent fixer and developer for X-Ray film.

4. When:

1953 to 1965.

5. Generated By:

Fixer and developer are used to develop X-Ray film. Some of the silver, which is on the film, becomes "fixed" to the X-Ray and the remainder of the silver is washed off. Both the spent fixer and washwater, which contain silver, were discharged behind Building 731 into two separate swales.

6. Amount:

Up to 720 pounds of silver.

7. Work Completed:

a. The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program.

b. A Confirmation Study, the NACIP equivalent of an IR site inspection was completed in 1985 to determine if silver was actually present in the sediment at the site.

c. A removal action was performed on the eastern swale from November 1992 through January 1993. The silver-contaminated soil of the swale was removed, solidified, and stabilized, and then placed in an earthen berm.

d. A removal action was performed on the western swale from December 1994 through January 1995. The silver-contaminated soil of the swale was removed and placed in a borrow pit at Rum Point on Stump Neck Annex. The soil was covered with an impermeable layer of soil (clay), which was then covered with topsoil and reseeded.

e. A site screening assessment (SSA) field investigation was completed in 2001 and 2002. Groundwater monitoring wells were installed and sampled for a target compound list volatile and semivolatile organic compounds and target analyte list (TAL) metals. Sediment and surface water samples were collected in a portion of the western swale, which was previously not sampled, and analyzed for TAL metals.

8. Current Status:

The SSA report is currently undergoing Navy and regulatory review. The final SSA report is anticipated to be completed in July 2003.

HYPO SPILL, RADIOGRAPHIC FACILITY ACCELERATOR

CONTROL BUILDING, AND OPEN DRAIN
(OLD MAP GRID G3)
IR Site 6
Fact Sheet

1. Contamination:

Silver from spent fixer.

2. Location:

Drainage swales south of Buildings 1349 and 1140.

3. From:

Spill of fixer for X-Ray film during transfer of storage tank contents.

4. When:

Reportedly 1965 to 1977.

5. Generated By:

Fixer and developer are used to develop X-Ray film. Some of the silver, which is on the film, becomes "fixed" to the X-Ray, and the remainder of the silver is washed off.

6. Amount:

10 gallons.

7. Work Completed:

a. The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study should be conducted for Site 6 if the Site 5 study revealed a danger to aquatic life. Because Site 5 soil was determined to pose a threat to ecological receptors, it was determined that a remedial investigation (RI) should be conducted at Site 6.

b. RI fieldwork was completed at Site 6 in 2001. Surface soil, shallow subsurface soil, surface water, and shallow groundwater samples were collected and analyzed for silver.

8. Current Status:

The RI report is currently undergoing Navy and Regulatory review. The final RI report is expected to be completed in September 2003.

HMX SPILL, SLURRY MIX BUILDING

(OLD MAP GRID G17)
IR Site 7
Fact Sheet

1. Contamination:

Lead, HMX, phthalate esters, nitrate esters, amines, oil, and grease.

2. Location:

Slurry Mix Building, Building 682, and associated open drainage ditch, which flows to (IW10).

3. From:

Wastewater from dewatering HMX and building floor washdown.

4. When:

Between 1964 and 1968.

5. Generated By:

Facility processing procedures included dewatering HMX, which was purchased in a slurry form and dewatered in an eductor vacuum filter. Wastewater was discharged into the floor drain and from there to an open storm ditch, which flows to (IW10).

6. Amount:

168 pounds of HMX and 5 pounds of lead.

7. Work Completed:

The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 7.

8. Current Status:

Awaiting Initiation of Site Screening Process.

MERCURY CONTAMINATION FROM BUILDING 766

(OLD MAP GRID G-20)
IR Site 8
Fact Sheet

1. Contamination:

Mercury.

2. Location:

The drainage system from Building 766, which included a stormwater manhole, a ditch, and a pond that discharges into Mattawoman Creek.

3. From:

Lab operations.

4. When:

1958 to 1981.

5. Generated By:

During sensitivity tests, nitrometer bulbs, which contained mercury, sometimes exploded under pressure. After testing, the spent mercury, which also contained sulfuric acid, was poured into a "slop jar." Tap water was run into the jar to remove the sulfuric acid from the mercury. Small spills from transferring mercury to the slop jar were common. Jars of mercury often broke during rinsing in the sink.

6. Amount:

Estimates range from 23 to 500 pounds of elemental mercury.

7. Work Completed:

a. The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program.

b. A Confirmation Study, the NACIP equivalent of an IR Site Inspection was completed in 1985 to determine if mercury was actually present in the sediment at the site.

c. While construction work was being performed in the area of Building 766 in 1985, the contractor inadvertently broke the drain pipe leading from the building to a manhole. Mercury was discovered in the pipe and ground at the site of excavation. Approximately 200 drums of mercury-contaminated soil were removed from the area near the manhole and properly disposed.

d. The floor drains were sealed shut with concrete, and sink drains were re-routed to the sewage treatment system. In addition, mercury traps were placed on the drains to collect any mercury that may inadvertently enter the drain.

e. A Confirmation Study was performed in 1985 to determine the extent of mercury contamination throughout the ditch. The mercury in the soil was present in the highest concentration directly under the pipe which discharges into the ditch. The mercury concentrations then decreased downstream from the pipe. The Confirmation Study recommended monitoring mercury levels over a 5-year period. Water monitoring samples taken between the pond and Mattawoman Creek did not indicate any movement of the mercury.

f. The U.S. Fish and Wildlife Service sampled fish in Mattawoman Creek for the 5-year period ending in 1991 to determine if fish were bioaccumulating mercury. Fish upstream from the entrance location to the creek have been sampled to determine background levels of mercury within the fish. The background level is the amount of mercury that is normally found in the fish. The U.S. Fish and Wildlife Service has also sampled fish downstream from the entrance location to the Creek to determine if the levels are different. In the past, fish downstream were found to contain mercury at a level slightly higher than those upstream. The latest report from the U.S. Fish and Wildlife Service indicates that the mercury levels in both the fish upstream and downstream from IR Site 8 contain equivalent levels of mercury. Mercury levels of the fish from both areas, however, have been within regulatory limits.

g. A potential problem with IR Site 8 is the transport of mercury downstream through entrainment, especially during storm events, such as heavy rains. With the installation of a weir in June 1992, the tidal pond acts as a natural sediment basin. The weir provides additional settling time to ensure that any sediment that has flowed from the upper section of the stream into the pond will not exit into Mattawoman Creek.

h. Approximately 200 water and sediment samples were taken from the ditch, the pond, and Mattawoman Creek during the week of August 24, 1992 to better characterize the location and extent of mercury in the drainage system. Based on the sample results, an Engineering Evaluation/ Cost Analysis (EE/CA) was prepared to determine the best alternative to be taken to ensure protection of human health and the environment. The alternative recommended in the EE/CA was to remove the area of highest mercury contamination. This area, the upper section of the stream, could be considered a source to the receptor (tidal pond) downstream, it was approximately 300 feet in length, and it contained mercury at concentrations above 10 parts per million (ppm).

i. In October 1992, a biomonitoring program was initiated to determine the effect of mercury on the biota (plant and animal life) in the tidal pond. The results of the study did not show any adverse affects on the biota of the pond due to the mercury.

j. In June 1994, the removal action was begun to remove the mercury-contaminated sediment in the first 300 feet of the ditch, as recommended in the EE/CA. The soil that was removed was placed in the soil cover of an explosives storage magazine, Building 606. The soil was capped with clay and then topsoil and was reseeded. This work was completed in December 1994.

8. Current Status:

Awaiting Initiation of Site Screening Process.

PATTERSON AVENUE, OIL SPILL

(OLD MAP GRID G37)
IR Site 9
Fact Sheet

1. Contamination:

Fuel Oil.

2. Location:

South of Building 320.

3. From:

Spill of fuel oil from a tanker truck.

4. When:

Circa 1958.

5. Generated By:

Spill of fuel oil from a tanker truck.

6. Amount:

10,000 gallons.

7. Work Completed:

The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 9.

8. Current Status:

Awaiting Initiation of Site Screening Process.

SINGLE-BASE PROPELLANT GRAINS SPILL AREA

(OLD MAP GRID I37 TO I39; O37 TO O39)
IR Site 10
Fact Sheet

1. Contamination:

Nitrocellulose propellant grains.

2. Location:

14-acre site near the Powder Dry Houses.

3. From:

Spill of NC grains during railroad transportation.

4. When:

Estimated between 1900 and 1957.

5. Generated By:

Spill of NC grains during railroad transportation.

6. Amount:

Unknown.

7. Work Completed:

The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 10.

8. Current Status:

Awaiting Initiation of Site Screening Process.

Included in the Munitions Response Program as site UXO 000009.

CAFFEE ROAD LANDFILL

(OLD MAP GRID K6, L6)
IR Site 11
Fact Sheet

1. Contamination:

Metals and polynuclear aromatic hydrocarbons (PAHs) from disposal and burning of bulk metals items.

2. Location:

Terminus of Caffee Road, from east of Building 1608 to the unnamed creek discharging to the Mattawoman Creek on the west side of the site.

3. From:

Disposal of building debris bulk metal items, open burning residues, and bulk metal items.

4. When:

Unknown.

5. Generated By:

Disposal and open burning of various wastes.

6. Amount:

Unknown.

7. Work Completed:

a. The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program.

b. In late 1980, NSWC removed approximately 5,000 to 6,000 cubic yards of deposited material. This material was primarily flashed metal parts and dunnage, which were removed by a private contractor for off-station disposal.

c. Initial remedial investigation (RI) fieldwork was completed in 2000. Surface soil, subsurface soil, sediment, surface water and groundwater samples were collected in the area of waste disposal and analyzed for target compound list (TCL) volatile and semivolatile organic compounds (VOCs and SVOCs) and target analyte list (TAL) metals.

d. Further historical information was obtained indicating the presence of four open burning pits on the eastern side of the area initially investigated. Additional RI sampling of surface and subsurface soils, sediment, surface water and groundwater for TCL, VOCs, SVOCs, and TAL metals was conducted on the eastern side of the site in 2002.

8. Current Status:

Continuation of the Remedial Investigation/Feasibility Study phase.

The RI report is currently undergoing regulatory review. The final RI report is anticipated to be completed in August 2003. The RI recommended that a feasibility study be performed.

TOWN GUT LANDFILL

(OLD MAP GRID K-22)
IR Site 12
Fact Sheet

1. Contamination:

Construction debris, including scrap metal, empty cans, and drums containing paint and varnish residue, demolition debris, such as asphalt, concrete, and rubble, possible chemical waste

2. Location:

Approximately 4 acres bisected by Atkins Road extension (northwest of Building 471).

3. From:

Disposal of landscaping waste, fill material, rubble, and construction debris.

4. When:

1968 to 1980.

5. Generated By:

Disposal of various wastes.

6. Amount:

Unknown.

7. Work Completed:

a. The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program.

b. A Confirmation Study, the NACIP equivalent of an IR site inspection was completed in 1985 to determine if contamination was actually present at the site. Low levels of metals were found in the sediment at this site. The Confirmation Study recommended monitoring the site for 5 years to ensure that no contamination is migrating from the landfill.

c. The 5-year monitoring results did not show that any contamination is migrating from this area.

d. A remedial investigation report for Site 12 was completed in July 1999. The report determined that the human health risk for non-residential scenarios is within acceptable limits. The document identified a potential ecological risk in connection with surface soil contamination. The document recommended a feasibility study report to evaluate alternatives that would address the ecological risk, as well as the State of Maryland requirements for closing landfills.

e. A feasibility study was completed in January 2001. The study developed several potential remedial alternatives, including one requiring total landfill removal and others involving various capping scenarios combined with institutional controls.

f. A Proposed Plan was completed in January 2001. The preferred remedial alternative presented in the document provided for covering the landfill with a 2-foot-thick soil cover.

g. A public meeting was held on January 23, 2001 to present the Proposed Plan to the public.

h. Completion of the final design documents occurred in February 2002.

i. Due to unresolved issues related to Land Use Controls between the EPA and the Navy with respect to Records of Decision (RODs), an Engineering Evaluation and Cost Analysis was prepared in June 2002. On June 27, 2002 an Action Memorandum was signed describing a Removal Action to be performed at this site, which consists of covering the landfill with a 2-foot thick soil cover.

j. Construction of the Removal Action began in September 2002.

k. The Record of Decision will be modified to state that the Removal Action has been completed and will incorporate any changes required by the resolution of the LUC issue between the EPA and the Navy.

8. Current Status:

Awaiting completion of construction in May 2003.

Long-Term Monitoring contract expected to be awarded in June 2003.

PAINT SOLVENTS DISPOSAL GROUND

(OLD MAP GRID K31)
IR Site 13
Fact Sheet

1. Contamination:

Kerosene, mineral spirits, lacquer thinners, and solvents.

2. Location:

200-square-foot depressed area located 50 feet behind the Paint Shop, Building 870.

3. From:

Dumping of thinners, solvents, and spent paint behind the building.

4. When:

Between 1953 and 1979.

5. Generated By:

Shop activities included painting various items by hand, aerosol sprays, or in paint spray booths, and wastes were generated during paint equipment cleaning operations.

6. Amount:

Up to 20,000 pounds of waste.

7. Work Completed:

a. The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 13.

b. Fieldwork for a Remedial Investigation (RI) was completed in 2000. Surface and subsurface soil samples were collected and analyzed for target compound list volatile and semivolatile organic compounds and target analyte list metals.

8. Current Status:

The RI report is currently undergoing regulatory review. The final RI report is anticipated to be completed in August 2003. No human health or ecological risks that require remediation were identified, therefore no further action is planned at this site.

WASTE ACID DISPOSAL PIT

(OLD MAP GRID L33)
IR Site 14
Fact Sheet

1. Contamination:

Waste acids and other chemicals.

2. Location:

15 to 20-foot-deep disposal pit located 50 feet northeast of the Solvent Storehouse (Building 881) and 75 feet northwest of the Test Paper Manufacturing building (Building 444).

3. From:

Dumping of waste acids and other chemicals.

4. When:

Until 1975.

5. Generated By:

Waste acids and other chemicals were collected from these and other buildings.

6. Amount:

Unknown.

7. Work Completed:

a. The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 14.

b. The acid pit was believed to be found under the chemical disposal pit during the investigation of the Lab Area. In order to obtain samples from under the chemical disposal pit, it had to be removed, which revealed a concrete and brick structure resembling descriptions of the waste acid pit.

8. Current Status:

The RI report is currently undergoing Navy and regulatory review. The final RI report for the Lab Area is expected to be completed in July 2003, and is expected to be followed by a feasibility study.

MERCURY DEPOSITS IN MANHOLE, FLUORINE LAB

(OLD MAP GRID L34)
IR Site 15
Fact Sheet

1. Contamination:

Mercury, lead, and oil/grease.

2. Location:

Manhole located 100 feet from Building 502.

3. From:

Disposal of laboratory wastewater into storm sewer.

4. When:

1942 to 1981.

5. Generated By:

Wastewater from laboratory activities in Buildings 502 and 103.

6. Amount:

Up to 1 pound of mercury and 64 pounds of lead.

7. Work Completed:

a. The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 15.

b. This site is included in the "Lab Area" grouping of sites. Remedial investigation (RI) fieldwork was completed at the Lab Area in 2001. Surface and shallow subsurface soil, sediment and surface water samples were collected in the Lab Area and analyzed for target analyte list metals, target compound list volatile and semivolatile organic compounds, and an expanded list of explosives.

8. Current Status:

The RI report is currently undergoing Navy and regulatory review. The final RI report for the Lab Area is expected to be completed in July 2003 and is expected to be followed by a feasibility study.

LABORATORY CHEMICAL DISPOSAL

(OLD MAP GRID K34)
IR Site 16
Fact Sheet

1. Contamination:

Acids, amines (RNH_3), cyanide compounds, metals, and chlorinated and nonchlorinated solvents.

2. Location:

Wastewater collection system within the Research and Development Building (Building 600).

3. From:

Disposal of laboratory chemicals into wastewater system.

4. When:

1944 to present.

5. Generated By:

Wastewater from laboratory activities in Building 600.

6. Amount:

Unknown.

7. Work Completed:

a. The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 16.

b. This site is included in the "Lab Area" grouping of sites. An RI field investigation was completed at the Lab Area in 2001. Surface and shallow subsurface soil, sediment and surface water samples were collected in the Lab Area and analyzed for target analyte list metals, target compound list volatile and semivolatile organic compounds, and an expanded list of explosives.

8. Current Status:

The RI report is currently undergoing Navy and regulatory review. The final RI report for the Lab Area is expected to be completed in July 2003 and is expected to be followed by a feasibility study.

DISPOSED METAL PARTS ALONG SHORELINE

(OLD MAP GRID M 6, 7, 8 and L 5)
IR Site 17
Fact Sheet

1. Contamination:

Rocket motor casings, shipping containers, empty drums, solvents, and various metal parts.

2. Location:

A 1,000-foot stretch of shoreline east of the Decontamination Burning Point, along Mattawoman Creek and extending back approximately 100 feet from the shoreline in the wooded area near Building 1569.

3. From:

Disposal of metal parts and drums in the adjacent wooded area.

4. When:

From 1960 to about 1980.

5. Generated By:

Disposal of metal parts and drums in the adjacent wooded area.

6. Amount:

Unknown.

7. Work Completed:

a. The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 17.

b. Initial remedial investigation (RI) fieldwork was completed in 2000. Surface soil, subsurface soil, sediment, surface water and groundwater samples were collected in the metal parts and drum disposal areas and analyzed for target compound list (TCL) volatile and semivolatile organic compounds (VOCs and SVOCs) target analyte list metals, and an expanded list of explosives.

c. Additional pre-feasibility study field investigation was conducted in 2002. Groundwater and surface water samples were collected and analyzed for TCL VOCs.

d. Exposed drums located throughout the site were removed in April 2003.

8. Current Status:

The RI report is currently undergoing regulatory review. The final RI report is anticipated to be completed in August 2003. The RI recommended that a feasibility study be performed.

HOG ISLAND

(OLD MAP GRID M20)
IR Site 18
Fact Sheet

1. Contamination:

Grit and sludge.

2. Location:

1.8-acre site situated 600 feet southwest of Building 474, near Atkins Road.

3. From:

Depositing grit/sludge in the marshy area near Hog Island.

4. When:

Unknown.

5. Generated By:

Sewage treatment plant grit chambers, primary tanks, or sludge drying beds.

6. Amount:

Unknown.

7. Work Completed:

The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 18.

8. Current Status:

Awaiting Initiation of Site Screening Process.

CATCH BASINS AT CHIP COLLECTION HOUSES

(OLD MAP GRID M26 AND M28)
IR Site 19
Fact Sheet

1. Contamination:

Wastewater contaminated with lead and copper salts.

2. Location:

Catch basins of the Chip Collection Houses (Buildings 1051 and 785).

3. From:

Wastewater contaminated with lead and copper salts.

4. When:

Unknown.

5. Generated By:

Wastewater generated from the Chip Collection Houses (Building 1051 and 785).

6. Amount:

Unknown.

7. Work Completed:

The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 19.

8. Current Status:

Awaiting Initiation of Site Screening Process.

SINGLE-BASE POWDER FACILITIES

(OLD MAP GRID M35 TO N33)
IR Site 20
Fact Sheet

1. Contamination:

Suspected PCBs.

2. Location:

Single-base Powder Facilities.

3. From:

Leaks from PCBs from transformer switches.

4. When:

Circa 1940s.

5. Generated By:

PCBs from transformer switches.

6. Amount:

Unknown.

7. Work Completed:

The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 20.

8. Current Status:

Awaiting Initiation of Site Screening Process.

BRONSON ROAD LANDFILL

(OLD MAP GRID N21 AND O21)
IR Site 21
Fact Sheet

1. Contamination:

Solid waste including various quantities of paint sludges, asbestos, barium sulfate, zinc, and lead.

2. Location:

2-acre abandoned borrow pit located near the terminus of Bronson Road, directly across the street from Building 1384.

3. From:

Dumping of solid waste from facilities in the explosives manufacturing area.

4. When:

Between 1975 and 1982.

5. Generated By:

Solid waste from facilities in the explosives manufacturing area.

6. Amount:

Up to 1500 tons of solid waste, 2.5 tons of barium sludge, 3.3 tons of asbestos, and 3 tons of paint sludge.

7. Work Completed:

a. The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 21.

b. Initial remedial investigation (RI) fieldwork was completed in 2000. Surface soil and groundwater samples were collected and analyzed for target compound list (TCL) volatile and semivolatile organic compounds (VOCs and SVOCs), target analyte list (TAL) metals, and an expanded list of explosives.

c. An additional pre-feasibility study field investigation was conducted in 2002. Groundwater samples were collected and analyzed for TCL VOCs, TAL metals, and explosives.

d. The installation and sampling of monitoring wells was completed in January 2003. High detections of perchlorate were found in MW 04. It was later determined that the perchlorate is not associated with the landfill based on probable ground water flow direction and that the source is off-site.

8. Current Status:

The RI report is currently undergoing regulatory review. The final RI report is anticipated to be completed in August 2003. The RI recommended that a feasibility study be performed.

NG SLUMS BURNING SITE

(OLD MAP GRID O12)
IR Site 22
Fact Sheet

1. Contamination:

Nitroglycerin slums.

2. Location:

50-foot-wide strip along the shoreline of the Greenslade Road Peninsula and Mattawoman Creek.

3. From:

Spills of nitroglycerin slums during burning.

4. When:

Late 1940s until 1953.

5. Generated By:

Nitroglycerin slums from nitroglycerin plant production.

6. Amount:

Unknown.

7. Work Completed:

The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 22.

8. Current Status:

Awaiting Initiation of Site Screening Process.

Currently designated as Munitions Response Program site UXO 000006.

HYDRAULIC OIL DISCHARGES FROM EXTRUSION PLANT

(OLD MAP GRID P24)
IR Site 23
Fact Sheet

1. Contamination:

Hydraulic oil.

2. Location:

Press lines (Buildings 561 and 564).

3. From:

Discharge of wastewater containing hydraulic oil to the Mattawoman Creek via IW18.

4. When:

1943 until 1981.

5. Generated By:

Wastewater used to cool pumps and press dies.

6. Amount:

Unknown.

7. Work Completed:

The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 23.

8. Current Status:

Awaiting Initiation of Site Screening Process.

ABANDONED DRAIN LINES

(OLD MAP GRID O35, 37, 38)
IR Site 24
Fact Sheet

1. Contamination:

Acid water and nitrocellulose (NC) white water.

2. Location:

Abandoned drain lines from former NC production facilities.

3. From:

Discharge of neutralized acid water and NC white water to Mattawoman Creek.

4. When:

Unknown.

5. Generated By:

Production of NC, which used cotton liners, nitric acid, and sulfuric acid. NC, which is practically insoluble in water, may have deposited in abandoned drain lines located near the old NC Plant site.

6. Amount:

Unknown.

7. Work Completed:

The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 24.

8. Current Status:

Awaiting Initiation of Site Screening Process.

HYPO DISCHARGES FROM X-RAY BUILDING NO. 2

(OLD MAP GRID P27)
IR Site 25
Fact Sheet

1. Contamination:

Silver from spent fixer and developer.

2. Location:

Drainage swales behind Building 588, which flow to the Mattawoman Creek.

3. From:

Discharge of spent fixer and developer for X-Ray film.

4. When:

1944 to 1964.

5. Generated By:

Fixer and developer are used to develop X-Ray film. Some of the silver, which is on the film, becomes "fixed" to the X-Ray, and the remainder of the silver is washed off. Both the spent fixer and washwater, which contain silver, were discharged behind Building 588 and into IW46.

6. Amount:

Estimated 864 pounds of silver.

7. Work Completed:

a. The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a confirmation study be conducted at Site 25 if the study at Site 5 indicated a danger to aquatic life.

b. Initial remedial investigation (RI) fieldwork was completed in 2000. Surface soil, shallow subsurface soil, and groundwater samples were collected and analyzed for target compound list (TCL) volatile and semivolatile organic compounds (VOCs and SVOCs), target analyte list (TAL) metals, and nitroglycerin.

c. Additional RI sampling was conducted in 2002. Groundwater samples were collected and analyzed for TAL metals.

8. CURRENT STATUS:

The RI report is currently undergoing regulatory review. The final RI report is anticipated to be completed in August 2003. The RI recommends no further action for this site.

THERMAL DESTRUCTOR 2

(OLD MAP GRID P30)
IR Site 26
Fact Sheet

1. Contamination:

Hydrazine fuel and unsymmetrical dimethyl hydrazine (UDMH)-contaminated water.

2. Location:

Thermal Destructor 2 facility (Building 1595).

3. From:

Spills of hydrazine- and UDMH-contaminated water at the incinerator.

4. When:

1976 until 1978.

5. Generated By:

Thermal destruction of hydrazine- and UDMH-contaminated water.

6. Amount:

1.3 million pounds per year of hydrazine- and UDMH-contaminated water was treated in the incinerator. An unknown quantity of this wastewater may have spilled in the vicinity of the site.

7. Work Completed:

The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 26.

8. Current Status:

Awaiting initiation of Site Screening Process.

THERMAL DESTRUCTOR 1

(OLD MAP GRID S32)
IR Site 27
Fact Sheet

1. Contamination:

Hydrazine-contaminated water.

2. Location:

Thermal Destructor 1 facility (Building 1584).

3. From:

Spills of hydrazine-contaminated water at the incinerator.

4. When:

1976 until 1979.

5. Generated By:

Thermal destruction of hydrazine-contaminated water.

6. Amount:

1.3 million pounds per year of hydrazine-contaminated water was treated in the incinerator. An unknown quantity of this wastewater may have spilled in the vicinity of the site.

7. Work Completed:

The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 27.

8. Current Status:

Awaiting Initiation of Site Screening Process.

ORIGINAL BURNING GROUND

(OLD MAP GRID S36, 37)
IR Site 28
Fact Sheet

1. Contamination:

Smokeless powder and zinc.

2. Location:

1.8-acre site on southeastern corner of base along Mattawoman Creek.

3. From:

Open burning of materials and operation of a zinc recovery furnace.

4. When:

Burning estimated between 1890 and 1942; zinc recovery estimated between 1928 and the mid-1950s.

5. Generated By:

Burning of waste materials from base manufacturing, and residual contamination from the zinc recovery process.

6. Amount:

Unknown.

7. Work Completed:

a. The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 28.

b. Soil samples were collected at the site in 1993 and analyzed for soil texture, pH, and fertility. Elevated levels of zinc were detected.

c. Sampling off shore of this site was performed during the Toxicity Identification Evaluation Study in 2000 and the Mattawoman Creek Study in 2001. Both studies confirmed elevated levels of zinc in the sediment.

8. Current Status:

The Remedial Investigation filedwork began in May 2003.

IR is focusing on zinc recovery furnace and the original burning area has been designated as MRP site UXO 000008.

THE VALLEY

(OLD MAP GRID A37, B37, C37)
IR Site 29
Fact Sheet

1. Contamination:

Exploded ordnance.

2. Location:

Naturally occurring valley along Torrence Road for ½ mile beginning at the Potomac River, northwest of Building 54.

3. From:

Firing of shells into butts in the valley walls.

4. When:

From 1891 to 1921.

5. Generated By:

Firing of shells into butts in the valley walls.

6. Amount:

Unknown.

7. Work Completed:

The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. NACIP is the former name of the Navy Installation Restoration (IR) Program and the IAS is equivalent to the Preliminary Assessment portion of the IR Program. The IAS recommended that a Confirmation Study not be performed for Site 29.

8. Current Status:

Awaiting Initiation of Site Screening Process.

Currently designated as Munitions Response Program site UXO 000011.

SILVER RELEASE TO SEDIMENTS

(OLD MAP GRID P29)
IR Site 39
Fact Sheet

1. Contamination:

Elemental silver and possibly silver nitrate, dinitropropanol, ethylene dichloride, methyl chloride, formaldehyde, unsymmetrical dimethylhydrazine (UDMH), and nitroguanidine (NQ).

2. Location:

Area surrounding Building 497.

3. From:

Production of bis-2,2-dinitropropyl acetal/formal and explosives.

4. When:

Releases to Mattawoman Creek 1961 to 1965; stack emissions 1942 to 1994.

5. Generated By:

Release of silver and silver nitrate during production of acetal/formal. Silver nitrate was used as a catalyst in the production of acetal/formal, a plasticizer, or propellant binder, used in Polaris rocket motors. In the reaction, the silver nitrate catalyst was converted to elemental silver. The silver was recovered from the reaction vessel and returned to the supplier to undergo nitration back to silver nitrate. However, interviews with Navy personnel revealed that a significant amount of silver, as well as the other chemicals listed above, may have entered the creek through spills and human error, such as valves mistakenly left open. Additional releases may have occurred from the stacks on Buildings 497 and 498. Emissions from these stacks may have contaminated surface soils in the surrounding areas, however the quantity of contaminants that may have been discharged is unknown.

6. Amount:

Unknown.

7. Work Completed:

a. A site inspection under the Navy Installation Restoration (IR) Program was conducted as recommended by the Preliminary Assessment to determine if contamination is actually present. This inspection included taking four ponar grab samples from the top sediment of the Mattawoman Creek and two sediment samples in the creek near Industrial Wastewater Outfall 05 (IW05). These samples were analyzed for acetal/formal, pelletized nitrocellulose, unsymmetrical dimethyl hydrazine, high bulk density nitroguanidine, and Target Compound List volatile organic compounds and semi-volatile organic compounds. Subsequent investigation of the sediments near IW05 is being conducted under the ongoing Mattawoman Creek study.

b. Because the site inspection did not address potential stack emissions, a remedial investigation (RI) is underway at Site 39. RI fieldwork was completed in 2001. Surface and shallow subsurface soil samples were collected and analyzed for semivolatile organic compounds (SVOCs), target analyte list metals, and an expanded list of explosives.

8. Current Status:

The RI report is currently undergoing Navy and regulatory review. The final RI report is anticipated to be completed by July 2003.

PALLADIUM CATALYST IN SEDIMENT

(OLD MAP GRID P29)
IR Site 40
Fact Sheet

1. Contamination:

Palladium.

2. Location:

Mattawoman Creek southeast of Building 497.

3. From:

Production of Unsymmetrical-Dimethylhydrazine (UDMH).

4. When:

1974 and 1975.

5. Generated By:

Release of palladium, a catalyst used in the production of UDMH. Forty percent of the catalyst purchased by the NAVORDSTA was lost and cannot be accounted for. Therefore, it is possible that this catalyst entered Mattawoman Creek.

6. Amount:

Based on the 40% estimated loss of the total palladium purchased, the total amount of palladium that may have entered the creek is 88 pounds.

7. Work Completed:

A preliminary assessment was performed but a site inspection (SI) was not recommended under the Navy Installation Restoration Program because palladium is not a regulated hazardous substance. However, an SI was performed to ensure that a problem does not exist. This inspection included taking four ponar grab samples from the top sediment of Mattawoman Creek and two sediment samples in the Creek near the wastewater outfall, which is no longer in use. These samples were analyzed for palladium.

8. Current Status:

Further study at this site was not recommended in the SI. However, this site will continue to the Remedial Investigation/Feasibility Study phase.

SCRAP YARD

(OLD MAP GRID R31, S31)
IR Site 41
Fact Sheet

1. Contamination:

Arsenic, iron, lead, and polychlorinated biphenyls (PCBs).

2. Location:

Scrap yard west of Building 436.

3. From:

Storage of PCB and PCB-contaminated transformers. By definition, PCB transformers contain oil with greater than 500 parts per million (ppm) of PCBs, and PCB-contaminated transformers contain oil within 50 to 500 ppm PCBs.

4. When:

From the 1960s to 1988.

5. Generated By:

Before Building 1440 was dedicated to the storage of removed PCB equipment, transformers containing PCBs were stored at the Scrap Yard. Transformers, some in poor condition, which leaked PCB oil on the ground, were stored at the northwestern end of the Scrap Yard near Mattawoman Creek.

6. Amount:

Unknown.

7. Work Completed:

a. A Site Inspection under the Navy Installation Restoration Program was conducted as recommended in the Preliminary Assessment to determine if contamination is actually present. Soil and groundwater samples along with sediment samples from Mattawoman Creek were collected and analyzed for target compound lists (TCLs), target analyte lists (TALs), and total petroleum hydrocarbons (TPHs).

b. A remedial investigation report for Site 41 was completed in July 1999. The report determined that the human health risk for non-residential scenarios is within acceptable limits, with the exception of the full-time worker. The document identified a potential ecological risk in connection with surface soil contamination. The document recommended a feasibility study report to evaluate alternatives to address the full-time worker and ecological risks.

c. A feasibility study was completed in January 2001. The study developed a potential remedial alternative requiring removal of contaminated soil from areas adjacent to the Scrap Yard, the removal of contaminated soil from within the Scrap Yard, and the remediation of contamination on the concrete slab within the Scrap Yard, all in combination with institutional controls.

d. A proposed plan was completed in February 2001. The preferred remedial alternative presented in the document provided for the removal of contaminated soil from areas adjacent to the Scrap Yard, the removal of contaminated soil from within the Scrap Yard, and the remediation of contamination on the concrete slab within the Scrap Yard, all in combination with institutional controls.

e. A public meeting was held on February 20, 2001 to present the Proposed Plan to the public.

f. Completion of the final design documents occurred in August 2002.

g. Due to unresolved issues related to Land Use Controls between the EPA and the Navy with respect to Records of Decision (RODs), an Engineering Evaluation and Cost Analysis was prepared in June 2002. On June 27, 2002 an Action Memorandum was signed describing a Removal Action to be performed at this site, which consists of removing contaminated soil from within the Scrap Yard as well as from outside the Scrap Yard.

h. Construction of the Removal Action began in November 2002, but was halted due to an incident involving scrap metal at the site.

i. Once the Removal Action at this site has been completed, the Record of Decision will be modified to state that the Removal Action has been completed and will incorporate any changes required by the resolution of the LUC issue between the EPA and the Navy.

8. Current Status:

Stop work in effect and currently awaiting results of accident investigation.

OLSEN ROAD LANDFILL

(OLD MAP GRID G5, G6)
IR Site 42
Fact Sheet

1. Contamination

Unknown.

2. Location:

Near Building 1866.

3. From:

Disposal of various solid wastes from all over the Station.

4. When:

A period of approximately 5 years ending in 1987.

5. Generated By:

Normal operations. Whether hazardous wastes were disposed at the landfill cannot be confirmed or denied by activity records or personnel. Analysis of the former topography suggests that earth-moving equipment was used to fill the area.

6. Amount:

Unknown.

7. Work Completed:

a. A Site Inspection was performed under the Navy Installation Restoration Program, as recommended in the Preliminary Assessment. Soil, groundwater, sediment, and surface water samples were collected and analyzed for volatile organic compounds (VOCs), target compound list (TCLs), target analyte list (TALs), and total petroleum hydrocarbons (TPHs).

b. A remedial investigation report for Site 42 was completed in July 1999. The report determined that the human health risk for non-residential scenarios is within acceptable limits. The potential for ecological risks was identified in connection with a small creek running along the downgradient, southwestern edge of the site. An additional issue focused on the need to close the landfill in accordance with State of Maryland regulations.

c. In December 1999, a toxicity study of the sediments in the above-described creek was completed. Sediment contaminants detected during the remedial investigation were found to not exhibit toxicity.

d. The Feasibility Study was completed in June 2002. The study developed several potential remedial alternatives, including one requiring total landfill removal and others involving various capping scenarios combined with institutional controls.

8. Current Status:

Alternatives in the FS are being examined to determine the most appropriate alternative for remediation. A Proposed Plan will then be developed for public review.

TOLUENE DISPOSAL

(OLD MAP GRID D8)
IR Site 43
Fact Sheet

1. Contamination:

Acetone and toluene.

2. Location:

Near utility pole across the street from Building 1041 and the northern corner of Building 1040.

3. From:

Disposal of acetone and toluene used for propellant removal at Building 1041 and disposal of acetone used for propellant removal at Building 1040.

4. When:

Parts cleaning operations took place from the late 1950s through November 1989 at Building 1041 and from 1960 to 1989 at Building 1040. It is estimated that, for a period of more than two years during the operation, spent solvent was improperly disposed at the base of the pole by Building 1041 and in the drainage ditch outside the door of Building 1040.

5. Generated By:

After parts were cleaned within Buildings 1040 and 1041, the spent solvent was normally combined or "slummed" with sawdust in a 55-gallon drum for treatment at the Strauss Avenue Thermal Treatment Point. Occasionally, however, the spent solvent was carried across the street from Building 1041 to the utility pole and poured on the ground at the base of the pole and in the ditch outside the door of Building 1040.

6. Amount:

One report estimated that 15 to 20 gallons per week of spent solvent were disposed at the base of the pole. It was not possible to determine the amount of solvent disposed at this site. In addition, acetone was reportedly sometimes poured in the ditch outside the door of Building 1040.

7. Work Completed:

a. A Preliminary Assessment was performed and a Site Inspection (SI) was recommended under the Navy Installation Restoration (IR) Program to determine if contamination is actually present.

b. A Site Inspection under the Navy Installation Restoration Program was conducted at the base of the utility pole across the street from Building 1041. This inspection included obtaining 10 soil-gas samples from 10 borings and analyzing for VOCs. In addition, four soil samples were taken using a hand auger at a depth not greater than three feet for analysis of volatile organic compounds (VOCs), base-neutral acids (BNAs), and total petroleum hydrocarbons (TPHs).

TOLUENE DISPOSAL

(OLD MAP GRID D8)
IR Site 43
Fact Sheet

8. Current Status:

Additional sampling was recommended in the SI. Therefore, this site will continue to the Remedial Investigation/Feasibility Study phase of the IR Program and will include taking samples from both the Building 1040 and 1041 areas.

SOAK OUT AREA

(OLD MAP GRID F18)
IR Site 44
Fact Sheet

1. Contamination:

An unknown nonflammable solvent, believed to be Pennchem 901B, a polysulfide solvent containing mercaptan.

2. Location:

Area approximately 75 feet east of Building 1363 and 40 feet south of Building 907.

3. From:

Removal of propellant from rocket motor catapult tubes.

4. When:

Late 1960s to early 1970s.

5. Generated By:

Rocket motor catapult tubes were allowed to soak in the solvent contained in two 55-gallon drums that were welded together. The tubes soaked for 2 to 3 days and were then removed without regard to solvent spillage. However, a smaller catch tank was placed in the larger tank to collect pieces of propellant that fell out of the tubes. Reports indicated that the solvent drums (less than 10 55-gallon) were taken into the woods for storage until a disposal method was found. These drums could not be located.

6. Amount:

Unknown.

7. Work Completed:

a. A Site Inspection under the Navy Installation Restoration Program was conducted as recommended in the Preliminary Assessment to determine if contamination is actually present. Soil and groundwater samples were collected and analyzed for VOCs, base-neutral acids (BNAs), and total petroleum hydrocarbons (TPHs).

b. A remedial investigation report for Site 44 was completed in July 1999. The report determined that the human health risk for all receptors is within acceptable levels. Ecological risks were not evaluated since it had previously been determined that the site did not offer any suitable habitat.

c. A Proposed Plan was completed in February 2001. The plan presented a no further action approach to the site.

d. A public meeting was held on February 20, 2001 to present the Proposed Plan to the public.

e. The Record of Decision, which recommends No Further Action, was signed in September 2002.

8. Current Status:

The site is awaiting removal from the IR Program based on the signed No Further Action ROD.

ABANDONED DRUMS

(OLD MAP GRID E18)
IR Site 45
Fact Sheet

1. Contamination:

Unknown.

2. Location:

250 feet west of Building 1363.

3. From:

Unknown.

4. When:

Estimated 15 to 20 years ago.

5. Generated By:

Unknown. Possibly the same solvent that was used in the Soak Out Area.

6. Amount:

Assuming the 21 55-gallon drums and two overpack drums were full, a total of 1295 gallons of solvent would have leaked onto the ground.

7. Work Completed:

a. A Site Inspection under the Navy Installation Restoration Program was conducted as recommended in the Preliminary Assessment to determine if contamination is actually present. Three soil samples were taken from three soil borings with a hand auger. The borings were obtained at a depth not greater than three feet. These samples were analyzed for volatile organic compounds (VOCs), base-neutral acids (BNAs), and target analyte list (TAL) metals. In addition, four soil-gas samples were taken and analyzed for VOCs.

b. Remedial investigation (RI) fieldwork was completed in 2001. Surface soil, subsurface soil, shallow groundwater and sediment samples were collected and analyzed for target compound list volatile and semivolatile organic compounds, target analyte list metals and an expanded list of explosives.

8. Current Status:

The RI report is currently undergoing Navy and regulatory review. The final RI is anticipated to be completed by July 2003.

CADMIUM SANDBLAST GRIT

(OLD MAP GRID E20)
IR Site 46
Fact Sheet

1. Contamination:

Cadmium.

2. Location:

Gravel area behind Building 855.

3. From:

Sandblast grit disposal.

4. When:

Mid 1960s to possibly early 1980s.

5. Generated By:

Rocket catapult tubes plated with cadmium were sandblasted at Building 855 as part of a resurfacing operation. Often, the cadmium-contaminated grit was dumped in the gravel area behind Building 855.

6. Amount:

Estimates as to the amount, frequency, and time period over which the grit was disposed near the building could not be confirmed.

7. Work Completed:

a. A Preliminary Assessment was performed and a Site Inspection (SI) was recommended under the Navy Installation Restoration (IR) Program to determine if contamination is actually present.

b. SI under the Navy IR Program was conducted. This inspection included taking nine soil samples using a hand auger and analyzing them for target analyte list (TAL) metals.

8. Current Status:

Additional sampling was recommended in the SI. Therefore, this site will continue to the Remedial Investigation/Feasibility Study phase of the IR Program.

MERCURIC NITRATE DISPOSAL AREA

(OLD MAP GRID F21)
IR Site 47
Fact Sheet

1. Contamination:

Mercuric nitrate, barium sludge, and solvents.

2. Location:

South of the concrete pad behind Building 856.

3. From:

Disposal of mercuric nitrate dissolved in nitric acid, disposal of barium sludge, and storage of solvents.

4. When:

Mercuric nitrate disposal from 1957 through 1965, barium sludge disposal between 1969 and 1974.

5. Generated By:

Mercuric nitrate is a catalyst that was used to produce hydrazinium nitroformate, an oxidizer used in the propellants for the Polaris missile. The spent solution, one ounce of mercuric nitrate dissolved in 98% nitric acid, was poured from 55-gallon drums onto a 6 x 4 foot bed of limestone chips. Additionally, a slurry of particulate barium sulfate used in the manufacturing process was pumped to a pit located approximately 50 feet to the east of Building 856.

6. Amount:

Assuming enough limestone was present to neutralize the nitric acid, up to 274 pounds of mercuric nitrate (equivalent to 169 pounds of elemental mercury) would have precipitated out as a salt. An estimated 2,000 pounds of barium sulfate may have been disposed of in the barium pit.

7. Work Completed:

a. A Preliminary Assessment was performed and a Site Inspection (SI) was recommended under the Navy Installation Restoration (IR) Program to determine if contamination is actually present.

b. An SI under the Navy IR Program was conducted. This inspection included taking two soil samples with a hand auger in the ditch where the mercuric nitrate may have settled, and analyzing for volatile organic compounds (VOCs), base-neutral organic acids (BNAs), and target analyte list (TAL) metals. In addition, 10 soil samples were taken with a hand auger at the south edge of the concrete pad. The samples were taken at various depths from zero to one foot and were analyzed for VOCs, BNAs, and TAL metals. No limestone was found during the sampling.

c. Remedial investigation fieldwork has been conducted in several phases at Site 47. Groundwater, concrete chips, surface soil and sediment samples were collected and analyzed for target compound list (TCL) volatile and semivolatile organic compounds (VOCs and SVOCs), target analyte list (TAL) metals, and an expanded list of explosives during the initial field investigation in 1999. In 2001, membrane interface probe/electrical conductivity (MIP/EC) technology was used to further define the extent of VOC contamination, and six monitoring wells were installed and sampled for TCL VOCs. Further delineation of the VOC plume, as well as investigation of the reported barium sludge pit was completed in 2002.

8. Current Status:

The revised draft final RI report has been completed and is currently under review and will be followed by a feasibility study.

A Baseline Ecological Risk Assessment (BERA) has also been completed and comments were received.

NITROGLYCERIN PLANT DISPOSAL AREA

(OLD MAP GRID H20)
IR Site 48
Fact Sheet

1. Contamination:

Unknown.

2. Location:

On the hill behind Building 766.

3. From:

Unknown, possibly laboratory samples.

4. When:

Unknown.

5. Generated By:

Unknown. Bottles, metal scrap, solvent containers, and refuse, possibly generated at Building 766, are visible on the hill. Most containers appear to be old and empty.

6. Amount:

Unknown.

7. Work Completed:

A Preliminary Assessment was performed and a Site Inspection (SI) was recommended under the Navy Installation Restoration (IR) Program to determine if contamination is actually present.

a. Two soil samples were taken on the hillside where the bottles and scrap are located in 1991. The samples were analyzed for mercury to determine if this site could be a source of mercury at the Building 766 ditch. No mercury was detected in the samples.

b. SI under the Navy IR Program was conducted. This SI included obtaining nine soil samples from three borings, three per boring at approximately 5-foot intervals. These samples were analyzed for volatile organic compounds (VOCs), base-neutral acids (BNAs), and total petroleum hydrocarbons (TPHs).

8. Current Status:

Because three unknown BNA tentatively identified compounds (TICs), which may be naturally occurring, were detected, additional sampling was recommended in the SI. This site will continue to the Remedial Investigation/Feasibility Study phase of the IR Program.

CHEMICAL DISPOSAL PIT

(OLD MAP GRID L33)
IR Site 49
Fact Sheet

1. Contamination:

Waste chemicals, solvents, and mercury.

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2. Location:

Northeast of Building 444.

3. From:

Lab operations.

4. When:

Limited use up to the early 1970s.

5. Generated By:

Bottles containing wastes were placed on a steel grate in the pit and the drop plate was dropped. The plate then crushed the bottles containing waste chemicals. The glass fell into a wire basket, and the contents of the bottles were allowed to soak into the bottom of the pit.

6. Amount:

Unknown.

7. Work Completed:

a. A Preliminary Assessment was performed and a Site Inspection was not recommended under the Navy Installation Restoration program. According to Navy personnel, the pit received little, if any, use. No visible signs of disposal can be seen, such as chemical stains or broken glass.

b. Five soil samples were taken at one soil boring and analyzed for volatile organic compounds (VOCs), base-neutral acids (BNAs), target analyte list (TALs), and nitrate esters. One soil sample from inside the pit was obtained and was analyzed for VOCs, BNAs, TALs, and nitrate esters.

c. This site is included in the "Lab Area" grouping of sites. An RI field investigation was completed at the Lab Area in 2001. Surface and shallow subsurface soil, sediment and surface water samples were collected in the Lab Area and analyzed for target analyte list metals, target compound list volatile and semivolatile organic compounds, and an expanded list of explosives.

d. As part of the Lab Area investigation the chemical disposal pit was removed and disposed of offsite. Confirmatory samples were collected around and beneath the chemical disposal pit before the excavation was backfilled with clean imported fill.

8. Current Status:

The RI report is currently undergoing Navy and regulatory review. The final RI report for the Lab Area is expected to be completed in July 2003.

The chemical disposal pit has been removed and disposed of offsite, no further action is anticipated for this site, however the remedial investigation/feasibility study phase continues for the remainder of the Lab area.

BUILDING 103 CRAWL SPACE

(OLD MAP GRID L34)
IR Site 50
Fact Sheet

1. Contamination:

Elemental mercury and possibly other chemicals.

2. Location:

Crawl space of Building 103.

3. From:

Sinks in Building 103.

4. When:

From 1902 to 1985. During construction in 1985, it was discovered that the sinks did not drain to either the sanitary or storm sewer system. Instead, the sinks discharged directly to the soil under Building 103.

5. Generated By:

Laboratory equipment containing mercury was used in Building 103 at various times. During sensitivity tests, nitrometer bulbs, which contained mercury, sometimes exploded under pressure. After testing, the spent mercury, which also contained sulfuric acid, was poured into a "slop jar." Tap water was run into the jar to remove the sulfuric acid from the mercury. Small spills from the transfer of mercury to the "slop jar" were common. Jars of mercury often broke during rinsing in the sink. Other chemicals were also placed in the sinks. A visual inspection of the crawl space revealed possible asbestos insulation covering the pipes. The insulation appeared to be in good condition.

6. Amount:

Unknown.

7. Work Completed:

a. The sinks were re-routed to the sanitary sewer system. In addition, chemicals are no longer put down the sink.

b. A Site Inspection under the Navy Installation Restoration Program was conducted as recommended in the Preliminary Assessment to determine if contamination is actually present. This inspection included taking soil-boring samples from the crawl space under Building 103 and analyzing for volatile organic compounds (VOCs), base-neutral acids (BNAs), target analyte list (TAL) metals, and nitrate esters.

c. This site is included in the "Lab Area" grouping of sites. An RI field investigation was completed at the Lab Area in 2001. Surface and shallow subsurface soil, sediment and surface water samples were collected in the Lab Area and analyzed for target analyte list metals, target compound list volatile and semi-volatile organic compounds, and an expanded list of explosives.

8. Current Status:

The RI report is currently undergoing Navy and regulatory review. The final RI report for the Lab Area is expected to be completed in July 2003, and is expected to be followed by a feasibility study.

BUILDING 101 DRY WELL

(OLD MAP GRID L34)
IR Site 51
Fact Sheet

1. Contamination:

None.

2. Location:

Dry well by Building 101.

3. From:

N/A.

4. When:

N/A.

5. Generated By:

Initially, it was believed that a laboratory waste stream was separated for disposal purposes. The volatile component was evaporated in a flash tank while the remaining liquid wastes were discharged into a dry well. However, inspection of Department of the Navy, Bureau of Yards and Docks drawings revealed that the flash tank did not discharge to the dry well.

6. Amount:

None.

7. Work Completed:

a. A Preliminary Assessment was performed and a Site Inspection was not recommended under the Navy Installation Restoration program.

b. This site was subjected to a site screening assessment (SSA) during 2002. The field investigation included a geophysical survey and the collection of subsurface soil samples for analysis of Target Compound List (TCL) volatile organic compounds.

c. The final SSP Report was completed in March 2003.

8. Current Status:

The final SSP Report recommended no action for this site.

BUILDING 102 DRY WELL

(OLD MAP GRID L34)
IR Site 52
Fact Sheet

1. Contamination:

None.

2. Location:

Dry well by Building 102.

3. From:

N/A.

4. When:

N/A.

5. Generated By:

Initially, it was believed that a laboratory waste stream was separated for disposal purposes. The volatile component was evaporated in a flash tank while the remaining liquid wastes were discharged into a dry well. However, inspection of Department of the Navy, Bureau of Yards and Docks drawings revealed that the flash tank did not discharge to the dry well.

6. Amount:

None.

7. Work Completed:

a. A Preliminary Assessment was performed and a Site Inspection was not recommended under the Navy Installation Restoration program.

b. This site was subjected to a site screening assessment (SSA) during 2002. A visual of the physical conditions at the site as well as available drawings of the site did not indicate the presence of a dry well in the area separate from the Site 51 dry well (which is located nearby). No further investigation of the Site 51 was conducted.

c. The final SSP Report was completed in March 2003.

8. Current Status:

The final SSP Report recommended no action for this site.

MERCURY CONTAMINATION OF THE SEWAGE SYSTEM

(OLD MAP GRID L34)
IR Site 53
Fact Sheet

1. Contamination:

Mercury.

2. Location:

Storm and sanitary sewer pipes.

3. From:

Building 102.

4. When:

1909 through 1986.

5. Generated By:

In 1969, approximately 10 pounds of mercury were discovered in a storm sewer manhole and, in 1989, approximately one pound of mercury was discovered in a sanitary sewer manhole. Both manholes have drain line connections to Building 102. Laboratory equipment that contained mercury, such as nitrometers, was used extensively in Building 102. Mercury often entered drains during the cleaning of laboratory equipment. In 1986, when mercury traps were placed on all sinks in Building 102, mercury was discovered in the U-joints of the sinks.

6. Amount:

The Draft Preliminary Assessment Report states that only about ten percent of the mercury sent to Building 102 was returned to the Building 444 storage vault for reclamation. Laboratory workers estimated that approximately one liter of mercury was lost per month. Therefore, it is possible that 28,000 pounds of mercury could have been discharged to the drain lines over the 77-year period that the building operated without mercury traps on the sinks.

7. Work Completed:

a. Ten pounds of mercury discharged in the storm sewer manhole in 1969 were recovered.

b. One pound of mercury discharged in the sanitary sewer manhole in 1989 was recovered.

c. A television inspection of the gravity sewer lines was conducted in late 1988. The vitrified clay and terra cotta pipes were broken, cracked, sagging, separated, and, in some cases, collapsed. Mercury contamination of the sewage sludge rose to 150 parts per million while the television inspection was being conducted. This suggests that the sewer cleaning, which was done prior to the television inspection, washed mercury down to the Sewage Treatment Plant. Mercury levels have since dropped to levels acceptable for sending the sludge to an approved landfill.

d. A Site Inspection was conducted under the Navy Installation Restoration Program and included:

1) Taking 26 soil samples from 13 borings. One sample per boring was located below the level of the sewer line. These samples were analyzed for mercury and nitrate esters. In addition, some samples were analyzed for volatile organic compounds (VOCs), base-neutral acids (BNAs), target analyte list (TAL), and total petroleum hydrocarbon (TPH).

2) Obtaining 4 sediment samples from sanitary and storm sewer manholes and analyzing for mercury and nitrate esters.

e. During the SI, six monitoring wells were to be installed. However, at a depth of approximately 41 feet, a marker bed was encountered that was subsequently identified as a unit of the Tertiary Brandywine Formation, that is on top of the Patapsco Formation. The Upper Patapsco Formation is a confining unit, which is estimated to be 100 feet thick. Therefore, no shallow water-bearing zones were present.

f. This site is included in the "Lab Area" grouping of sites. An RI field investigation was completed at the Lab area in 2001. Surface and shallow subsurface soil, sediment and surface water samples were collected in the Lab Area and analyzed for target analyte list metals, target compound list volatile and semi-volatile organic compounds, and an expanded list of explosives.

8. Current Status:

The RI report is currently undergoing Navy and regulatory review. The final RI report for the Lab Area is expected to be completed in July 2003, and is expected to be followed by a feasibility study.

BUILDING 101

(OLD MAP GRID L34)
IR Site 54
Fact Sheet

1. Contamination:

Mercury and asbestos.

2. Location:

Basement of Building 101.

3. From:

Use of laboratory equipment that contained mercury and possibly leaking pipes.

4. When:

From building construction in 1909 to mid-1980s.

5. Generated By:

In January 1990, several droplets of mercury were discovered on the insulation of a steam pipe located in the southeastern corner room of the basement in Building 101. In addition, in the mid-1980s, an employee noticed solvent odors in the basement when solvent was flushed down the sink in the room above, indicating a leaky pipe.

Laboratory equipment that contained mercury was used in the room above the basement where mercury was discovered. A 1918 blueprint shows four nitrometers located in this room. During sensitivity tests, nitrometer bulbs, which contained mercury, sometimes exploded under pressure. After testing, the spent mercury, which also contained sulfuric acid, was poured into a "slop jar." Tap water was run into the jar to remove the sulfuric acid from the mercury. Small spills were common from transferring mercury to the "slop jar". Jars of mercury often broke during rinsing in the sink.

6. Amount:

Unknown.

7. Work Completed:

a. A Site Inspection was conducted under the Navy Installation Restoration Program as recommended in the Preliminary Assessment, to determine the extent of contamination. This inspection included:

1) Taking five wipe samples within the building and analyzing for mercury.

2) Taking five media samples from within the building and analyzing for mercury.

3) Obtaining five soil boring samples from beneath the building and analyzing for mercury and nitrate esters.

b. This site is included in the "Lab area" grouping of sites. An RI field investigation was completed at the Lab Area in 2001. Surface and shallow subsurface soil, sediment and surface water samples were collected in the Lab Area and analyzed for target analyte list metals, target compound list volatile and semi-volatile organic compounds, and an expanded list of explosives.

8. Current Status:

The RI report is currently undergoing Navy and regulatory review. The final RI report for the Lab Area is expected to be completed in July 2003, and is expected to be followed by a feasibility study.

All CERCLA-related work will be limited to discharges from Building 101 and not the contamination inside of the building.

BUILDING 102

(OLD MAP GRID L34)
IR Site 55
Fact Sheet

1. Contamination:

Mercury and asbestos.

2. Location:

Building 102.

3. From:

Use of laboratory equipment that contained mercury.

4. When:

From building construction in 1909 to 1963 when renovations to the building were made.

5. Generated By:

On October 6, 1987, metallic mercury was discovered dripping from the ceiling onto the sink table top of the coffee mess, located in the northern end of the basement of Building 102. Review of Department of the Navy, Bureau of Yards and Docks drawings indicates that a nitrometer was once located in the room directly above the area were the metallic mercury was discovered.

While installing mercury traps in the sinks of Building 102 in 1986, the plumber reported approximately a teaspoon of mercury in each of the U-joints.

During sensitivity tests, nitrometer bulbs, which contained mercury, sometimes exploded under pressure. After testing, the spent mercury, which also contained sulfuric acid, was poured into a "slop jar." Tap water was run into the jar to remove the sulfuric acid from the mercury. Small spills from transferring mercury to the "slop jar" were common. Jars of mercury often broke during rinsing in the sink.

6. Amount:

Unknown.

7. Work Completed:

a. During building renovations in 1963, the nitrometer operation was moved to the southern room on the first floor of Building 102, and the floor was sealed with a 2-inch layer of concrete.

b. In the mid 1970s, the nitrometer was moved to the southern room in the basement of Building 102 and, in the early 1980s, the floor drains were sealed to prevent mercury release in case of a spill.

c. Cleanup of the mercury began after the mercury was found dripping from the ceiling but promptly ceased after asbestos was discovered.

d. Plastic sheeting was placed under the ceiling to encapsulate the leaking mercury, and the northern end of the building was closed to protect the health of the employees.

e. In February 1989, the building was abandoned. In June 1991, the water supply to the building was disconnected to eliminate the potential for mercury contamination of the sludge generated from sewage treatment.

f. A Site Inspection was conducted under the Navy Installation Restoration Program. This inspection included:

1) Taking five wipe samples within the building and analyzing for mercury.

2) Taking five media samples from within the building and analyzing for mercury.

3) Obtaining five soil boring samples from beneath the building and analyzing for mercury and nitrate esters.

g. This site is included in the "Lab Area" grouping of sites. An RI field investigation was completed at the Lab Area in 2001. Surface and shallow subsurface soil, sediment and surface water samples were collected in the Lab Area and analyzed for target analyte list metals, target compound list volatile and semi-volatile organic compounds, and an expanded list of explosives.

8. Current Status:

The RI report is currently undergoing Navy and regulatory review. The final RI report for the Lab Area is expected to be completed in July 2003, and is expected to be followed by a feasibility study.

All CERCLA-related work will be limited to discharges from Building 102 and not the contamination inside of the building.

LEAD CONTAMINATION AT INDUSTRIAL WASTEWATER OUTFALL (IW) 87

(OLD MAP GRID H19)
IR Site 56
Fact Sheet

1. Contamination:

Lead.

2. Location:

Pit, pipe, and sediment leading to IW87 from Building 790

.

3. From:

Washdown of lead-lined floor.

4. When:

1953 to October 1992.

5. Generated By:

Building 790 contains a tank of nitric acid and a tank of sulfuric acid. The fumes from these acids get on the walls and floor inside the building, requiring a periodic washdown of the walls and floor. The fumes from the strong acids dissolved the lead from the flooring, and the washdown provided a route for the dissolved lead to discharge from the building to IW87.

6. Amount:

Unknown.

7. Work Completed:

An Engineering Evaluation/Cost Analysis (EE/CA) was prepared to determine the best method for cleaning this lead from the pit, pipe, and sediment.

A removal action conducted in late 1996 included removal and cleaning of the pipe leading to IW87, excavation of the outfall area, treatment of contaminated water on the site, and relining of the pipe.

8. Current Status:

This site will continue to the Remedial Investigation/Feasibility Study phase.

BUILDING 292 TCE CONTAMINATION

(OLD MAP GRID P33)
IR Site 57
Fact Sheet

1. Contamination:

Trichloroethylene (TCE).

2. Location:

Building 292.

3. From:

Possible discharges and spills from drainage of the vapor-degreasing tank.

4. When:

1964 to 1989.

5. Generated By:

Emptying of a 2000-gallon vapor-degreasing tank. The cleaning system used TCE vapors to clean metal parts. The 2000-gallon tank of TCE was emptied and refilled approximately every six months.

6. Amount:

Unknown. Extent of contamination to be determined.

7. Work Completed:

a. A limited subsurface investigation was conducted in March 1996. This investigation indicated elevated levels of TCE in the soil and groundwater in the area south of Building 292.

b. A Draft Engineering Evaluation/Cost Analysis (EE/CA) was completed in October 1996. Before the EE/CA was completed, a treatability study was conducted to determine if Soil Vapor Extraction (SVE) was an effective remedy. The results of the Treatability study indicated that SVE would not work at the site due to the geology and location of the groundwater table.

c. In 1998, the Navy completed a Removal Action at Site 57 to address infiltration of TCE-contaminated groundwater into a storm sewer leading to outfall IW-80. Approximately 700 feet of storm sewer were lined to inhibit the accelerated migration of TCE.

d. The Navy completed a remedial investigation at Site 57 in July 2000.

e. During August 2001, a field investigation was conducted at Site 57 to collect field data to aid in the evaluation of remedial alternatives during the preparation of an FS.

f. A pilot study, which includes injecting Hydrogen Release Compound (HRC) in shallow groundwater to facilitate natural attenuation, began in May 2003.

BUILDING 292 TCE CONTAMINATION

(OLD MAP GRID P33)
IR Site 57
Fact Sheet
(Continued)

8. Current Status:

Development of the Feasibility Study on hold pending the results of the HRC pilot study.

UNDERGROUND STORAGE TANKS AT TRANSPORTATION DEPARTMENT

(OLD MAP GRID E37)
IR AOC
(Main Area SWMUs 4 and 5)
Fact Sheet

1. Contamination:

Waste oil from equipment maintenance.

2. Location:

These units consist of one 550-gallon underground storage tank (UST) (SWMU 4) behind the automotive shop (Building 290) and a second 1,000-gallon UST (SWMU 5) behind the heavy equipment shop (Building 525).

3. From:

Waste oil from equipment maintenance is placed in a basin, which is approximately 36 inches by 18 inches by 12 inches deep, inside the shops. The waste oil drains through a pipe to the USTs. A contractor pumps the waste oil from the tanks to a truck for off-site disposal.

4. When:

Facility personnel indicated that the units have been in operation since 1978.

5. Generated By:

The wastes managed at this unit include waste oils from the transportation equipment maintenance branch.

6. Amount:

One 550-gallon underground storage tank (SWMU 4) and a second 1,000-gallon UST (SWMU 5).

7. Work Completed:

a. During the visual site inspection (VSI), stained soil was observed in the vicinity of the stand pipe from the UST behind Building 55 (SWMU 5). No evidence of release was observed in the vicinity of SWMU 4.

b. These units were included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002. Based on the information provided in the document, the team agrees that no action is required at these units.

8. Current Status:

These units will be eliminated from further consideration in the IR Program and will be removed from the next version of the Site Management Plan.

USED BATTERY ACCUMULATION AREA (BUILDING 290)

(OLD MAP GRID R27)
IR AOC
(Main Area SWMU 6)
Fact Sheet

1. Contamination:

Unit is used for storage of used batteries.

2. Location:

Automotive shop (Building 290).

3. From:

The Transportation Department automotive shop (Bldg. 290) uses an area outside the building for accumulation of used batteries. The batteries are stored on wooden pallets over a concrete driveway. The area is uncovered and measures approximately 6 feet wide by 10 feet long

4. When:

According to facility representatives, the date the area was first used for storage is not known. However, the area has been used for several years.

5. Generated By:

The Transportation Department automotive shop (Building 290) uses an area outside the building for accumulation of used batteries.

6. Amount:

Unknown

7. Work Completed:

a. Staining was observed on the concrete pad during the visual site inspection (VSI). However, no visible signs of release to soils were noted, and no releases were noted in available file information.

b. This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002. Based on the information provided in the document, the team agrees that no action is required at this unit.

8. Current Status:

This unit will be eliminated from further consideration in the IR Program and will be removed from the next version of the Site Management Plan.

WASTE OIL STORAGE AREA (GOODARD POWER PLANT)

(OLD MAP GRID N31)
IR AOC
(Main Area SWMU 27)
Fact Sheet

1. Contamination:

The area is approximately 150 feet long by 50 feet wide and includes metal drums of waste oil sitting on the soil surface. At the time of the visual site inspection (VSI), the unit contained 8 drums of waste oil from the oil/water separator, five empty drums labeled pelletized nitrocellulose, and a pile of oily soil that was approximately 12 feet by 10 feet by 3 feet high. The pile appeared to contain waste oil and absorbent collected from spills inside the power plant.

Remediation activities included the removal of the empty drums and the partial removal of the empty waste oil and absorbent. The remaining stained soil was drummed for off-site disposal.

2. Location:

Fuel storage area at Goddard Power Plant.

3. From:

Goddard Power Plant.

4. When:

Area had been used for storage of this type since the start-up of the power plant in 1957.

5. Generated By:

This unit is used for storage of waste oil collected from the power plant. The drums of waste oil are taken to the Caffee Road thermal treatment unit (SWMU 21) for burning or to Building 455 (SWMU 2) for off-site disposal.

6. Amount:

At the time of the VSI, the unit contained 8 drums of waste oil from the oil/water separator, five empty drums labeled pelletized nitrocellulose, and a pile of oily soil approximately 12 feet by 10 feet by 3 feet high.

7. Work Completed:

a. On the second day of the VSI, a pile of stained soil was observed in the area. During the fifth day of the VSI, the unit was revisited and it was observed that the waste pile had been partially removed and that an area of stained soil remained.

b. This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002. Based on the information provided in the document, the team agrees that no action is required at this unit.

8. Current Status:

This unit will be eliminated from further consideration in the IR Program and will be removed from the next version of the Site Management Plan.

CAFFEE ROAD WASTE OIL STORAGE AREA

(OLD MAP GRID L6)
IR AOC
(Main Area SWMU 38)
Fact Sheet

1. Contamination:

This unit is a storage area for drums of waste oil used at the Decontamination Burn Point (SWMU 21).

2. Location:

Decontamination Burn Point (SWMU 21).

3. From:

The oil is used to start and maintain the fire at the burn point. The fire is initiated to flash explosive residue from discarded metal parts generated on-Station.

4. When:

Oil has been stored at this location since approximately 1986.

5. Generated By:

The unit is used for storage of waste oil from vehicles and machinery in drums. The oil is used to start and maintain the fire at the Decontamination Burn Point.

6. Amount:

Unknown.

7. Work Completed:

a. There was no known history of release at the unit, and no signs of release were observed during the visual site inspection.

b. This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

The decision reached during the desktop audit was that this unit will be investigated as part of the Remedial Investigation for Site 11.

WASTEWATER COLLECTION TREATMENT TANKS (MOSER PLANT)

(OLD MAP GRID E17)
IR AOC
(Main Area SWMUs 40 through 46)
Fact Sheet

1. Contamination:

These seven units are used for the collection and treatment of wastewater generated from the production of nitrate esters (e.g., nitroglycerin, nitrocellulose, etc.) at the Moser Plant. The wastewater contains concentrations of slightly acidic explosive residue.

2. Location:

Moser Plant.

3. From:

The tanks are used to collect the wastewater, settle the explosive residue, and neutralize the acidity, if necessary.

4. When:

The units were installed and began operation in the mid-1970s.

5. Generated By:

The units are used for collection and treatment of wastewater containing explosive residue, which is slightly acidic. The settled explosive residue from the wastewaters is adsorbed onto wood chips and burned at the Cast Plant Burn Point (SWMU 19). The water is discharged to an NPDES outfall after settling.

6. Amount:
Unknown.

7. Work Completed:

a. The tanks observed during the visual site inspection included two 300-gallon tanks, one 1,000-gallon tank, and one 200-gallon tank. The tanks were all constructed of steel, were located indoors on concrete floors, and were each covered. Three additional tanks of the same design and construction are located in the process area.

b. These units were included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

These units will be eliminated from further consideration in the IR Program and will be removed from the next version of the Site Management Plan.

SPENT ACID STORAGE TREATMENT TANKS (MOSER PLANT)

(OLD MAP GRID E17)
IR AOC
(Main Area SWMU 47 through 51)
Fact Sheet

1. Contamination:

These five units are used for the collection and treatment of spent acid generated during production of nitrated esters at the Moser Plant.

2. Location:

Moser Plant.

3. From:

The tanks include three spent acid tanks, including one 150-gallon and two 553-gallon tanks, one 200-gallon slum recovery tank, and one 6,000-gallon neutralization tank (divided into two compartments). The tanks are constructed of steel, are located indoors, and are covered. The level in the tanks is controlled by batch flow to the units.

4. When:

Tanks were installed and began operation in the mid-1970s.

5. Generated By:

The units are used for collection and treatment of spent acid from the production of nitrated esters. The wastewater from neutralization is discharged to an NPDES outfall. The NOS representative stated that no sludge was generated by the neutralization process.

6. Amount:

Unknown.

7. Work Completed:

a. There is no history of release from the units, and there were no visible signs of release during the visual site inspection.

b. These units were included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

These units will be eliminated from further consideration in the IR Program and will be removed from the next version of the Site Management Plan.

WASTEWATER STORAGE TANKS (BLDG. 1596)

(OLD MAP GRID P30)
IR AOC
(Main Area SWMU 64 through 66)
Fact Sheet

1. Contamination:

The units were used for storage of water contaminated with hydrazine fuel.

2. Location:

Building 1596.

3. From:

The wastewater storage tanks located in Building 1596 were used for storage of water contaminated with hydrazine fuel. The water was incinerated in Thermal Destructor 2 (SWMU 63). The tanks are located indoors over concrete flooring. They are constructed of polyurethane and are approximately 10,000-gallon each in capacity.

4. When:

The exact date of installation of the tanks is not certain; however, it is assumed the tanks were installed circa 1976 [i.e. the same time as construction of Thermal Destructor 2 (SWMU 63)].

5. Generated By:

The tanks are located indoors on a concrete floor and have been empty for a number of years. No details were available on the control of flow to the tanks.

6. Amount:

Unknown.

7. Work Completed:

a. There is no known history of release from the units, and no visible signs of release were observed during the visual site inspection.

b. These units were included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

These units will be eliminated from further consideration in the IR Program and will be removed from the next version of the Site Management Plan.

TEMPORARY ACCUMULATION DUMPSTERS FOR EXPLOSIVE SCRAP

IR AOC
(Main Area SWMU 69)
Fact Sheet

1. Contamination:

The units are used for storage of explosive scrap from processes throughout the facility.

2. Location:

Throughout the Station.

3. From:

The Naval Ordnance Station uses metal dumpsters for collection of explosive scrap from manufacturing and associated operations throughout the Station.

4. When:

The practice of storing explosive scrap in dumpsters was used at the Station from the late 1950s and until 1992.

5. Generated By:

The dumpsters are color coded (blue or yellow) for use only as storage for explosive scrap. They are constructed of metal, measure approximately 5 feet long by 4 feet wide by 4 feet deep, and are typically located over concrete or asphalt. The explosive scrap contained in a water bath is in the dumpster. Water must be present in the dumpsters for safety reasons: dry propellant scrap is an explosive hazard. When filled, the dumpster is transported to the burn point (SWMU 19); the water is filtered and discharged through an NPDES outfall and the explosive scrap is burned at the burn point.

The dumpsters are filled to fill-lines marked on the dumpster. The fill-line leaves ample freeboard to prevent overflow or spilling from the dumpster.

6. Amount:

50 to 60 dumpsters

7. Work Completed:

There is no known history of release from the dumpsters. Visual inspection of several units during the visual site inspection found no a signs of release. All inspected units were found to be in good condition.

b. This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

This unit will be eliminated from further consideration in the IR Program and will be removed from the next version of the Site Management Plan.

TEMPORARY ACCUMULATION BUILDINGS FOR DRUMMED EXPLOSIVE SCRAP
IR AOC

(Main Area SWMU 70)
Fact Sheet

1. Contamination:

The units are used for temporary storage of explosive scrap generated at process areas throughout the facility.

2. Location:

The storage locations are wooden sheds, all of similar design, constructed over concrete pads. The sheds are covered and typically measure approximately 6 feet by 6 feet.

3. From:

The Naval Ordnance Station has 51 storage buildings for accumulation of explosive scrap in metal cans. The metal cans (commonly called G.I. cans) are about 30 gallons in size and are color coded blue or yellow for use only as storage for explosive scrap.

4. When:

There are 51 temporary accumulation areas that have been constructed at various times during the facility operation.

5. Generated By:

Explosive scrap is typically adsorbed (i.e., liquid) onto wood chips and collected in non-conductive rubber bags, placed in the metal cans, and stored in the accumulation area. Cans were removed daily to the burn point (SWMU 19) for safety reasons.

The explosive scrap is collected in non-conductive rubber bags, placed in the metal cans, and stored in the building. The buildings have concrete floors but no curbs.

6. Amount:

Unknown.

7. Work Completed:

a. There is no known history of release from the units, and the visual inspection found no signs of release.

b. This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

This unit will be eliminated from further consideration in the IR Program and will be removed from the next version of the Site Management Plan.

OIL/WATER SEPARATORS

IR AOC
(Main Area SWMU 72)
Fact Sheet

1. Contamination:

Several wastewater discharge lines at the Naval Ordnance Station include an oil/water separator for removal of floating oil from the wastewater prior to discharge through an NPDES outfall.

2. Location:

Various process areas on-Station.

3. From:

The unit separates floating oil from wastewater generated by various process areas on-Station. Waste oil is collected at the units and either used on site or disposed offsite. The units are typically constructed of concrete and are generally covered with a metal-lid. Many of the units overflow to NPDES discharge points.

4. When:

It is assumed that the separators were typically constructed at the time of building construction

5. Generated By:

The waste oil is either used on site (e.g., such as the waste oil used for starting fires at the Decontamination Burn Point or disposed off-site.

6. **Amount**:

The Industrial Wastewater Treatment Study listed at least 15 separators associated with various buildings and process lines.

7. Work Completed:

a. There is no known history of release from the units, and visual inspection of two units found no signs of release.

b. This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

This unit will be eliminated from further consideration in the IR Program and will be removed from the next version of the Site Management Plan.

UNLINED OVERLAND DRAINAGE DITCHES

IR AOC
(Main Area SWMU 74)
Fact Sheet

1. Contamination:

Process wastewater containing various contaminants.

2. Location:

Drainage ditches throughout the Activity

3. From:

Discharge of process wastewater to unlined overland drainage ditches

4. When:

Startup varies with each ditch. However, the practice of discharge in unlined ditches has been used since the beginning of production at the Activity.

5. Generated By:

Various processes throughout the Activity

6. **Amount**:

Unknown

6. Work Completed:

a. This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

The decision reached during the desktop audit was this SWMU will remain an AOC and additional work is needed to identify and verify ditches with potential contamination. It is expected that limited sampling will be conducted in the identified ditches. An approach to address these types of ditches will be developed in the future.

SAND BLASTING SAND STORAGE AREA

(OLD MAP GRID B8)
IR AOC
(Main Area RCRA AOC G)
Fact Sheet

1. Contamination:

Sand blasting is used to remove paint from rocket motor casings. Sand blasting sand commonly contains heavy metals.

2. Location:

The equipment is located indoors on a floor and containment area constructed of steel and concrete (Building 1134).

3. From:

The sand is collected and continuously recycled to the sand blast equipment, resulting in no waste sand.

4. When:

Unknown.

5. Generated By:

The process is currently being converted to use of a plastic medium (i.e., to replace the sand) for removal of the paint.

6. Amount:

Unknown.

7. Work Completed:

This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

This unit will be eliminated from further consideration in the IR Program and will be removed from the next version of the Site Management Plan.

DRUM AT FUEL STORAGE AREA

(OLD MAP GRID C8)
IR AOC
(Main Area RCRA AOC H)
Fact Sheet

1. Contamination:

During visual inspection of the vehicle maintenance area (Building 290), a single drum containing an unidentified liquid was observed adjacent to the nearby fuel storage area. There was no indication, however, that the contents of the drum were a waste (i.e., no signs that activities in the area would generate a waste). The drum was located outdoors on an asphalt roadway. There was no apparent leakage from the drum, and visual inspection found no signs indicating that the area was routinely used for storage of drums.

2. Location:

Unknown.

3. From:

Unknown.

4. When:

Unknown.

5. Generated By:

Unknown.

6. Amount:

Unknown.

7. Work Completed:

This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

This unit will be eliminated from further consideration in the IR Program and will be removed from the next version of the Site Management Plan.

SAFETY THERMAL TREATMENT POINT

(OLD MAP GRID F1)
IR AOC
(Main Area SWMU 20)
Fact Sheet

1. Contamination:

The Safety Thermal Treatment Point is an open burning area that operates in a manner similar to the Cast Plant Burn Point (SWMU 119). The unit is used for thermal treatment of explosive and flammable waste.

2. Location:

The Safety Thermal Treatment Point is located west of the Cast Plant Burn Point on a small peninsula extending into the Potomac River (south of Building 1248).

3. From:

The treatment point is an area of bare soil on the end of the peninsula where various explosive and flammable materials are burned. The Safety Thermal Treatment Point is used for burning of pyrotechnics including igniters, detonators, and other explosive devices.

Like the Cast Plant Burn Point, the state of Maryland has determined that the unit will require a RCRA permit under Subpart X regulations.

4. When:

The start-up date of the unit is estimated to be the late 1940s or early 1950s.

5. Generated By:

The unit is used for thermal treatment of explosive and flammable waste. The unit is an area of bare soil with no secondary containment preventing runoff into the river. The unit is designed to release to air. Some residue may remain from incomplete burning of the waste materials; however, facility representatives stated that the area is periodically "shocked" to remove any residual explosive or flammable material.

6. Amount:

Unknown.

7. Work Completed:

This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

SAFETY THERMAL TREATMENT POINT

(OLD MAP GRID F1)
IR AOC
(Main Area SWMU 20)
Fact Sheet

8. Current Status:

The decision reached during the desktop audit was that this unit should be subjected to a remedial investigation/feasibility study.

SWMU 20 has also been included in the MRP and designated as site UXO 000020.

CAFFEE ROAD DECONTAMINATION BURN POINT

(OLD MAP GRID L6)
IR AOC
(Main Area SWMU 21)
Fact Sheet

1. Contamination:

The Decontamination Burn Point is a thermal treatment open burn area for decontamination of scrap metal contaminated with explosive. The burn area has two large piles of scrap metal, one awaiting thermal treatment and a second, treated pile. The waste oil used to ignite and sustain the fire is stored in drums at a storage area near the burn point.

Like the Cast Plant and Safety Burn Points, the state of Maryland has determined that the Decontamination Burn Point will require a RCRA permit under Subpart X regulations.

2. Location:

The unit lies at the south end of Caffee Road on top of the inactive Caffee Road Landfill and approximately 253 yards from Mattawoman Creek.

3. From:

The metal is placed into a pile and ignited to remove any explosive contaminants by burning. Waste oil is used on the metal to ignite and sustain the fire. Following treatment, the metal is sold to off-site contractors as scrap.

4. When:

This unit has been in operation since the Caffee Road Landfill was covered in the early 1980s.

5. Generated By:

This unit is used for the thermal treatment of solids, including wood and metal contaminated with explosives. The contaminated material is burned with waste oil to aid combustion. Thermally treated material is periodically collected and sold as scrap. The unit is located on the soil cover over the Caffee Road Landfill.

6. Amount:

Unknown.

7. Work Completed:

This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

The decision reached during the desktop audit was that this unit will be investigated as part of the remedial investigation of Site 11.

2.2 SITE DESCRIPTIONS – STUMP NECK ANNEX

This section includes the fact sheets for the Stump Neck IR sites and AOCs.

STUMP NECK IMPACT AREA

(OLD MAP GRID F16, G16)
IR Site 30
(Stump Neck Annex SWMU 22)
Fact Sheet

1. Contamination:

Exploded ordnance.

2. Location:

The area is approximately 40 acres of marshland.

3. From:

According to facility representatives, this area was used for testing of single-base, powder-fired projectiles.

4. When:

The unit was reportedly used before World War II.

5. Generated By:

Projectile testing.

6. Amount:

Unknown.

7. Work Completed:

No projectiles have been recovered from the area.

The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

8. Current Status:

Awaiting Initiation of Site Screening Process.

Currently designated as Munitions Response Program site UXO 000010.

OLD DEMOLITION RANGE

IR Site 31
(Stump Neck Annex SWMU 23)
Fact Sheet

1. Contamination:

Small quantities of shrapnel and casings from detonation of explosives.

2. Location:

The area is approximately one acre in size. This unit is in the immediate vicinity of the Chicamuxen Creek's Edge Dump Site B (SWMU 4).

3. From:

Training activities at the site are believed to have been similar to those now practiced at Range 6 (SWMU 5), an explosive ordnance disposal training range.

4. When:

Used in 1962, and for many years prior to 1962, as an old demolition training ground.

5. Generated By:

Explosive ordinance disposal training.

6. Amount:

Small quantities of shrapnel and casings.

7. Work Completed:

The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

8. Current Status:

Awaiting Initiation of Site Screening Process.

Currently designated as Munitions Response Program site UXO 000007.

SUSPECTED TOOL BURIAL SITE

IR Site 32
(Stump Neck Annex SWMU 11)
Fact Sheet

1. Contamination:

Beryllium-copper alloy.

2. Location:

Vicinity of Building 31 Stump Neck.

3. From:

Hand tools used in explosive ordnance disposal work.

4. When:

Unknown.

5. Generated By:

This unit is suspected to contain special beryllium-copper alloy hand tools used in explosive ordnance work.

6. Amount:

Unknown.

7. Work Completed:

a. During the visual site inspection, the unit was covered with grass and rimmed by sparse woods. Facility representatives indicated the burial site's approximate size was 10 feet by 10 feet.

b. The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

c. This site was subjected to a site screening assessment (SSA) during 2002. Because the site is so similar to Site 34 with respect to the potential sources of contamination, the work plan allowed for not pursuing the investigation of Site 32 if the results from the Site 34 investigation indicated that no action was appropriate. Since the results of the Site 34 investigation indicated no reason to pursue Site 32, no field investigation was performed.

d. The final SSP Report was completed in March 2003.

8. Current Status:

A draft SSP decision document, which recommends no action, is currently being reviewed.

SCRAP METAL PIT

(OLD MAP GRID O16)
IR Site 33
(Stump Neck Annex SWMU 7)
Fact Sheet

1. Contamination:

Metal parts of mines, torpedoes, and other explosive-inert items.

2. Location:

The exact location of the Scrap Metal Pit could not be identified. The area is southwest of Building 2117.

3. From:

Used as a disposal pit for mines and torpedoes. This unit is an outdoor, unlined earthen area that measures approximately 10 feet by 30 feet by 10 feet deep.

4. When:

Prior to 1983

5. Generated By:

Disposed wastes include metal objects (parts of mines, torpedoes, and other inert materials) derived from the manufacture of explosives.

6. Amount:

Unknown.

7. Work Completed:

a. During the visual site inspection, the area was covered with grass and brier and was sparsely lined with trees. The area had been approximately two years earlier.

b. The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

c. A site screening assessment (SSA) field investigation was completed in 2002. The field investigation included a geophysical survey; temporary monitoring wells with groundwater samples analyzed for Target Analyte List (TAL) metals and explosive; subsurface soil samples analyzed for TAL metals and explosives; and test pits located based on the results of the geophysical survey.

8. Current: Status

The draft SSA report is currently undergoing Navy and regulatory review. The final SSA report was completed in March 2003

A supplemental sampling investigation is recommended before determining if an RI is justified.

TOOL BURIAL SITE

(OLD MAP GRID E15)
IR Site 34
(Stump Neck Annex SWMU 8)
Fact Sheet

1. Contamination:

Beryllium-copper alloy.

2. Location:

Located approximately 60 to 70 feet into a wooded area southeast of Building D21C.

3. From:

Two unlined burial pits, each measuring about 5 feet by 15 feet by 12 feet deep. The volume of tools in each pit is said to be about 5 feet by 8 feet by 2 feet.

4. When:

Used once in 1972 or 1973. Beryllium-copper alloy hand tools were disposed in the pits. These tools were discarded because they did not pass a magnetometer test and were considered unserviceable.

6. Amount:

Unknown.

7. Work Completed:

a. The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

b. A site screening assessment (SSA) field investigation was completed in 2002. The field investigation included a geophysical survey; temporary monitoring wells with groundwater samples analyzed for beryllium and copper; subsurface soil samples analyzed beryllium, copper, and explosives; and test pits located based on the results of the geophysical survey.

c. The final SSP Report was completed in March 2003.

8. Current Status:

A draft SSP decision document, which recommends no action, is currently being reviewed.

TORPEDO BURIAL SITE

(OLD MAP GRID E14, E15)
IR Site 35
(Stump Neck Annex SWMU 9)
Fact Sheet

1. Contamination:

Torpedoes and associated hardware, possibly containing fuzes and parts which are not rendered safe.

2. Location:

Located near Building 2075.

3. From:

The unit is an unlined earthen pit. Inert objects disposed in this unit included discarded torpedo shells and associated hardware.

4. When:

Used in the late 1940s and early 1950s and inactive since the early 1950s

5. Generated By:

The waste was transported from a torpedo station near Washington, D.C.

6. Amount:

Unknown.

7. Work Completed:

During the visual site inspection the area appeared flat and was covered with green grass. The perimeter of the unit is wooded and an unnamed creek dissects the area.

The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

8. Current Status:

Awaiting Initiation of Site Screening Process.

Currently designated as Munitions Response Program site UXO 000012.

CLOSED LANDFILL

(OLD MAP GRID H14, H15)
IR Site 36
(Stump Neck Annex SWMU 10)
Fact Sheet

1. Contamination:

Inert metal casings, mines, bombs, and torpedoes.

2. Location:

Unknown.

3. From:

Objects disposed in the landfill included metal casings, mines, bombs, and torpedoes, which reportedly were inert and contained no explosives or chemicals when buried.

4. When:

Used from 1972 to 1974; inactive since 1974.

5. Generated By:

Unknown.

6. Amount:

Unknown.

7. Work Completed:

a. The NACIP IAS report describes a landfill that consists of two distinct adjacent areas. The unit is an unlined, earthen area, approximately one to two acres in size, and is covered with grass and other low vegetation. The unit is contiguous with a wetland area and is rimmed by sparse woods.

b. During the visual site inspection, tall grass-covered the area and the soil was dark with a low brier ground cover.

c. The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

d. A site screening assessment (SSA) field investigation was completed in 2002. According to the work plan, the field investigation was limited to a geophysical survey.

e. The final SSA report was completed in March 2003.

8. Current Status:

The SSA report recommends moving into the RI/FS phase.

CAUSEWAY

(OLD MAP GRID E13)
IR Site 37
(Stump Neck Annex SWMU 24)
Fact Sheet

1. Contamination:

Causeway fill, which is primarily rubble partly composed of old torpedo casings.

2. Location:

The access road to the ranges at Stump Neck crosses a narrow neck of land. The causeway is directly adjacent to the Potomac River.

3. From:

The narrow neck of land has been built up with fill material.

4. When:

Unknown.

5. Generated By:

Shore stabilization.

6. Amount:

Unknown.

7. Work Completed:

a. Observation of the area indicated the presence of a raised land area and use of concrete blocks and rock to protect the Potomac River side of the roadway from erosion for a distance of 300 to 400 feet. Along the river's edge, there was a small beach which was rimmed with rip-rap wrapped in wire mesh. During the visual site inspection, the unit appeared relatively flat and grassy.

b. The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

c. A site screening assessment (SSA) field investigation was completed in 2002. The field investigation included the installation of temporary monitoring wells with groundwater samples analyzed for Target Compound List (TCL) volatile and semi-volatile organic compounds including pesticides and PCBs, Target Analyte List (TAL) metals, and explosives; subsurface soil samples analyzed for the same analytes; and surface water and sediment samples also analyzed for the same analytes.

d. The final SSA report was completed in March 2003.

8. Current Status:

The SSA report recommends moving into the RI/FS phase. It is recommended that the RI should also include further evaluation of ecological COPCs.

Currently designated as Munitions Response Program site UXO 000003.

RUM POINT LANDFILL(OLD MAP GRID U7)

IR Site 38
(Stump Neck Annex SWMU 1)
Fact Sheet

1. Contamination:

Various unknown containers and metals in addition to ash from a thermal treatment tank.

2. Location:

West of Rum Point Road.

3. From:

The unit is an unlined landfill that is approximately 1.5 to 2 acres in size.

4. When:

Until December 1989.

5. Generated By:

Ash from a thermal treatment tank, located on Range 3 Burn Point, was reportedly disposed here one time.

6. Amount:

Unknown.

7. Work Completed:

a. The site was identified in the Initial Assessment Study (IAS) of the Naval Assessment for the Control of Industrial Pollutants (NACIP) Program. The IAS report indicated disposal of several metal objects, including garbage cans and drums.

b. As required by the NEODTC RCRA Corrective Action Permit, an RFI/ VI Report was completed in draft in January 1998. That document recommended that a No-Further-Action decision be considered for this site.

8. Current Status:

Awaiting Initiation of Site Screening Process.

RANGE 3 BURN POINT

IR Site 58
(Stump Neck Annex SWMU 2)
Fact Sheet

1. Contamination:

Unknown explosives, waste ash, and petroleum.

2. Location:

Bank of Chicamuxen Creek. This unit is located downhill and slightly southwest of the Pink Water Treatment Tank (SWMU 13). The Range 3 Burn Point is located within the 100-year flood plain.

3. From:

The unit is used for burning or thermal treatment of explosive wastes, explosive-contaminated materials, and carbon.

4. When:

Currently in use.

5. Generated By:

The Range 3 Burn Point is used to periodically burn or thermally treat explosive wastes generated at the facility and is a RCRA-regulated unit. The wastes are burned either directly on bare soil using gasoline as an ignition source in a Thermal Treatment Tank (SWMU 16) that rests on bare soil approximately 30 feet from the Creek's edge. This area also contains a metal container used to test small blasting caps (squibs).

6. Amount:

Unknown.

7. Work Completed:

a. During the visual site inspection, burned scraps were observed in the container, and charred debris was observed on the soil in the immediate vicinity of the Thermal Treatment Tank. A paint solvent or paint odor was detected close to the creek, approximately 15 feet from the Thermal Treatment Tank.

b. As required by the NEODTC RCRA Corrective Action Permit, an RFI/VI Report was completed (draft) in January 1998. That document recommended that a No-Further-Action decision be considered for this site.

8. Current Status:

Awaiting Initiation of Site Screening Process.

CHICAMUXEN CREEK'S EDGE DUMP SITE A

IR Site 59
(Stump Neck Annex SWMU 3)
Fact Sheet

1. Contamination:

Unknown

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2. Location:

This unit is located directly under the Range 3 Burn Point (SWMU 2). Exactly what was dumped in this unit is not known. There are indications that the earthen area which comprises this unit and the Range 3 Burn Point (SWMU 2) are man-made fill areas. The unit is located adjacent to Chicamuxen Creek within the 100-year flood plain. The unit is surrounded on three sides by a rip-rap berm covered with wire mesh.

4. When:

Unknown.

5. Generated By:

Unknown.

6. Amount:

The unit is approximately 2 acres in size and is covered with bare soil.

7. Work Completed:

As required by the NEODTC RCRA Corrective Action Permit, a VI/RFI Report was completed (draft) in January 1998. That document recommended that a No-Further-Action decision be considered for this site.

8. Current Status:

Awaiting Initiation of Site Screening Process.

CHICAMUXEN CREEK'S EDGE DUMP SITE B

IR Site 60
(Stump Neck Annex SWMU 4)
Fact Sheet

1. Contamination:

This unit was used as a dump site but facility representatives were uncertain of the exact nature of materials disposed.

2. Location:

Immediate vicinity of the Old Demolition Range (SWMU 23).

3. From:

This unit is an unconfined earthen area located adjacent to Chicamuxen Creek.

4. When:

Unknown.

5. Generated By:

Unknown.

6. Amount:

Unknown.

7. Work Completed:

a. No release controls associated with this unit. During the visual site inspection, the unit was covered with grass, and a sparse stand of trees separated the area from the water's edge.

b. As required by the NEODTC RCRA Corrective Action Permit, an RFI/ VI Report was completed (draft) in January 1998.

8. Current Status:

Awaiting Initiation of Site Screening Process.

RANGE 6

IR Site 61
(Stump Neck Annex SWMU 5)
Fact Sheet

1. Contamination:

Explosives. The area was used as a demolition range. The site consists of five ranges that were used for open detonation training. Small amounts (less than two to three pounds) of explosives were used. Unexploded ordnance was open-detonated in place.

2. Location:

Range 6 is located at the end of Archer Avenue, on a point of land extending into the Potomac River and Chicamuxen Creek. This unit is located within the 100-year flood plain.

3. From:

Wastes that were managed in this unit include small quantities of shrapnel and casings from detonation of explosives.

4. When:

This unit has been phased out since the EOD school relocated to Florida during early 1998. The range is currently inactive.

5. Generated By:

EOD school training.

6. Amount:

This unit was used on a weekly basis, depending on the number of recruits at any given time.

7. Work Completed:

a. A verification investigation was completed in June 1996. The report on the investigation recommended that additional field investigations be conducted at the site.

b. As required by the NEODTC RCRA Corrective Action Permit, an RFI/VI Report was completed in draft in January 1998. That document recommended consideration for implementing a feasibility study or land use restrictions.

8. Current Status:

Awaiting Initiation of Site Screening Process.

AIR BLAST POND

(OLD MAP GRID F15)
IR Site 62
(Stump Neck Annex SWMU 6)
Fact Sheet

1. Contamination:

Explosives include Pentolite, HBX1, HBX2, H6, and C4 Propellant (similar to lead azide).

2. Location:

Adjacent to Chicamuxen Creek near industrial outfall IW 32.

3. From:

Explosives testing.

4. When:

Used by the facility from 1955 to 1975; has not been in service for 15 to 20 years.

5. Generated By:

The unit consists of an unlined earthen pit, measuring approximately 100 feet in diameter, with a capacity of 1.3 million gallons. During operation, explosives were detonated above water and in water during testing. The pit was filled with water from Chicamuxen Creek through a steel, 14-inch-diameter pipe at a rate of 1,300 gallons per minute. Wire was strung across the pit to measure the concussion factor of explosives above water. The water in the pond was periodically discharged into Chicamuxen Creek through the same pipe (IW 32). The pond was emptied two to three times per year. The unit is located in a wooded area of the facility.

6. Amount:

According to an interview of a former facility employee conducted by the Naval Explosive Ordnance Disposal Technology Center, a maximum of eight pounds of explosives were used per detonation event (shot). During the unit's period of operations, three to four shots were conducted per day, with an estimated total of 1,500 shots over the unit's active life.

7. Work Completed:

As required by the NEODTC RCRA Corrective Action Permit, a VI/RFI Report was completed (draft) in January 1998. That document recommended consideration of a No-Action-Decision for this site.

8. Current Status:

Awaiting Initiation of Site Screening Process.

Currently designated as Munitions Response Program site UXO 000001.

AREA 8

IR Site 63
(Stump Neck Annex SWMU 25)
Fact Sheet

1. Contamination:

Area 8 is an active facility used to train military personnel to defuse explosive devices. Explosives were detected in sediment samples collected at Area 8.

2. Location:

Located on Roach Road. Access to the site is controlled by a fence and a gate located on Archer Avenue. Area 8 is approximately 9.6 acres in size.

3. From:

At the water-shot locations, the explosive is placed 2 to 5 feet below the water surface. At the air-shot locations, the explosive is suspended (on wire) approximately 2 feet above ground. The types of ordnance that is used includes TNT stock, PETN, military dynamite, blasting caps, detonation cord, and similar devices.

4. When:

EOD School relocated in 1998.

5. Generated By:

EOD School training.

6. Amount:

Training exercises at Area 8 are performed 10 months a year. It is estimated that approximately 50 to 75 pounds (net explosive weight) of explosives are used at this training facility each year. No more than 0.5 pound of explosives is used at the air- or water-shot locations during training exercises.

7. Work Completed:

A verification investigation was completed in January 1996. The report recommended no further remedial action for the site, because contaminants detected at the site are unlikely to pose a risk to human health and the environment based on a future industrial land use scenario.

8. Current Status:

Awaiting Initiation of Site Screening Process.

Currently designated as Munitions Response Program site UXO 000002.

IMPROVISED EXPLOSIVE DEVICES (IED) SITE

IR Site 64
(Stump Neck Annex SWMU 26)
Fact Sheet

1. Contamination:

Training operations were performed at this site to demonstrate that household and other easily obtained chemicals could be used to make IEDs. During these operations, small amounts of residual waste were discarded on the ground. These waste chemicals included small amounts of silver nitrate.

2. Location:

Near Building 2118.

3. From:

Residual waste discarded on the ground.

4. When:

Since November 1957, the IED has been used to test and demonstrate the explosive potential of chemical mixtures.

5. Generated By:

Training demonstrations.

6. Amount:

Unknown.

7. Work Completed:

A verification investigation was completed in January 1996. The report recommended no further remedial action for the site, because contaminants detected at the site are unlikely to pose a risk to human health and the environment based on a future industrial land use scenario.

8. Current Status:

Awaiting Initiation of Site Screening Process.

Currently designated as a closed range.

INERT ORDNANCE DISPOSAL SITE (IOD)

IR Site 65
(Stump Neck Annex SWMU 27)
Fact Sheet

1. Contamination:

Inert Ordnance Disposal Site. This site consists of a cement bunker where inert ordnance and inert training aids were discarded.

2. Location:
3.

South of Building 2074SN.

3. From:

Historical activities at the IOD are not well documented, but the site was apparently used for disposal of inert ordnance.

4. When:

The initial date when the scrap metal was discarded is unknown.

5. Generated By:

Based on current information, only inert metal scrap was placed in this bunker. A layer of cement was poured over the metal scrap.

6. Amount:

Unknown.

7. Work Completed:

A verification investigation was completed in January 1996. The report recommended no further remedial action for the site, because contaminants detected at the site are unlikely to pose a risk to human health and the environment based on a future industrial land use scenario.

8. Current Status:

Awaiting Initiation of Site Screening Process.

Currently designated as Munitions Response Program site UXO 000005.

WASTE OIL STORAGE SITE

(OLD MAP GRID D15)
IR AOC
(Stump Neck Annex SWMU 12)
Fact Sheet

1. Contamination:

Waste oil.

2. Location:

Designated area of storage lot near Building 2019.

3. From:

Waste oil is stored in 55-gallon drums on wooden pallets in an asphalt-covered area surrounded by a chain-link fence.

4. When:

Since approximately 1985.

5. Generated By:

The waste oil is generated by vehicle maintenance operations and employee self-help oil changes at NAVEODTECHCEN. The waste is periodically collected from the storage site by Property Disposal (located off-site at the Indian Head Naval Ordnance Station) for off-site recycling or disposal.

6. Amount:

Unknown.

7. Work Completed:

a. The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

b. This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

This unit will be eliminated from further consideration in the IR Program and will be removed from the next version of the Site Management Plan.

PINK WATER TREATMENT TANK AND ASSOCIATED TRENCHES

IR AOC
(Stump Neck Annex SWMU 13)
Fact Sheet

1. Contamination:

TNT, RDX, and various other forms of explosives. Types of explosives treated at the unit have included Tolite, RDX, RDX/Octal, TNT, Comp B, TD-50, H-6, and Black Powder. Spent carbon contaminated with explosives (KO45).

2. Location:

Building 2057, northeast of the Range 3 Bum Point (SWMU 2).

3. From:

"Pink water" (KO47) that is contaminated with explosive residue. This contaminated water is collected and treated on site at the Pink Water Treatment Tank.

4. When:

Used from April until October each year since the permit was granted on November 14, 1985.

5. Generated By:

Pink water is generated at the facility by a process in which explosive residues are removed from various types of ordnance. The treatment unit is a RCRA-regulated unit. The explosive is removed by steaming the interior of the ordnance casing.

The contaminated water is collected and treated on site at the Pink Water Treatment Tank. As the pink water is generated during steaming, the water is collected in a concrete trench that directs the waste to a 1,500-gallon stainless-steel collection tank. The collection tank and additional treatment units are located in below-ground, concrete secondary containment structures. Treatment consists of filtering to remove solid explosive particles and activated carbon adsorption for removal of organic constituents. The carbon filters are assembled in two inline, 55-gallon drums. Following treatment, the water is discharged through a plastic pipe to NPDES outfall IW 49 on Chicamuxen Creek. The filter materials are periodically thermally treated at the Range 3 Bum Point (SWMU 2), and the spent carbon (KO45) is shipped off-site for disposal.

6. Amount:

Unknown.

7. Work Completed:

a. The facility was authorized to treat pink water from TNT operations under Controlled Hazardous Substances Facility Permit Number A-223a, issued by the Maryland Department of the Environment. The permit is dated November 14, 1985, authorizes the K047 waste to be treated by filtration and activated carbon adsorption. Filtration sludges (KO45) are drummed and shipped off-site for disposal. The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

b. This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

The decision reached during the desktop audit was that this unit should continue to be managed within the RCRA process.

SPENT PHOTOGRAPHIC SOLUTION STORAGE

(OLD MAP GRID G11)
IR AOC
(Stump Neck Annex SWMU 15)
Fact Sheet

1. Contamination:

Silver, sodium thiosulfate, and hydroquinone.

2. Location:

Photographic Laboratory, Building 22SN.

3. From:

The visual site inspection (VSI) team observed a drum containing spent photographic solution staged outside the building.

4. When:

At the time of the VSI in 1989.

5. Generated By:

Spent photographic solution is collected and stored at the Photographic Laboratory, Building 22SN. The spent photographic solution is stored in a 50-gallon polyethylene tank prior to shipment off site for silver recovery.

6. Amount:

One 55-gallon drum

7. Work Completed:

a. According to information provided by the facility after the VSI, the drums are normally staged indoors until they are transferred off-site. The drum observed during the VSI was prematurely moved outside for shipment.

b. The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

c. This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

The decision reached during the desktop audit was that no action should be taken in connection with this unit.

THERMAL TREATMENT TANK

IR AOC
(Stump Neck Annex SWMU 16)
Fact Sheet

1. Contamination:

The Thermal Treatment Tank is used for burning explosives and explosive-contaminated items.

2. Location:

Range 3 Bum Point (SWMU 2). Ash was observed on bare soil immediately beneath and around the unit.

3. From:

The Thermal Treatment Tank is an open-top, steel tank used for burning explosives and explosive-contaminated items. The tank is approximately 5 feet tall by 3 feet wide.

4. When:

Currently active.

5. Generated By:

Ash from the Thermal Treatment Tank was disposed one time in the Rum Point Landfill (SWMU 1). The ash is being tested for TCLP Toxicity. If hazardous, the ash is manifested as a hazardous waste. Otherwise, it is disposed in an off-site sanitary landfill.

6. Amount:

Unknown.

7. Work Completed:

a. During the visual site inspection, the tank was located on bare soil approximately 15 feet from Chicamuxen Creek's edge.

b. The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

c. This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

The decision reached during the desktop audit was that this unit will be investigated as part of the Remedial Investigation for Site 58.

BUILDING 2015-CHEMISTRY LAB ACCUMULATION AREA

(OLD MAP GRID S9)
IR AOC
(Stump Neck Annex SWMU 17)
Fact Sheet

1. Contamination:

Waste enamel, epoxy compound, capicure EH-30, and a resinous chlorinated paraffin (chlorowax 40).

2. Location:

This unit is located inside Building 2015.

3. From:

The unit consists of a metal-covered workbench used to store approximately 25 small metal and glass containers of spent chemicals. The containers are labeled and contained in zip-lock plastic bags.

4. When:

The waste, which was observed during the visual site inspection (VSI), had been stored here since the chemistry lab began operations approximately 20 years ago.

5. Generated By:

Unknown.

6. Amount:

Small containers of unknown volume

7. Work Completed:

a. In addition to a VSI according to facility representatives, prior to disposal off-site, the containers were placed in over-pack drums and transferred to the Main Area.

b. The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

c. This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

The decision reached during the desktop audit was that no action should be taken in connection with this unit.

WASTE PILE

(OLD MAP GRID F14)
IR AOC
(Stump Neck Annex SWMU 18)
Fact Sheet

1. Contamination:

Unknown.

2. Location:

This unit is adjacent to the Air Blast Pond (SWMU 6). Facility representatives indicated that this area was originally identified in an aerial photo, which showed a mounded area.

3. From:

Facility representatives indicated that the mounding seen in an aerial photo may have been excavated material from construction of the Air Blast Pond (SWMU 6).

4. When:

Unknown.

5. Generated By:

Construction excavation.

6. Amount:

Unknown.

7. Work Completed:

a. During the visual site inspection, the unit consisted of a flat, earthen area that was covered with grass. The unit is separated from the Air Blast Pond by a densely wooded area.

b. The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

c. This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

The decision reached during the desktop audit was that no action should be taken in connection with this unit.

DISPOSAL AREA NO. 1

(OLD MAP GRID YY21)
IR AOC
(Stump Neck Annex SWMU 19)
Fact Sheet

1. Contamination:

Inert material.

2. Location:

During the visual site inspection the area was observed to slope downhill from the northwest. A bunker, which functions as an office, occupies a portion of the area. The remaining portion consists of a leveled grassy area rimmed with sparse woods on the eastern side. The woods separate the unit from Chicamuxen Creek (south of Building 2063SN)

3. From:

This is an unlined earthen area that was later used for various types of training.

4. When:

Unknown.

5. Generated By:

Unknown.

6. Amount:

The unit's size was estimated to be approximately 1.5 acres.

7. Work Completed:

a. The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

b. This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

The decision reached during the desktop audit was that this unit will be investigated as part of the Remedial Investigation for Site 58.

DISPOSAL AREA NO. 2

(OLD MAP GRID D14)
IR AOC
(Stump Neck Annex SWMU 20)
Fact Sheet

1. Contamination:

Unknown.

2. Location:

This is a relatively flat earthen area that is bounded on the north by the Potomac River. It is located west of Building 2012SN.

3. From:

Facility representatives could not provide information about the composition of the inert material disposed here.

4. When:

Unknown.

5. Generated By:

Unknown.

6. Amount:

Unknown.

7. Work Completed:

a. During the visual site inspection, the area was covered with grass and is currently used as a skeet and trap shooting area.

b. The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

c. This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

The decision reached during the desktop audit was that this unit will be investigated as part of the site screening process for SWMU 28, Old Skeet and Trap Range.

DRUM STORAGE AREA

(OLD MAP GRID YY21)
IR AOC
(Stump Neck Annex SWMU 21)
Fact Sheet

1. Contamination:

Unknown.

2. Location:

This unit is a relatively flat earthen area where several drums of unknown materials and origin were stored on a short-term basis. (West of Building 2012SN)

3. From:

The drums were noted in an aerial photo, and facility representatives could provide no further information.

4. When:

Unknown.

5. Generated By:

Unknown.

6. Amount:

Unknown.

7. Work Completed:

a. At the time of the visual site inspection, no drums were being stored here.

b. The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

c. This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

The decision reached during the desktop audit was that no action should be taken in connection with this unit.

OLD SKEET AND TRAP RANGE

IR AOC
(Stump Neck Annex SWMU 28)
Fact Sheet

1. Contamination:

This area lies on what was originally identified as SWMU 20, Disposal Area 2, in the RCRA corrective action permit. The permit states that, "During the visual site inspection, the area was covered with grass and is currently used as a skeet and trap shooting area." In addition, the permit states, "EPA has determined that no further action is necessary at this time." However, since the draft RFA was written, use of the skeet range has been discontinued. The skeet range was used mainly for recreational purposes. Clay pigeons were used as targets. Therefore, lead shots remain on the ground at the skeet range and in the Potomac River.

2. Location:

West of Building 2012SN.

3. From:

Unknown.

4. When:

Operations began more than 25 years ago and ended in June 1991. The range is currently inactive.

5. Generated By:

Unknown.

6. Amount:

Unknown.

7. Work Completed:

This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

The decision reached during the desktop audit was that this unit should be subjected to the site screening process.

Currently designated as Munitions Response Program site UXO 000015.

SMALL ARMS RANGE (PISTOL RANGE)

(OLD MAP GRID V7)
IR AOC
(Stump Neck Annex SWMU 29)
Fact Sheet

1. Contamination:

The facility Security Department used this site for training for approximately seven years, ending in August 1991. Rounds were fired into the side of a hill. The side of the hill contains lead shots.

2. Location:

Near Building 2070SN.

3. From:

Unknown.

4. When:

Approximately seven years, ending in August 1991

5. Generated By:

Unknown.

6. Amount:

Unknown.

7. Work Completed:

This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

The decision reached during the desktop audit was that, due to lack of information available, this unit should be retained as an area of concern pending additional investigation.

Currently designated as a closed range and included in the Munitions Response Program as site UXO 000017.

PHOTOGRAPHIC LAB SEPTIC TANK SYSTEM

IR AOC
(Stump Neck Annex SWMU 14)
Fact Sheet

1. Contamination:

Possible dilute amounts of silver, sodium thiosulfate, and hydroquinone.

2. Location:

Near Photographic Lab, Building 22SN and X-ray facility, Building 2009, below-ground tank and associated collection and discharge lines and drain field.

3. From:

Discharge of spent fixer and developer from film development.

4. When:

Unknown.

5. Generated By:

In the past, this unit handled wastewater from the photographic lab, which may have contained dilute amounts of silver, sodium thiosulfate, and hydroquinone.

Waste fixers containing silver were drummed and transported off site for silver recovery. The unit handled sanitary wastewater only and was inspected weekly; in accordance with NPDES permit conditions sampling is conducted monthly.

The effluent is chlorinated and discharged to the Potomac River under NPDES permit MD0020885, which was issued in May 1988 and expired in April 1993.

In addition, dilute photographic wastewater is discharged to the Potomac River via NPDES permit #NMOOO3158(EPA) and #88-DP-2515 (MDE).

7. Work Completed:

a. After the visual site inspection, a new septic system was installed, eliminating surface discharge to the Potomac River.

b. The 1990 EPA RCRA Corrective Action Permit stated that no further action was necessary at the time.

c. This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

The decision reached during the desktop audit was that, due to lack of information available, this unit should be retained as an area of concern pending additional investigation.

BUILDING 2015 DRY WELL

IR AOC
(Stump Neck Annex SWMU 30)
Fact Sheet

1. Contamination:

This site consists of a dry well that is connected to a laboratory located in Building 2015.

2. Location:

Industrial Wastewater Outfall 64 (IW 64), Building 2015.

3. From:

Spent chemical reagents from the laboratory were discarded by pouring them down the drain. Currently, only wash water from a hand sink is discharged to the dry well.

4. When:

Approximately 10 years.

5. Generated By:

The overflow from the dry well enters permitted NPDES Outfall IW 64.

6. Amount:

Unknown.

7. Work Completed:

This unit was included in the January 2002 Desktop Audit Decision Document, which was signed by all Remedial Project Managers on April 23, 2002.

8. Current Status:

The decision reached during the desktop audit was that, due to lack of information available, this unit should be retained as an area of concern pending additional information.

3.0 SITE LOCATION SUMMARY

The locations of all the sites and AOCs identified in the previous sections of this Site Management Plan are illustrated in Figure 3-1 and 3-2. Figure 3-1 identifies the locations of the IHDIV-NSWC Main Area sites and AOCs, and Figure 3-2 identifies the locations for the IHDIV-NSWC Stump Neck Annex sites and AOCs.

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SITE KEY

1 Thorium Spill
2 Waste Crank Case Oil Applied to Torrence Road
3 Nitroglycerin Explosion, Nitration Building Area
4 Lloyd Road Oil Spill Sites
5 X-Ray Building 731
6 Building 1349, Hypo Spill
7 HMX Spill, Slurry Mix Building 682
8 Mercury Contamination From Building 766
9 Patterson Avenue Oil Spill
10 Single-base Propellant Grains Spill
11 Caffee Road Landfill
12 Town Gut Landfill
13 Paint Solvents Disposal Dumping Ground
14 Waste Acid Disposal Pit
15 Mercury Deposits in Manhole, Fluorine Lab
16 Laboratory Chemical Disposal
17 Disposed Metal Parts Along Shoreline
18 Hog Island
19 Catch Basin at Chip Collection House (1051)
20 Single-base Powder Facility
21 Bronson Road Landfill
22 NG Slums Burning Site
23 Hydraulic Oil Spill Discharges from Extrusion Plant
24 Abandoned Drain Lines
25 Hypo Discharge X-Ray Building No. 2
26 Thermal Destructor 2
27 Thermal Destructor 1
28 Original Burning Ground
29 The Valley
39 Silver Release to Sediment
40 Silver and Palladium Catalyst in Sediments
41 Scrap Yard
42 Olsen Road Landfill
43 Toluene Disposal Site
44 Soak Out Area
45 Abandoned Drums
46 Cadmium Sandblast Grit
47 Mercuric Nitrate Disposal Area
48 Nitroglycerine Plant Disposal Area
49 Chemical Disposal Pit
50 Building 103, Crawl Space
51/54 Building 101, Dry Well/Building 101
52/55 Building 102, Dry Well/Building 102
53 Mercury Contamination of the Sewage System
56 Lead Contamination at IW Outfall 87
57 Building 292 TCE Contamination

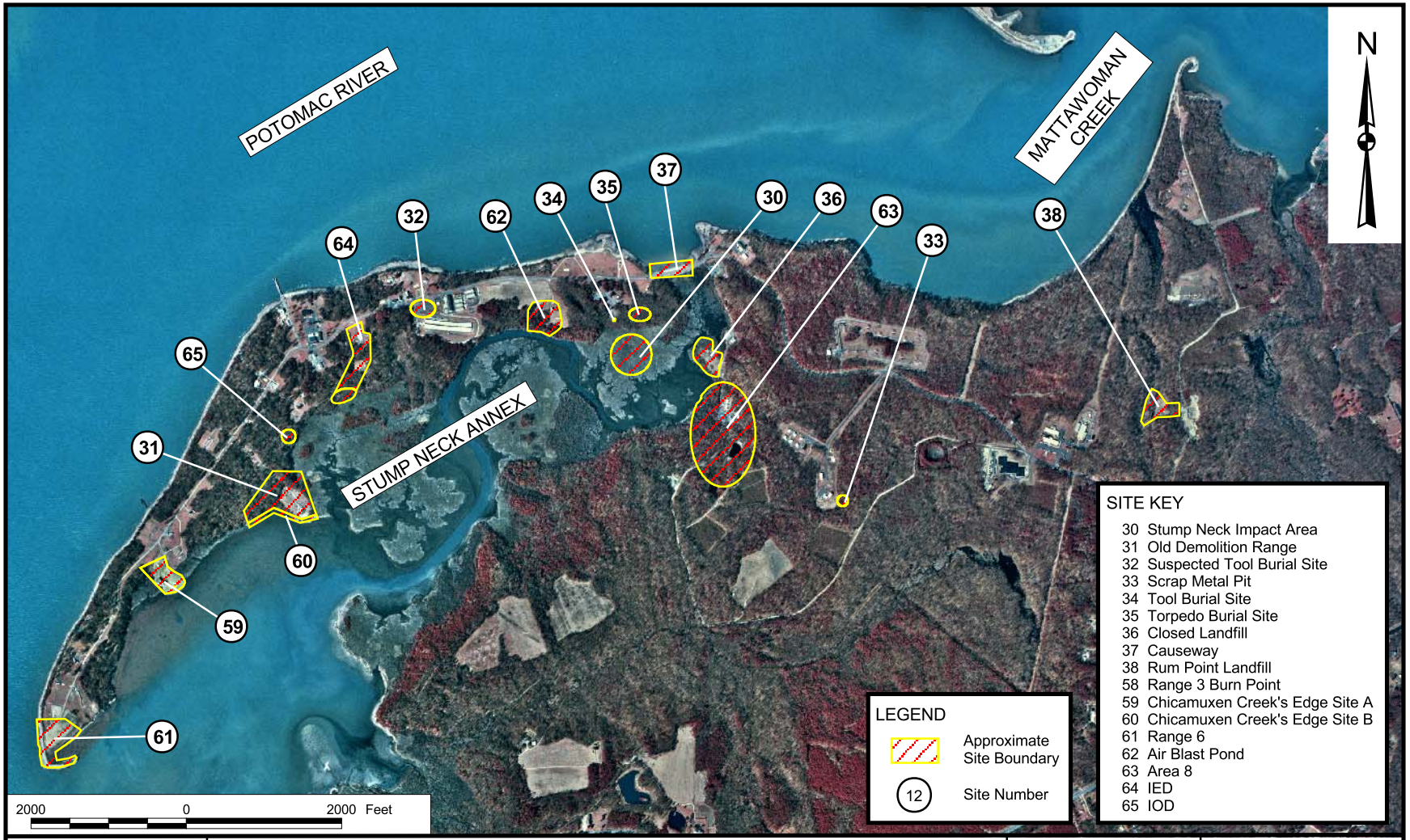
LEGEND

Approximate Site Boundary

12 Site Number

2000 0 2000 Feet

DRAWN BY K. PEILA	DATE 7/26/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER 4019 / OWNER NUMBER —
CHECKED BY GJL	DATE 7/26/02	SITE LOCATION MAP MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY GJL / DATE 8/8/02
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 3 - 1 / REV 0



DRAWN BY: K. PEILA — DATE: 7/26/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NUMBER: —
CHECKED BY: GJL — DATE: 7/26/02	SITE LOCATION MAP STUMP NECK ANNEX IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE 3 - 2	REV: 0

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4.0 SCHEDULES

Table 4-1 provides the schedule for the investigation and reporting of all the IR sites and AOCs identified in the preceding sections of this Site Management Plan.

Table 4-1

NSWC INDIAN HEAD DIVISION
INSTALLATION RESTORATION
TEAM GOAL SUMMARY
FY 03 AND FY 04

SITE	GOAL	PLANNED DATE	REVISED DATE	ACTUAL DATE	COMMENTS (Success stories in blue)
12	**Complete ROD**				
	Complete Draft Final ROD	TBD			Awaiting resolution of LUC issue
	Complete Final ROD	TBD			
	ROD Signed	TBD			
	Complete Remedial Action				
	Complete Construction	Apr-2003			
	Complete PCAS	Dec-2003			
	Complete LUCAP/LUCIP/LTMP	TBD			Awaiting resolution of LUC issue
	Award Long-Term Monitoring	May-2003			
	Implement LUCAP/LUCIP	TBD			
	Implement LTMP	Jun-2003			
41	**Complete ROD**				
	Complete Draft Final ROD	TBD			Awaiting resolution of LUC issue
	Complete Final ROD	TBD			
	ROD Signed	TBD			
	Complete Remedial Action				
	Complete Construction	TBD			Stop work in effect awaiting results of accident investigation
	Complete PCAS	TBD			
	Complete LUCIP/LTMP	TBD			
	Award Long-Term Monitoring	TBD			
	Implement LUCIP	TBD			
	Implement LTMP	TBD			
42	**Complete Feasibility Study**				
	Complete Draft Final FS	Jun-2003			
	Complete Final FS	Nov-2003			
	Complete Proposed Plans				
	Complete Draft PP	Dec-2003			
	Complete Draft Final PP	Mar-2004			
	Complete Final PP	Jun-2004			
	Complete ROD				
	Complete Draft ROD	TBD			Awaiting resolution of LUC issue
	Complete Draft Final ROD	TBD			
	Complete Final ROD	TBD			
	ROD Signed	TBD			
47	**Complete Remedial Investigation**				
	Complete Revised Draft Final RI	Mar-2003			
	Complete Final RI	Jun-2003			
	Complete Feasibility Study				
	Complete Draft FS	Sep-2003			
	Complete Draft Final FS	Dec-2003			
	Complete Final FS	Mar-2004			
	Complete Proposed Plans				
	Complete Draft PP	Apr-2004			
	Complete Draft Final PP	Jul-2004			
	Complete Final PP	Oct-2004			
57	**Complete Feasibility Study**				
	Complete Draft Final FS	Apr-2004			
	Complete Final FS	Sep-2004			
	Complete Proposed Plans				
	Complete Draft PP	Sep-2004			
	Complete Remedial Design				
	Award Remedial Design	Jun-2004			
	Complete 35% RD	Oct-2004			
Site 8	**Complete Remedial Investigation**				
	Award RI/FS	Dec-2003			
	Complete Draft RI WP	Mar-2004			
	Complete Draft Final RI WP	Jun-2004			
	Complete Final RI WP	Sep-2004			
Lab Area (14, 15, 16, 49, 50, 53, 54, 55)	**Complete Remedial Investigation**				
	Complete Draft Final RI	Apr-2003			
	Complete Final RI	Jul-2003			
	Complete Feasibility Study				
	Complete Draft FS	Oct-2003			
	Complete Draft Final FS	Jan-2004			
	Complete Final FS	Apr-2004			
	Complete Proposed Plans				
	Complete Draft PP	Jun-2004			
	Complete Draft Final PP	Aug-2004			

Table 4-1

NSWC INDIAN HEAD DIVISION
INSTALLATION RESTORATION
TEAM GOAL SUMMARY
FY 03 AND FY 04

SITE	GOAL	PLANNED DATE	REVISED DATE	ACTUAL DATE	COMMENTS (Success stories in blue)
	Complete Remedial Design				
	Award Remedial Design	Mar-2004			
	Complete Remedial Action				
	Award Remedial Action	Jul-2004			
11	**Complete Remedial Investigation**				
	Complete Final RI	Apr-2003			
	Complete Feasibility Study				
	Complete Draft FS	Jul-2003			
	Complete Draft Final FS	Oct-2003			
	Complete Final FS	Jan-2004			
	Complete Proposed Plans				
	Complete Draft PP	Feb-2004			
	Complete Draft Final PP	May-2004			
	Complete Final PP	Aug-2004			
	Complete Remedial Design				
	Award Remedial Design	Aug-2004			
13	**Complete Remedial Investigation**				
	Complete Final RI	Apr-2003			
	Complete Proposed Plan				
	Complete Draft PP	Mar-2003			
	Complete Draft Final PP	May-2003			
	Complete Final PP	Nov-2003			
	Complete ROD				
	Complete Draft ROD	Feb-2004			
	Complete Draft Final ROD	May-2004			
	Complete Final ROD	Aug-2004			
	ROD Signed				
17	**Complete Remedial Investigation**				
	Complete Final RI	Apr-2003			
	Complete Feasibility Study				
	Complete Draft FS	Sep-2003			
	Complete Draft Final FS	Dec-2003			
	Complete Final FS	Mar-2004			
	Complete Proposed Plans				
	Complete Draft PP	Apr-2004			
	Complete Draft Final PP	Jul-2004			
	Complete Remedial Design				
	Award Remedial Design	Dec-2003			
21	**Complete Remedial Investigation**				
	Complete Final RI	Apr-2003			
	Complete Feasibility Study				
	Complete Draft FS	Jul-2003			
	Complete Draft Final FS	Oct-2003			
	Complete Final FS	Jan-2004			
	Complete Proposed Plans				
	Complete Draft PP	Feb-2004			
	Complete Draft Final PP	May-2004			
	Complete Final PP	Aug-2004			
25	**Complete Remedial Investigation**				
	Complete Final RI	Apr-2003			
	Complete Proposed Plan				
	Complete Draft PP	Jun-2003			
	Complete Draft Final PP	Aug-2003			
	Complete Final PP	Nov-2003			
	Complete Draft ROD	Feb-2004			
	Complete Draft Final ROD	May-2004			
	Complete Final ROD	Jul-2004			
	ROD Signed				
	Complete Remedial Design				
	Award Remedial Design	Aug-2004			
6	**Complete Remedial Investigation**				
	Complete Draft Final RI	Apr-2003			
	Complete Final RI	Jul-2003			
	Complete Feasibility Study				
	Complete Draft FS	Oct-2003			
	Complete Draft Final FS	Jan-2004			
	Complete Final FS	Apr-2004			

Table 4-1

NSWC INDIAN HEAD DIVISION
INSTALLATION RESTORATION
TEAM GOAL SUMMARY
FY 03 AND FY 04

SITE	GOAL	PLANNED DATE	REVISED DATE	ACTUAL DATE	COMMENTS (Success stories in blue)
	Complete Proposed Plans				
	Complete Draft PP	May-2004			
	Complete Draft Final PP	Aug-2004			
	Complete Final PP	Nov-2004			
39	**Complete Remedial Investigation**				
	Complete Draft Final RI	Apr-2003			
	Complete Final RI	Jul-2003			
	Complete Feasibility Study				
	Complete Draft FS	Oct-2003			
	Complete Draft Final FS	Jan-2004			
	Complete Final FS	Apr-2004			
	Complete Proposed Plans				
	Complete Draft PP	May-2004			
	Complete Draft Final PP	Aug-2004			
45	**Complete Remedial Investigation**				
	Complete Draft Final RI	Apr-2003			
	Complete Final RI	Jul-2003			
	Complete Proposed Plans				
	Complete Draft PP	Sep-2003			
	Complete Draft Final PP	Dec-2003			
	Complete Final PP	Mar-2004			
	Complete ROD				
	Complete Draft ROD	May-2004			
	Complete Draft Final ROD	Aug-2004			
28	**Complete Remedial Investigation**				
	Complete Final RI WP	Apr-2003			
	Complete Draft RI	Oct-2003			
	Complete Draft Final RI	Feb-2003			
	Complete Final RI	May-2004			
	Complete Feasibility Study				
	Complete Draft FS	Aug-2004			
	Complete Remedial Design				
	Award Remedial Design	Aug-2004			
5	**Complete Site Screening Process**				
	Complete Draft Final SSA Report	Apr-2003			
	Complete Final SSA Report	Jun-2003			
	Complete Draft Final DD	TBD			If NFA
	Complete Final DD				
32, 33, 34, 36, 37, 51, 52	**Complete Site Screening Process**				
	Complete Final SSA Report	Mar-2003			
	Complete Draft DD	Apr-2003			
	Complete Final DD	Sep-2003			
Mattawoman Creek	**Complete Eco Risk Assessment**				
	Complete Draft Final ERA Report	Apr-2003			
	Complete Final ERA Report	Jul-2003			
All Sites	**Update Site Management Plan**				
	Complete Draft SMP	Jun-2003			
	Complete Draft Final SMP	Oct-2003			
	Complete Final SMP	Feb-2004			
	Update IHIRT Documents				On-going

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APPENDIX A

IHDIV - MAIN AREA SITE FIGURES

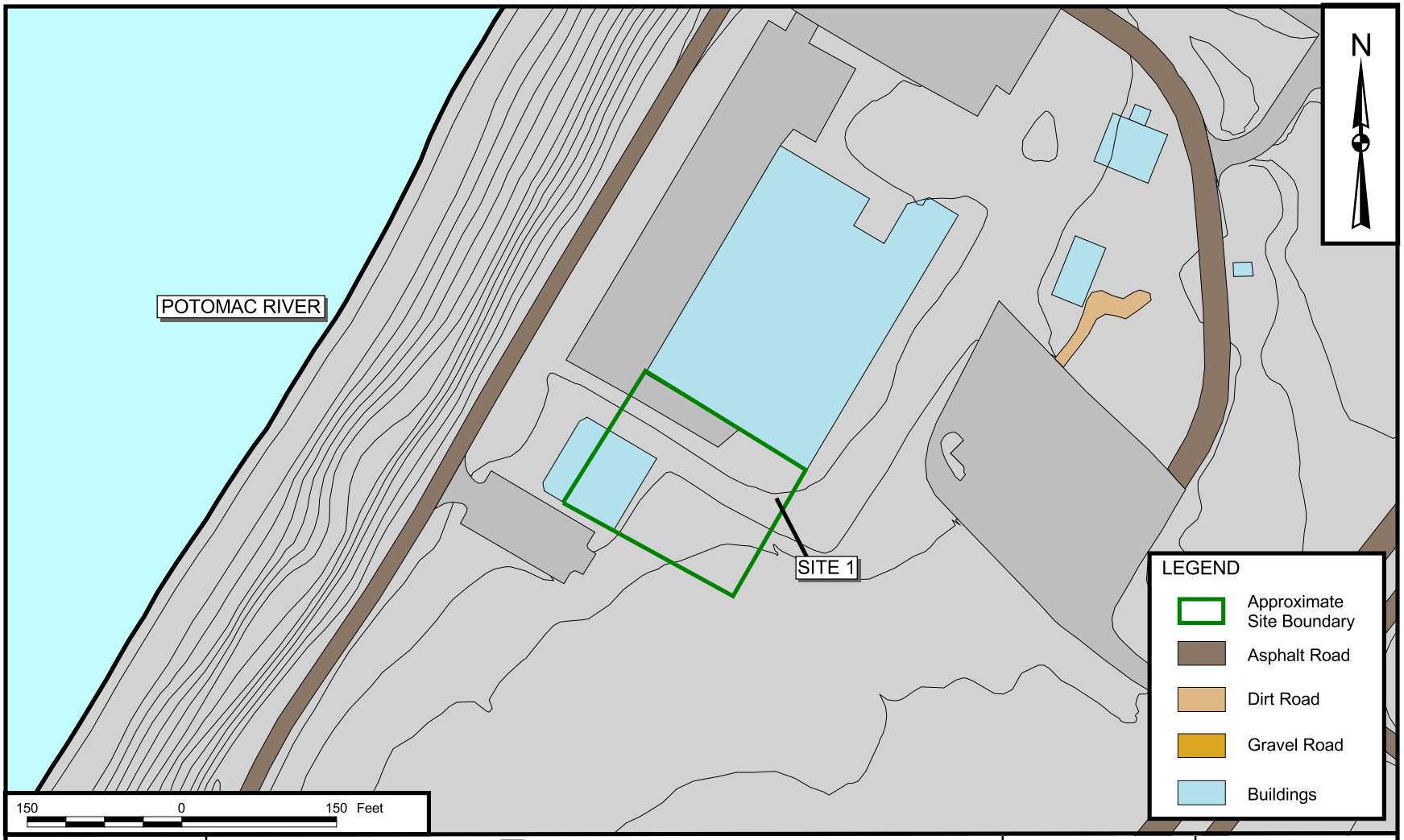
P:\GIS\INDIANHEAD_NSWC\APR\COMMUNITYRELATIONSPLAN.APR CRP-SITELOCATIONS-MAINSITE APPENDIX 5/29/03 KMP

SITE KEY

1 Thorium Spill
2 Waste Crank Case Oil Applied to Torrence Road
3 Nitroglycerin Explosion, Nitration Building Area
4 Lloyd Road Oil Spill Sites
5 X-Ray Building 731
6 Building 1349, Hypo Spill
7 HMX Spill, Slurry Mix Building 682
8 Mercury Contamination From Building 766
9 Patterson Avenue Oil Spill
10 Single-base Propellant Grains Spill
11 Caffee Road Landfill
12 Town Gut Landfill
13 Paint Solvents Disposal Dumping Ground
14 Waste Acid Disposal Pit
15 Mercury Deposits in Manhole, Fluorine Lab
16 Laboratory Chemical Disposal
17 Disposed Metal Parts Along Shoreline
18 Hog Island
19 Catch Basin at Chip Collection House (1051)
20 Single-base Powder Facility
21 Bronson Road Landfill
22 NG Slums Burning Site
23 Hydraulic Oil Spill Discharges from Extrusion Plant
24 Abandoned Drain Lines
25 Hypo Discharge X-Ray Building No. 2
26 Thermal Destructor 2
27 Thermal Destructor 1
28 Original Burning Ground
29 The Valley
39 Silver Release to Sediment
40 Silver and Palladium Catalyst in Sediments
41 Scrap Yard
42 Olsen Road Landfill
43 Toluene Disposal Site
44 Soak Out Area
45 Abandoned Drums
46 Cadmium Sandblast Grit
47 Mercuric Nitrate Disposal Area
48 Nitroglycerine Plant Disposal Area
49 Chemical Disposal Pit
50 Building 103, Crawl Space
51/54 Building 101, Dry Well/Building 101
52/55 Building 102, Dry Well/Building 102
53 Mercury Contamination of the Sewage System
56 Lead Contamination at IW Outfall 87
57 Building 292 TCE Contamination

2000 0 2000 Feet

DRAWN BY: K. PEILA	DATE: 7/26/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019 / OWNER NUMBER: —
CHECKED BY: GJL	DATE: 7/26/02	SITE LOCATION MAP MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL / DATE: 8/8/02
COST/SCHEDULE-AREA			APPROVED BY: — / DATE: —
SCALE: AS NOTED			DRAWING NO.: FIGURE A-1 / REV: 0



DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NUMBER: —
CHECKED BY: GJL — DATE: 8/7/02	SITE 1 - THORIUM SPILL MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE A-2	REV: 0

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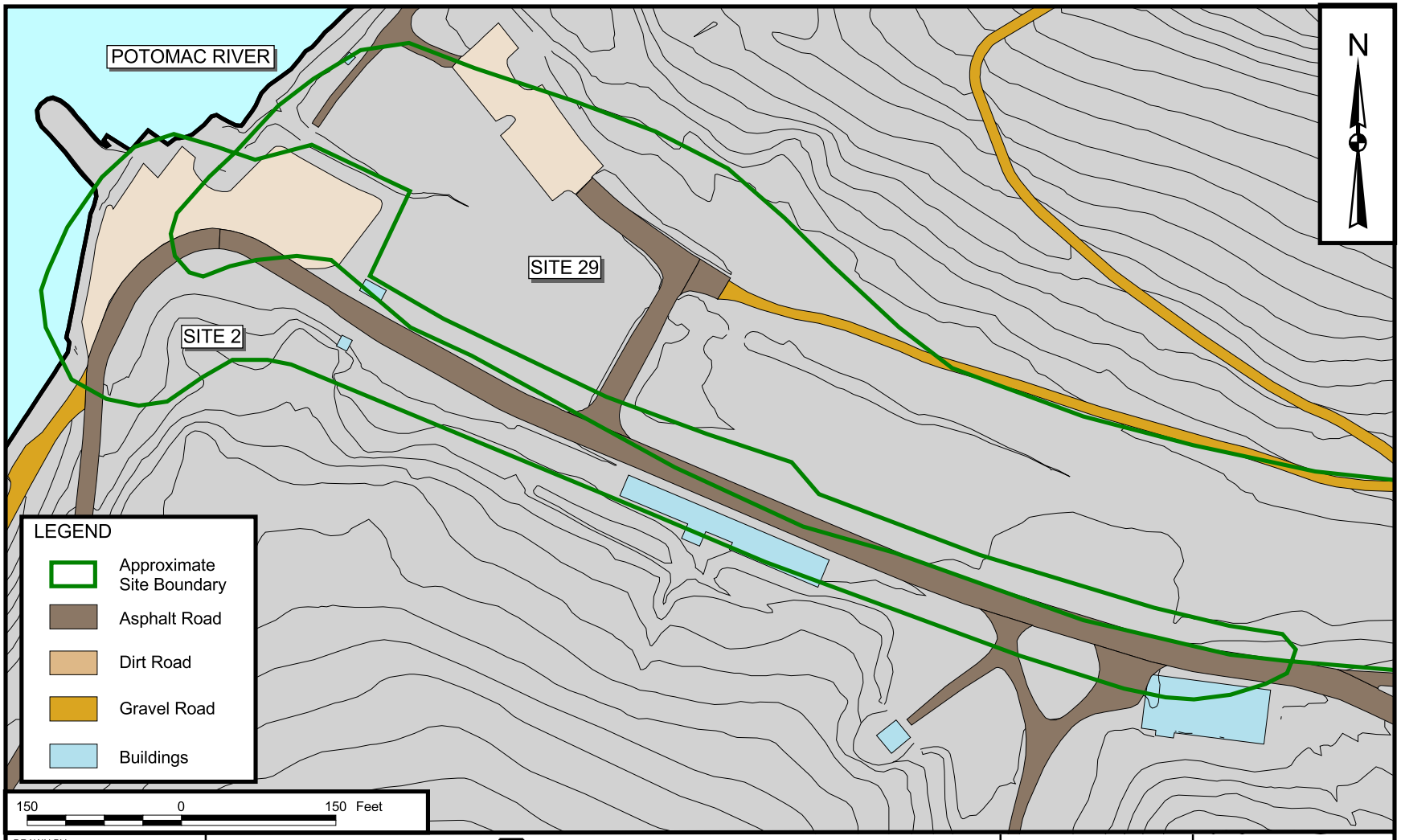
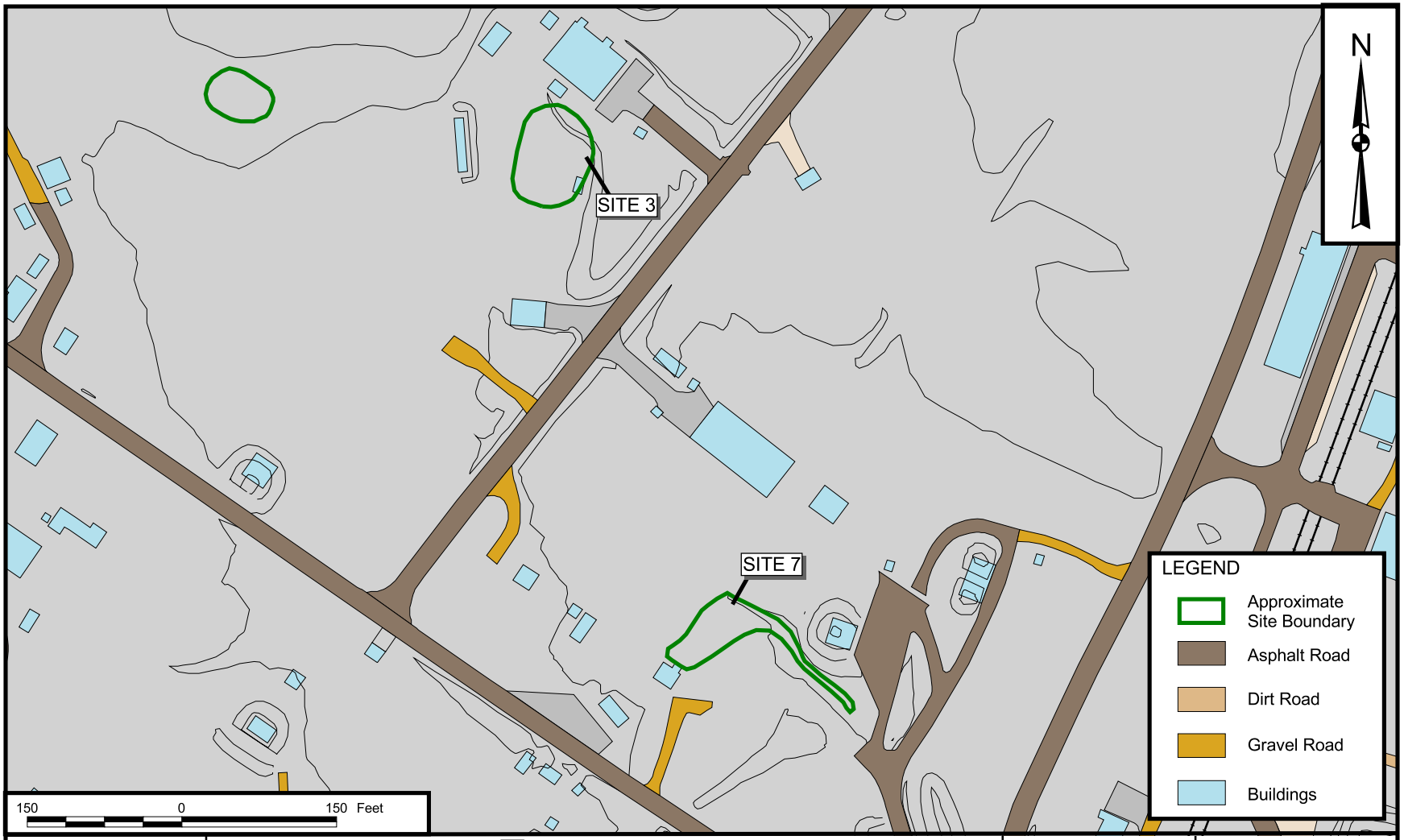


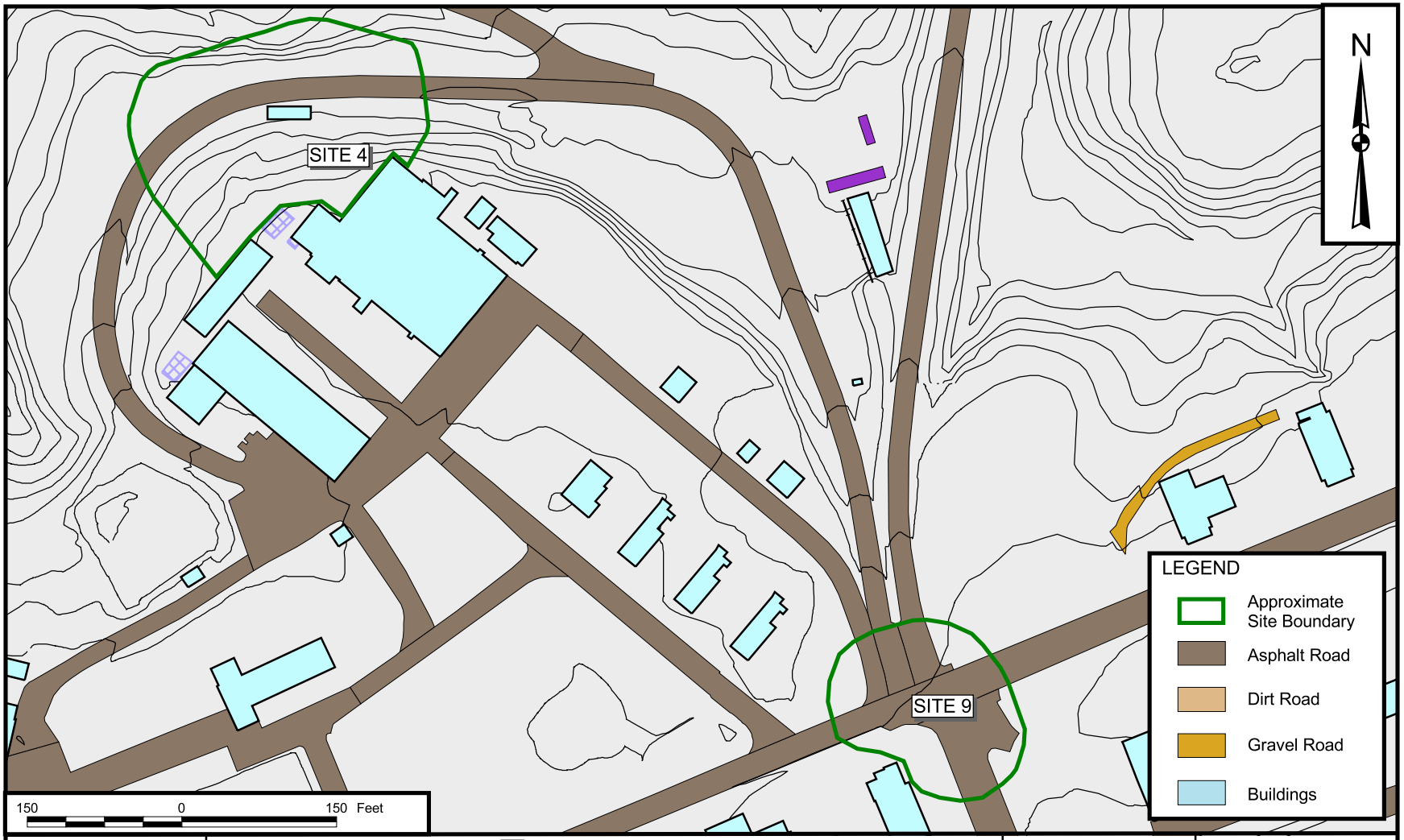
DRAWN BY K. PEILA	DATE 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER 4019 / OWNER NUMBER —
CHECKED BY GJL	DATE 8/7/02	SITE 2 - WASTE CRANK CASE OIL APPLIED TO TORRENCE ROAD AND SITE 29 - THE VALLEY MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY GJL / DATE 8/8/02
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE A-3 / REV 0

P:\GIS\INDIANHEAD_NSWC\APR\COMMUNITYRELATIONSPLAN.APR SITE 02/SITE 29 8/8/02 KMP



DRAWN BY: K. PEILA	DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019 / OWNER NUMBER: —
CHECKED BY: GJL	DATE: 8/7/02	SITE 3 - NITRATION BUILDING AREA AND SITE 7 - HMX SPILL, SLURRY MIX BUILDING 682 MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL / DATE: 8/8/02
COST/SCHEDULE-AREA			APPROVED BY: — / DATE: —
SCALE: AS NOTED			DRAWING NO.: FIGURE A-4 / REV: 0

P:\GIS\INDIANHEAD_NSWC\APR\COMMUNITYRELATIONSPLAN.APR SITE 03/SITE 07 8/8/02 KMP



DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NUMBER: —
CHECKED BY: GJL — DATE: 8/7/02	SITE 4 - LLOYD ROAD SPILL LINES AND SITE 9 - PATTERSON AVENUE OIL SPILL MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE A-5	REV: 0

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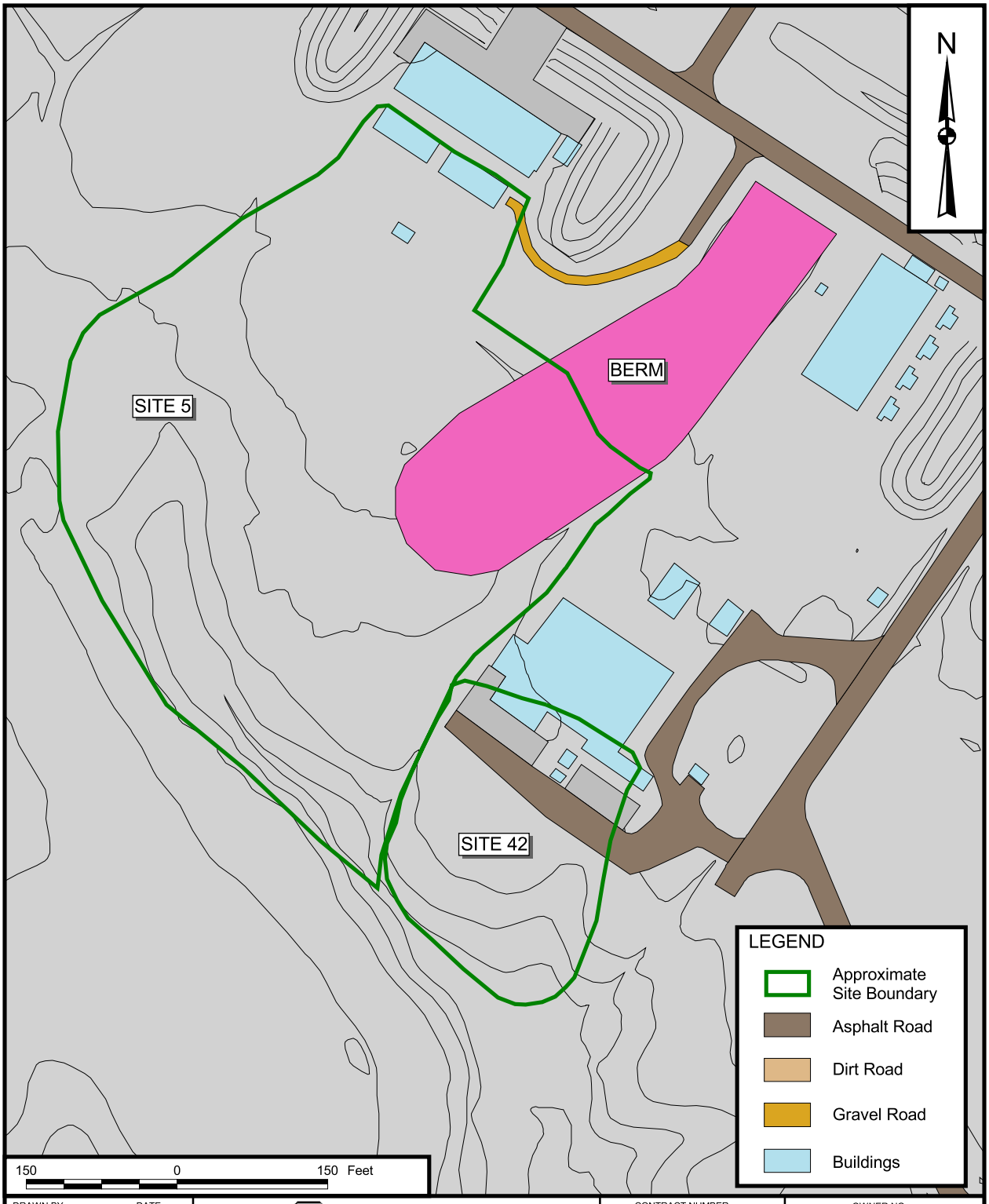

DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NO.: —
CHECKED BY: GJL — DATE: 8/7/02	SITE 5 - X-RAY BUILDING 731 AND SITE 42 - OLSEN ROAD LANDFILL MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE A-6	REV: 0

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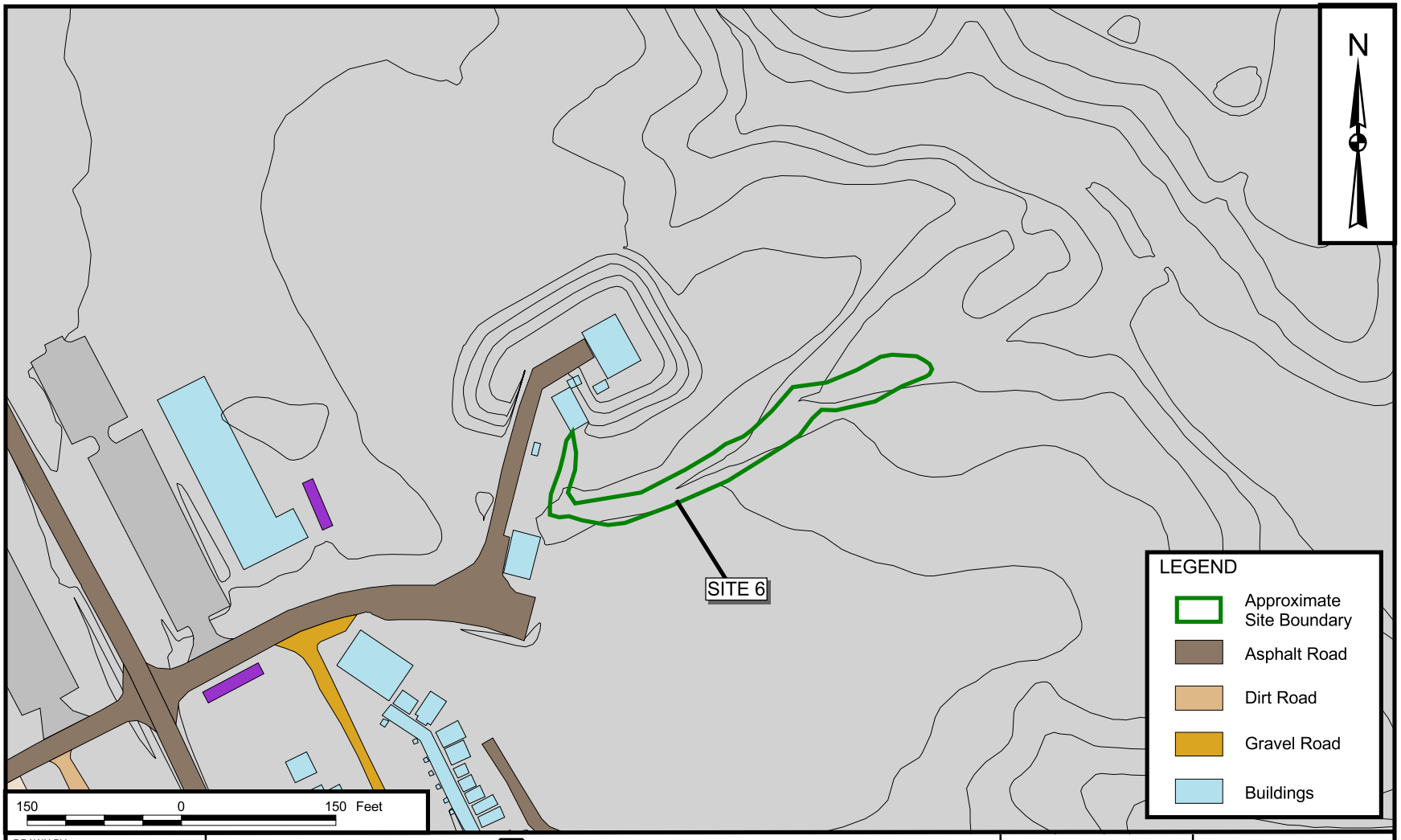

DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NUMBER: —
CHECKED BY: GJL — DATE: 8/7/02	SITE 6 - BUILDING 1349, HYPO SPILL MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE A-7	REV: 0

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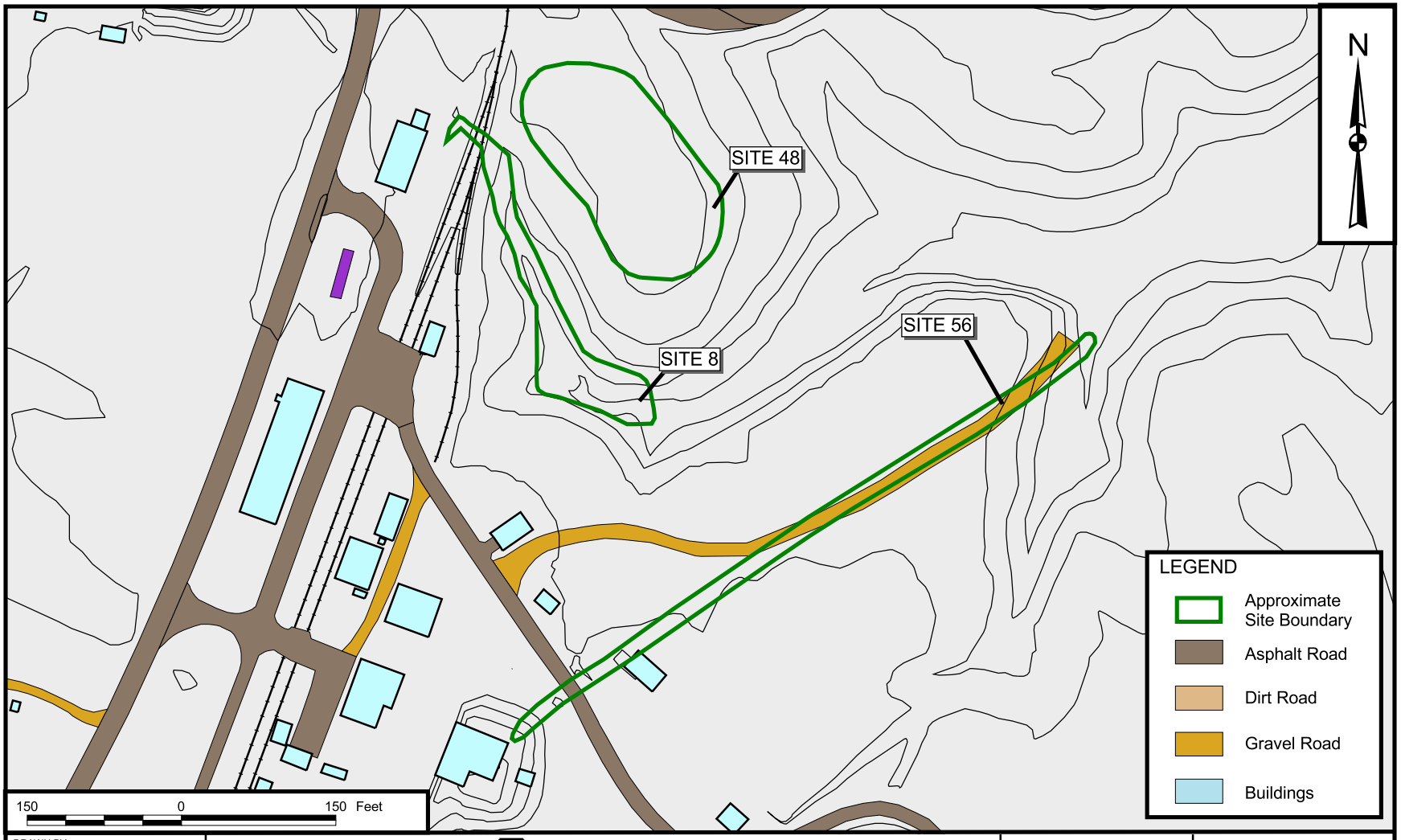

DRAWN BY: K. PEILA	DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019 / OWNER NUMBER: —
CHECKED BY: GJL	DATE: 8/7/02	SITE 8 - MERCURY CONTAMINATION FROM BUILDING 766, SITE 48 - NITROGLYCERIN PLANT DISPOSAL AREA AND SITE 56 - LEAD CONTAMINATION AT IW OUTFALL 87 MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL / DATE: 8/8/02
COST/SCHEDULE-AREA			APPROVED BY: — / DATE: —
SCALE: AS NOTED			DRAWING NO.: FIGURE A-8 / REV: 0

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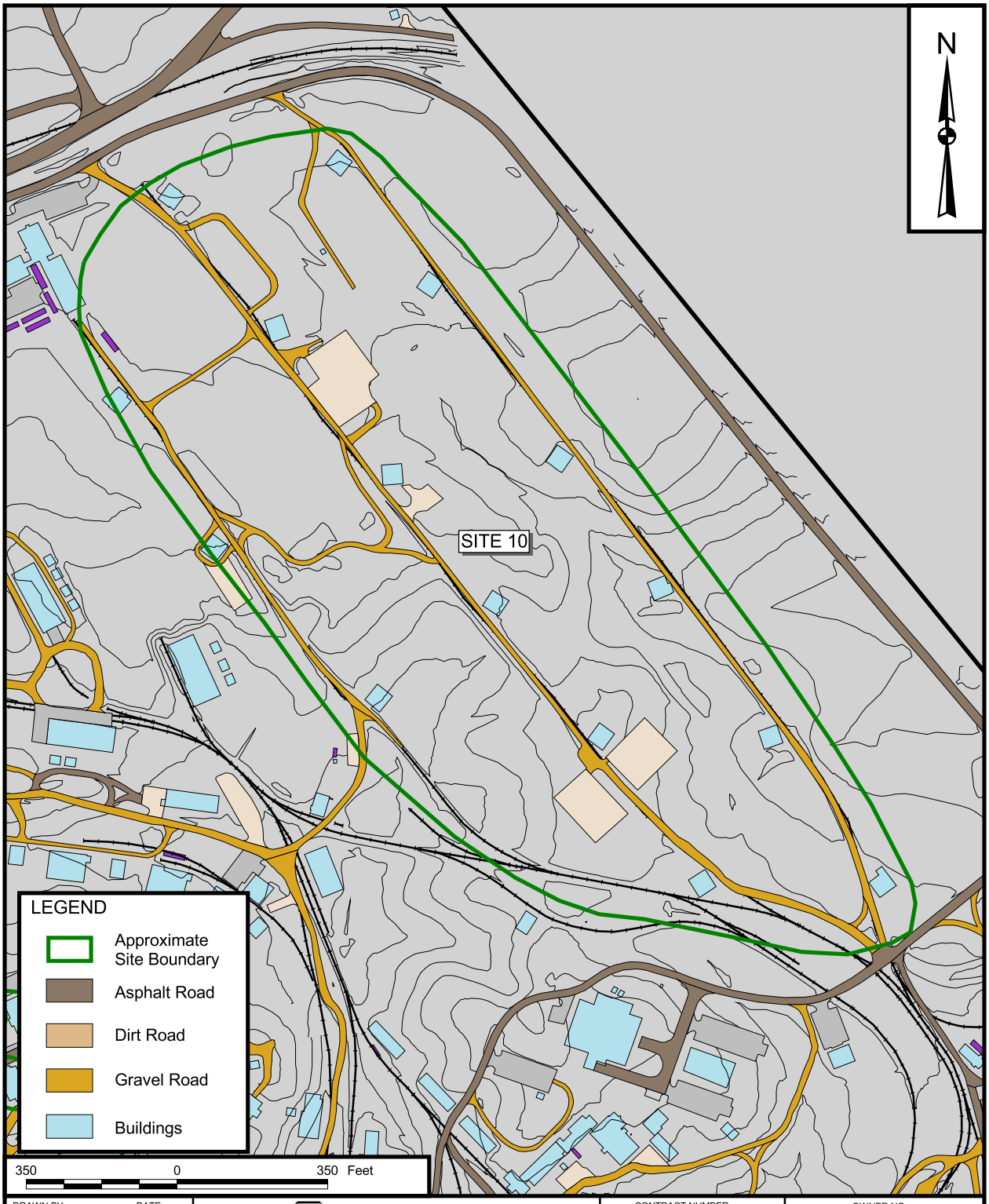

DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NO.: —
CHECKED BY: GJL — DATE: 8/7/02	SITE 10 - SINGLE-BASE PROPELLANT GRAINS SPILL AREA MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE A-9	REV: 0

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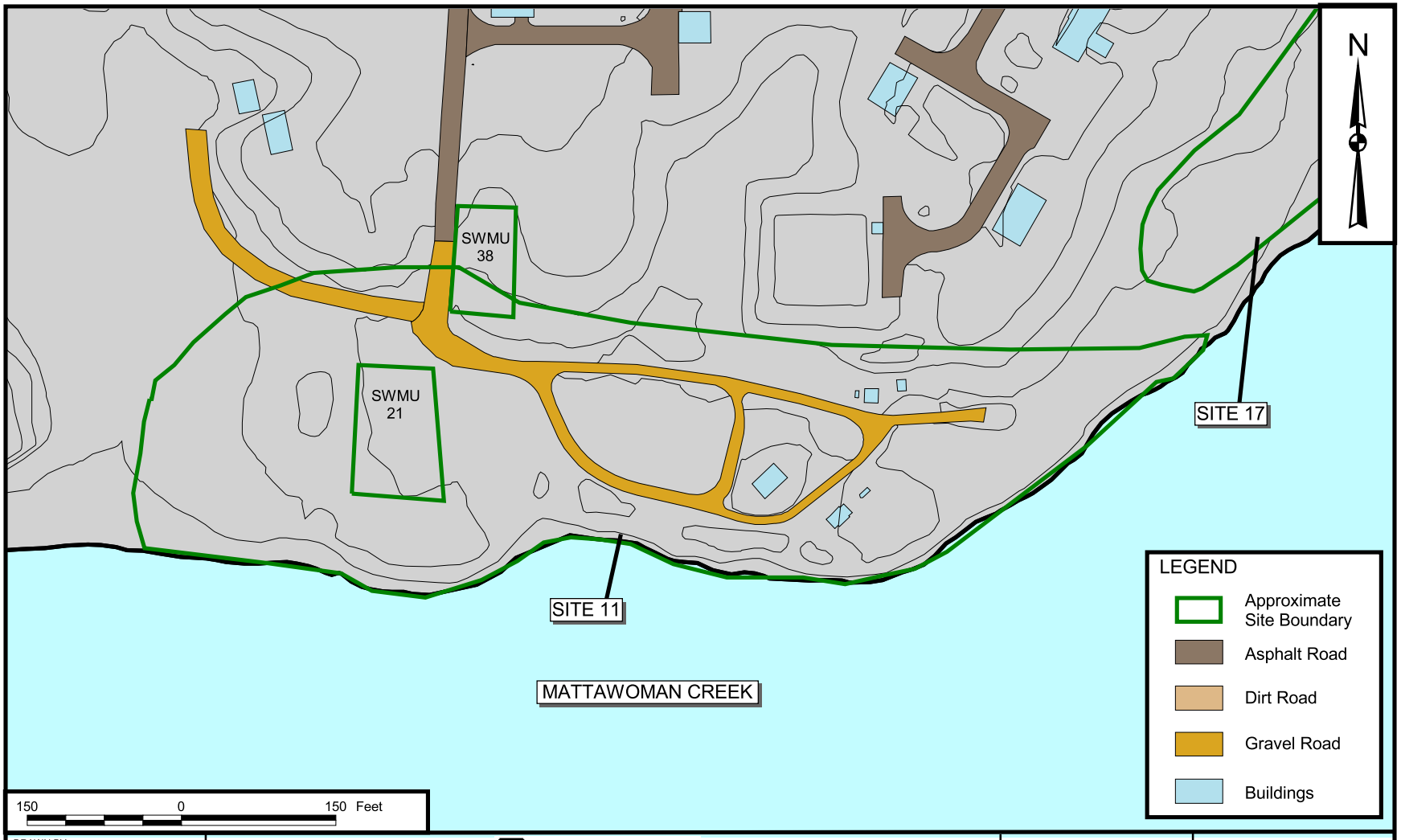

DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NUMBER: —
CHECKED BY: GJL — DATE: 8/7/02	SITE 11 - CAFFEE ROAD LANDFILL MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE A-10	REV: 0

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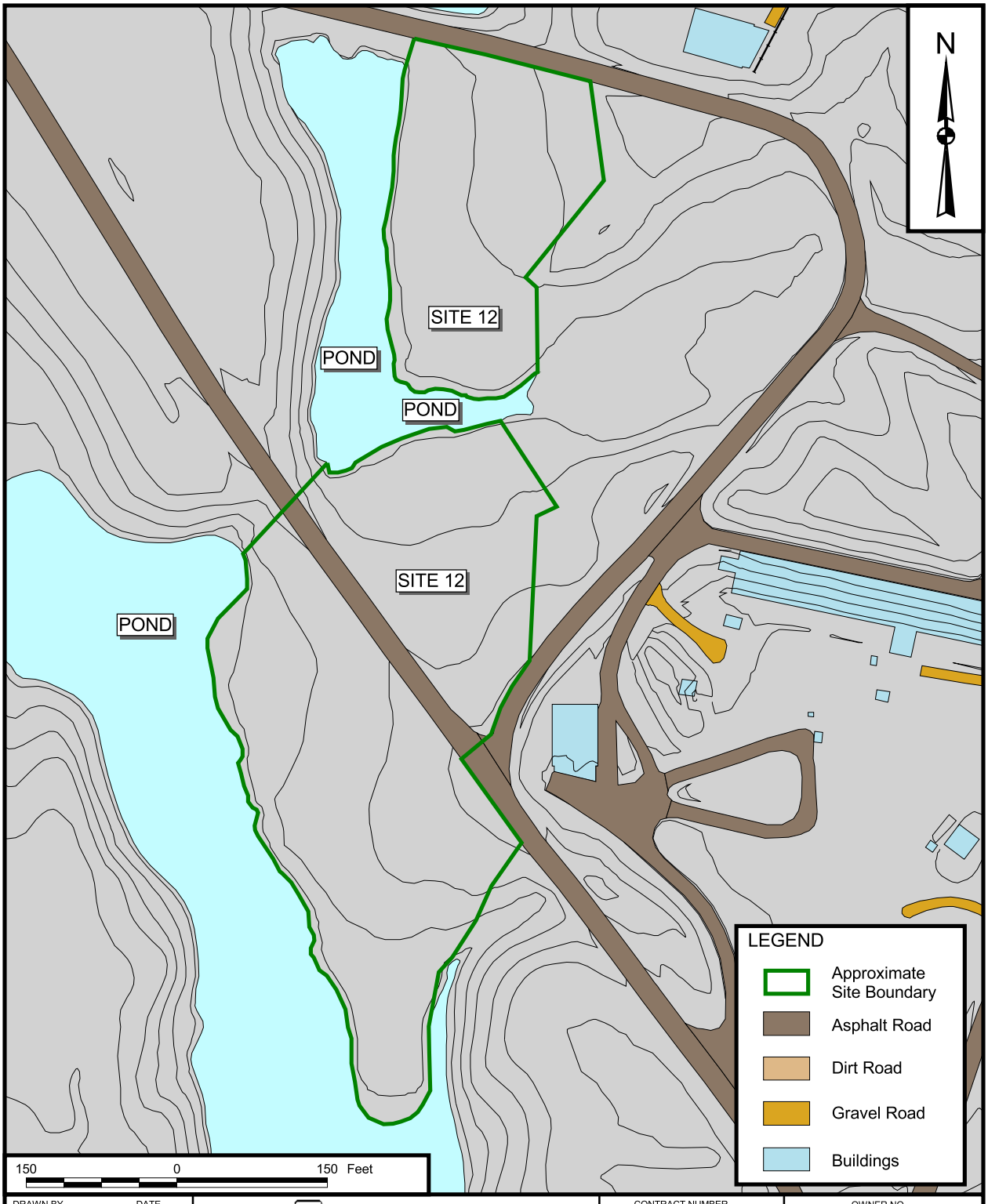

DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NO.: —
CHECKED BY: GJL — DATE: 8/7/02	SITE 12 - TOWN GUT LANDFILL MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE A-11	REV: 0

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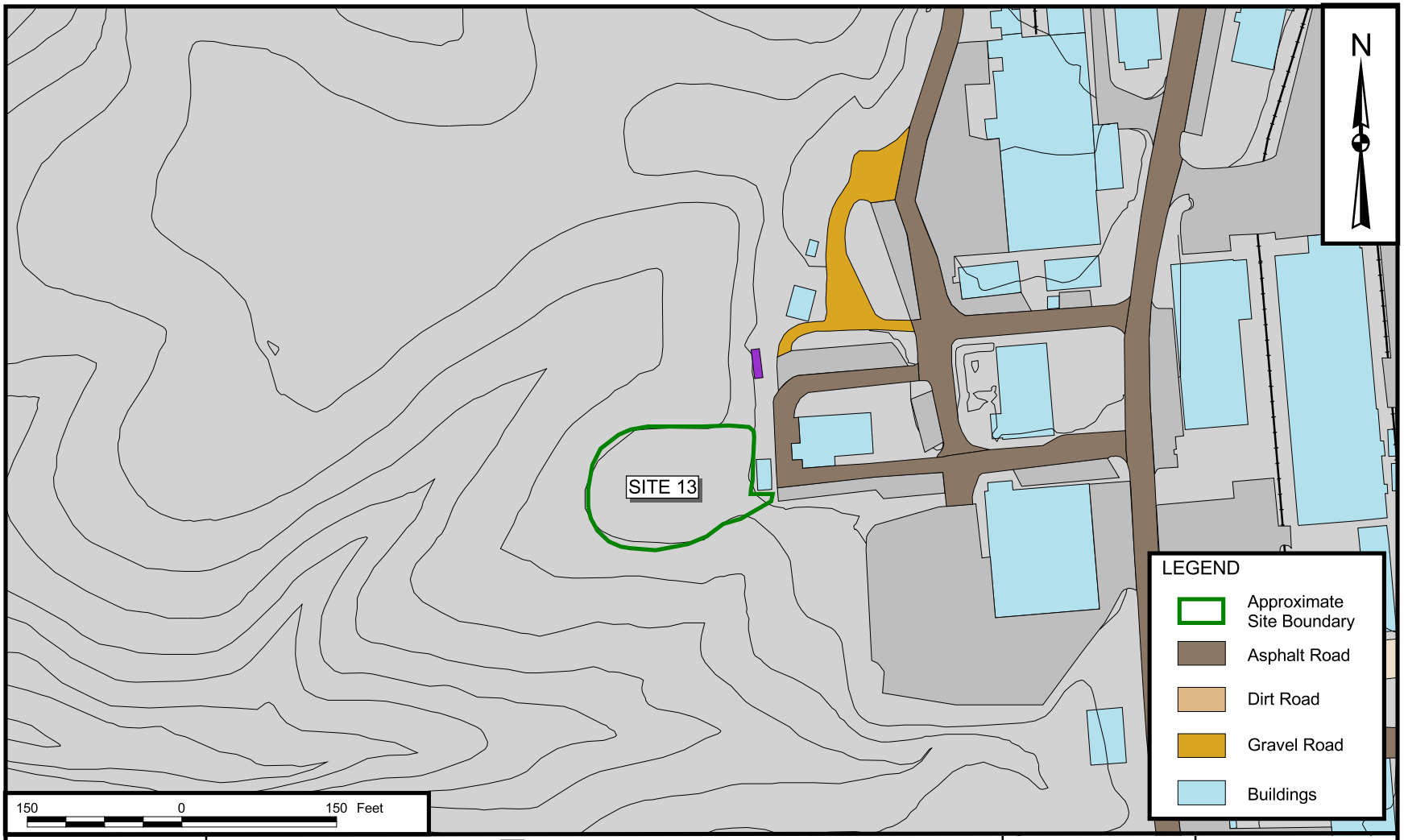

DRAWN BY: K. PEILA	DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019 / OWNER NUMBER: —
CHECKED BY: GJL	DATE: 8/7/02	SITE 13 - PAINT SOLVENTS DISPOSAL DUMPING GROUND MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL / DATE: 8/8/02
COST/SCHEDULE-AREA			APPROVED BY: — / DATE: —
SCALE: AS NOTED			DRAWING NO.: FIGURE A-12 / REV: 0

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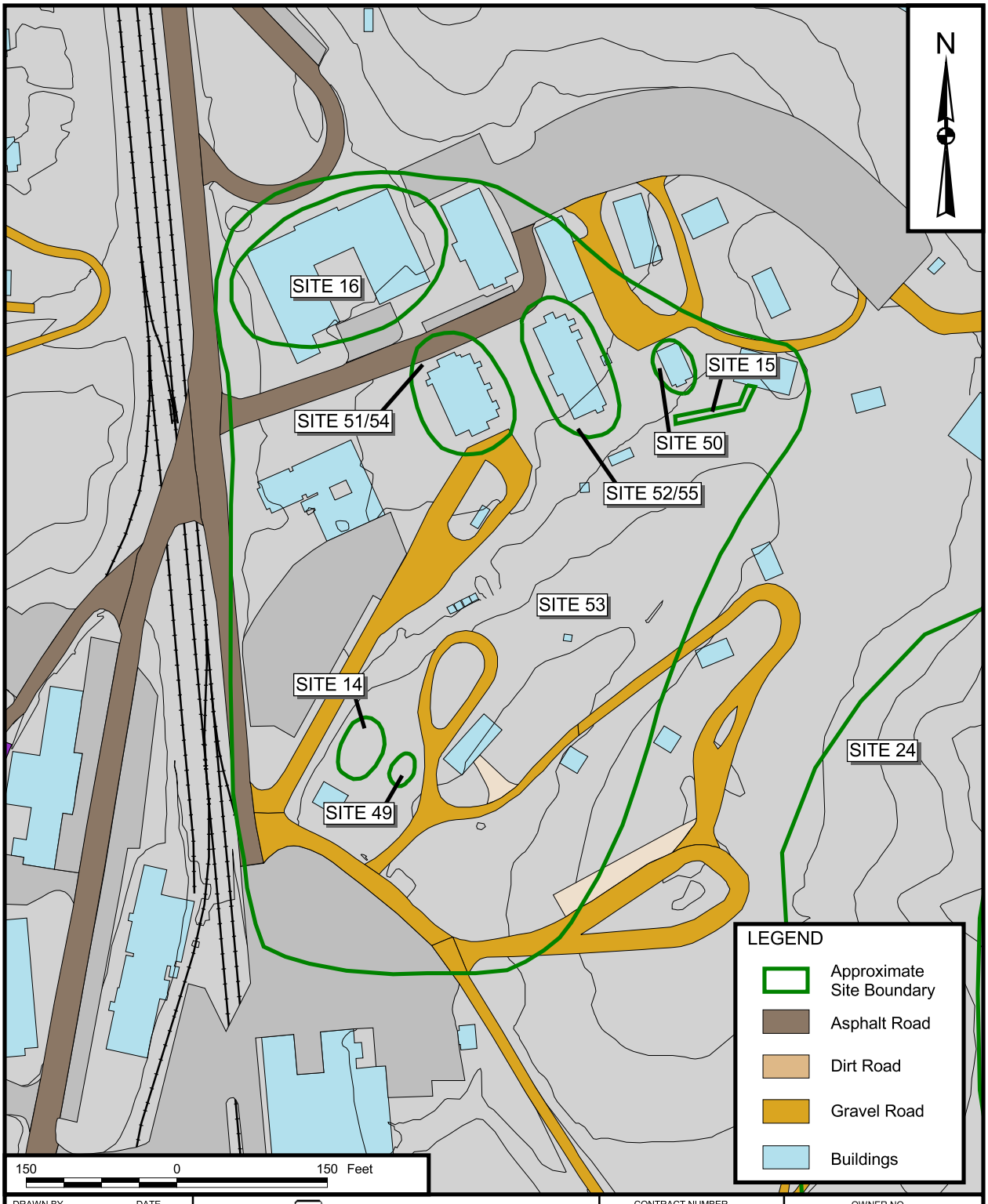

DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NO.: —
CHECKED BY: GJL — DATE: 8/7/02	SITES 14, 15, 16, 49, 50, 51/54, 52/55 AND 53 MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE A-13	REV: 0

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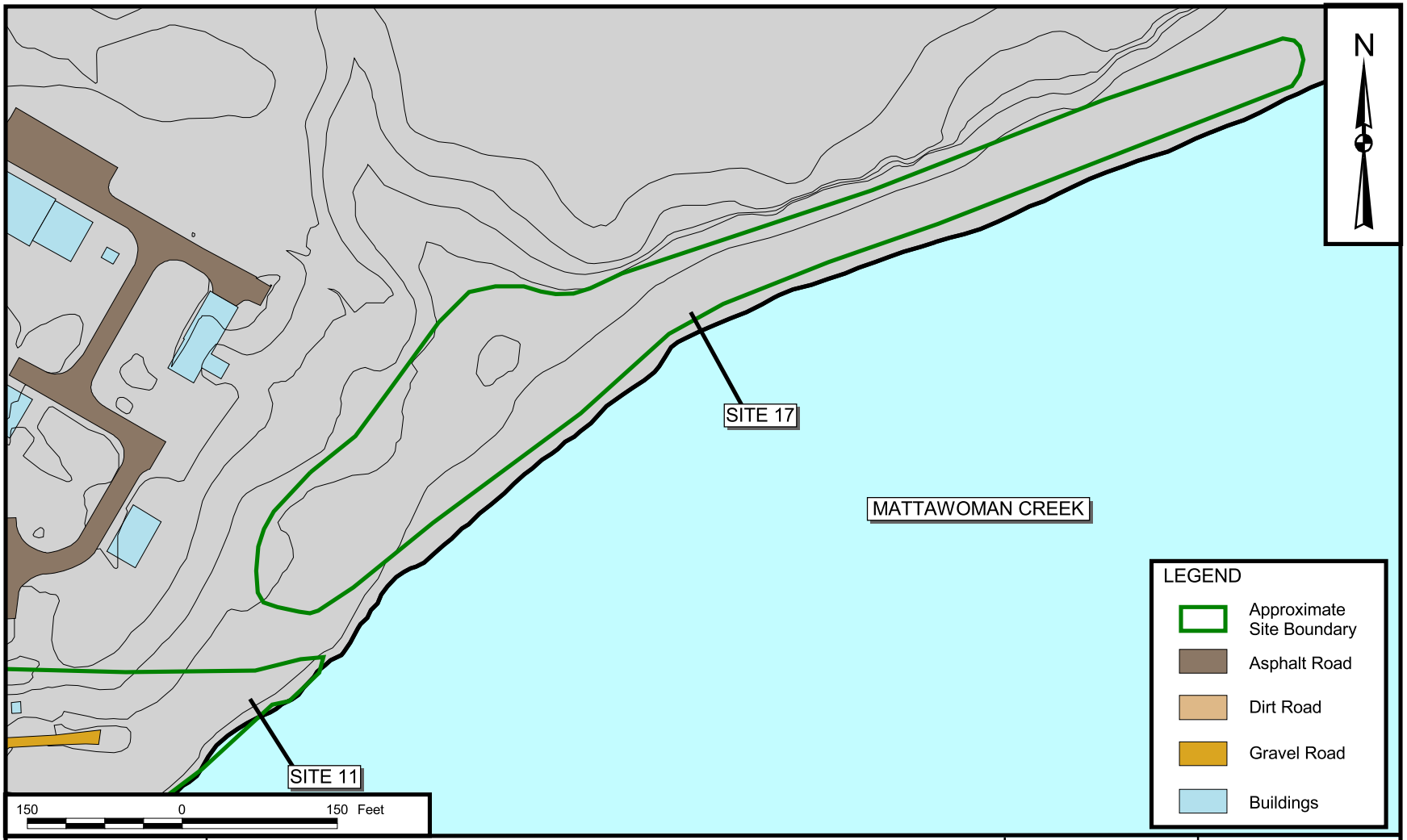

DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NUMBER: —
CHECKED BY: GJL — DATE: 8/7/02	SITE 17 - DISPOSED METAL PARTS ALONG SHORELINE MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE A-14	REV: 0

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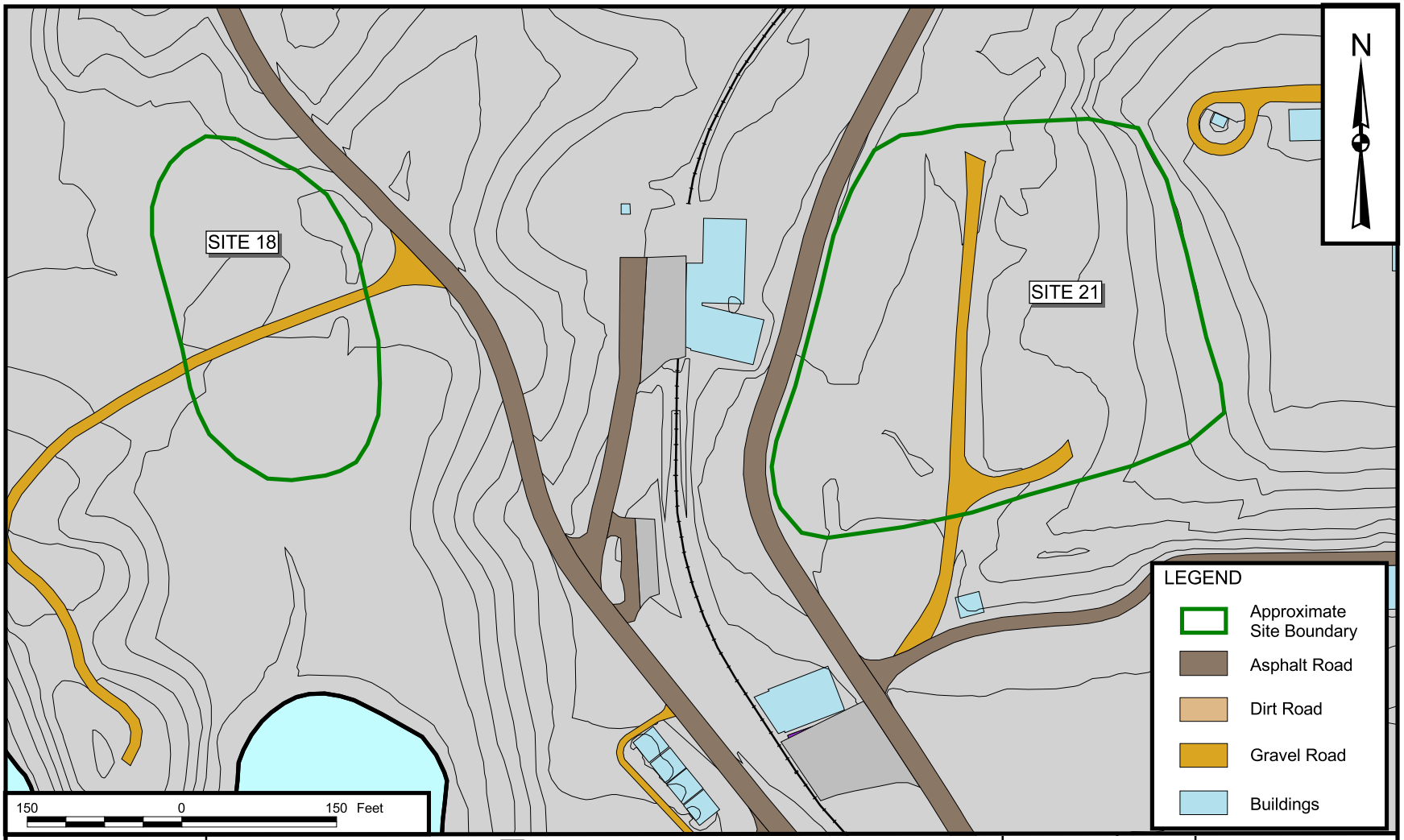

DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NUMBER: —
CHECKED BY: GJL — DATE: 8/7/02	SITE 18 - HOG ISLAND AND SITE 21 - BRONSON ROAD LANDFILL MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE A-15	REV: 0

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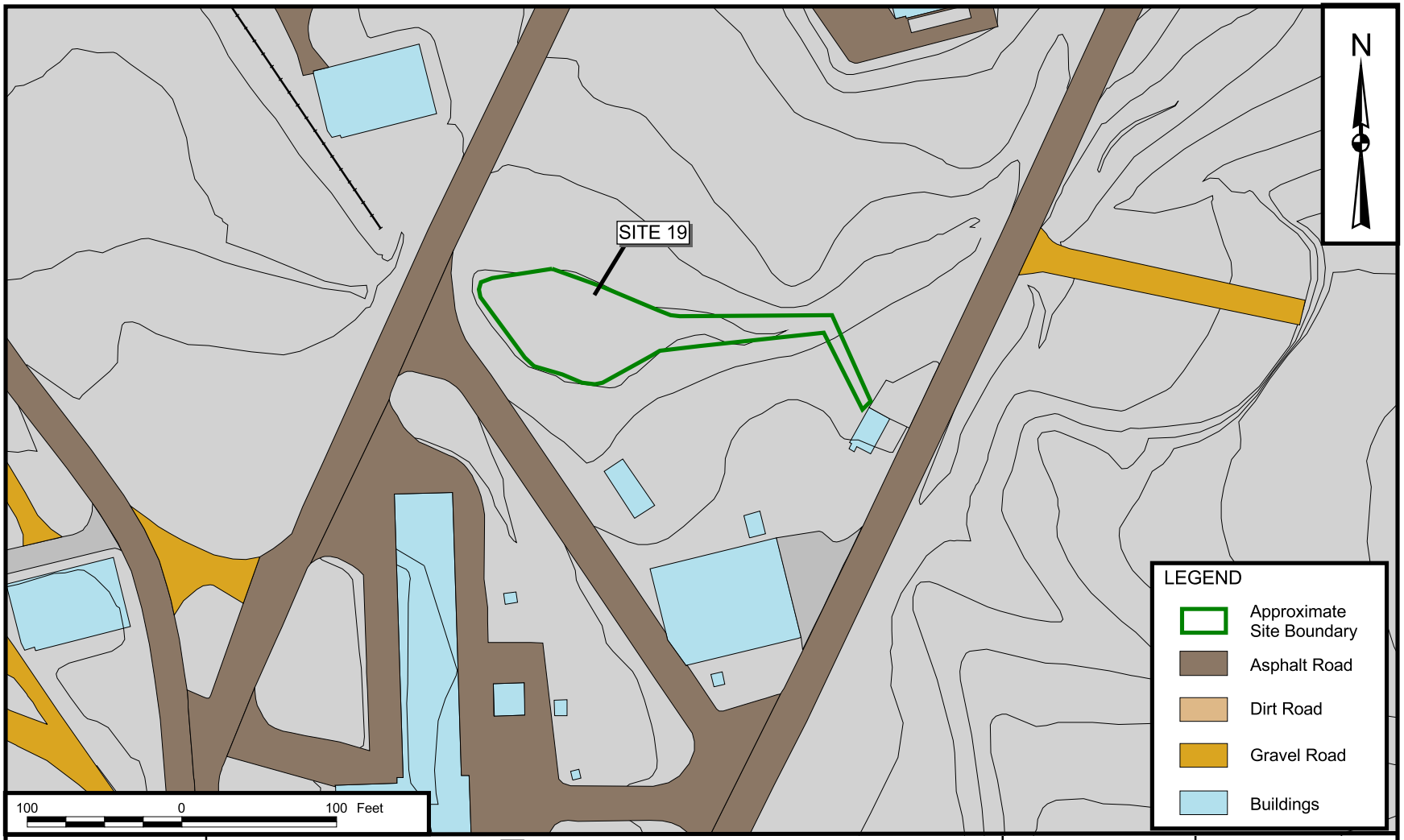

DRAWN BY: K. PEILA	DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019 / OWNER NUMBER: —
CHECKED BY: GJL	DATE: 8/7/02	SITE 19 - CATCH BASIN AT CHIP COLLECTION HOUSE (1051) MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL / DATE: 8/8/02
COST/SCHEDULE-AREA			APPROVED BY: — / DATE: —
SCALE: AS NOTED			DRAWING NO.: FIGURE A-16 / REV: 0

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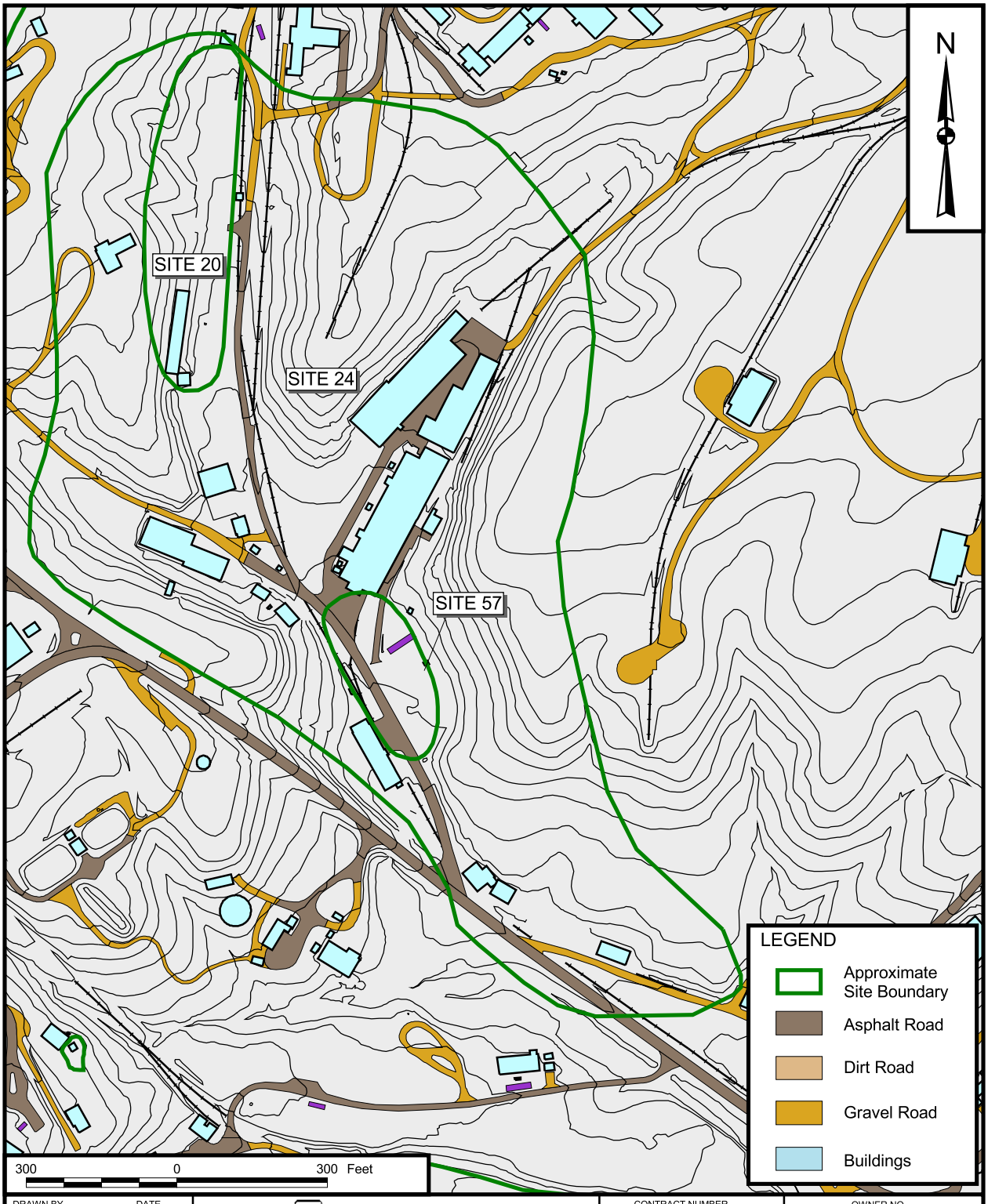

DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NO.: —
CHECKED BY: GJL — DATE: 8/7/02	SITE 20 - SINGLE-BASED POWDER FACILITY, SITE 24 - ABANDONED DRAIN LINES AND SITE 57 - BUILDING 292 TCE CONTAMINATION MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE A-17	REV: 0

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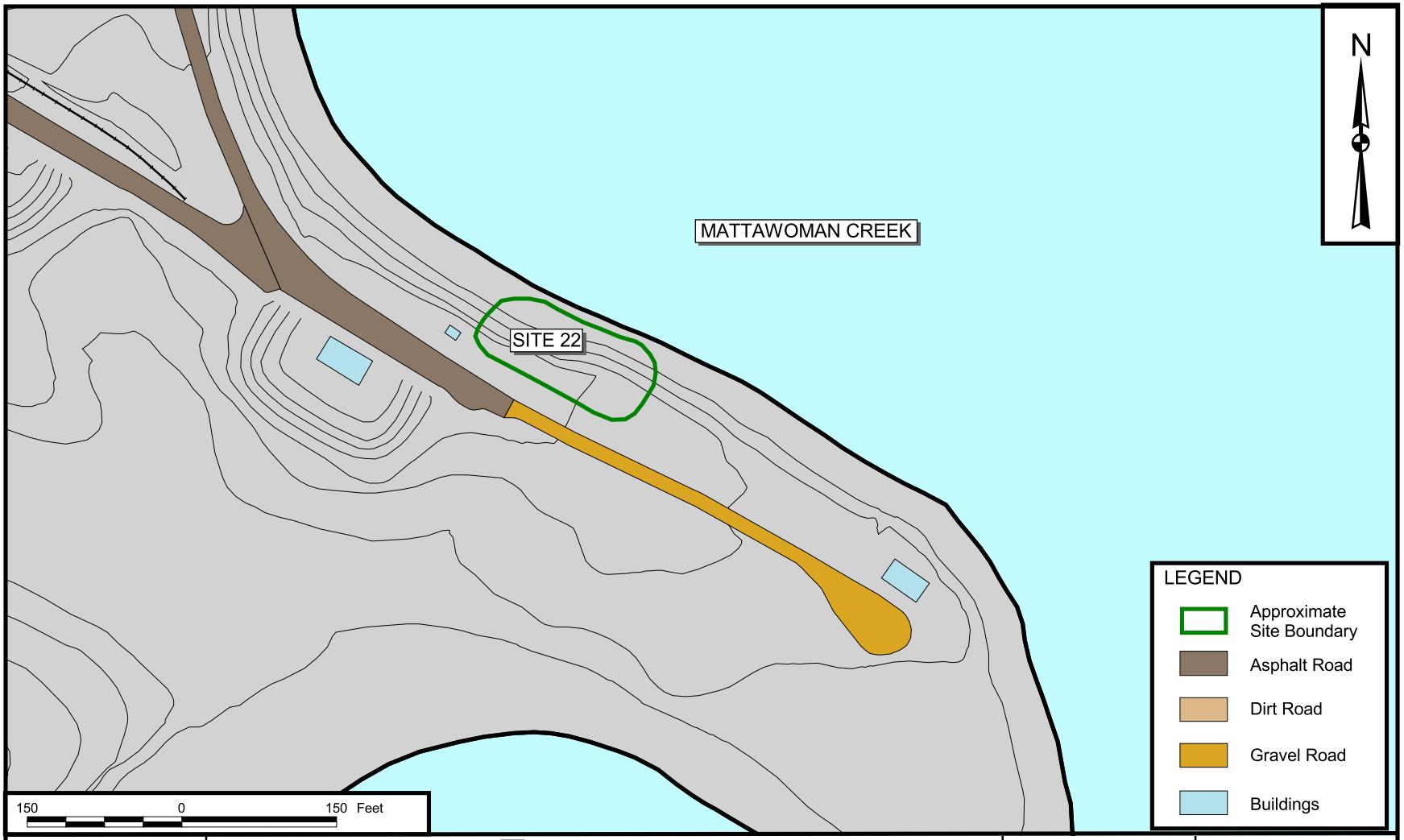

DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NUMBER: —
CHECKED BY: GJL — DATE: 8/7/02	SITE 22 - NG SLUMS BURNING SITE MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE A-18	REV: 0

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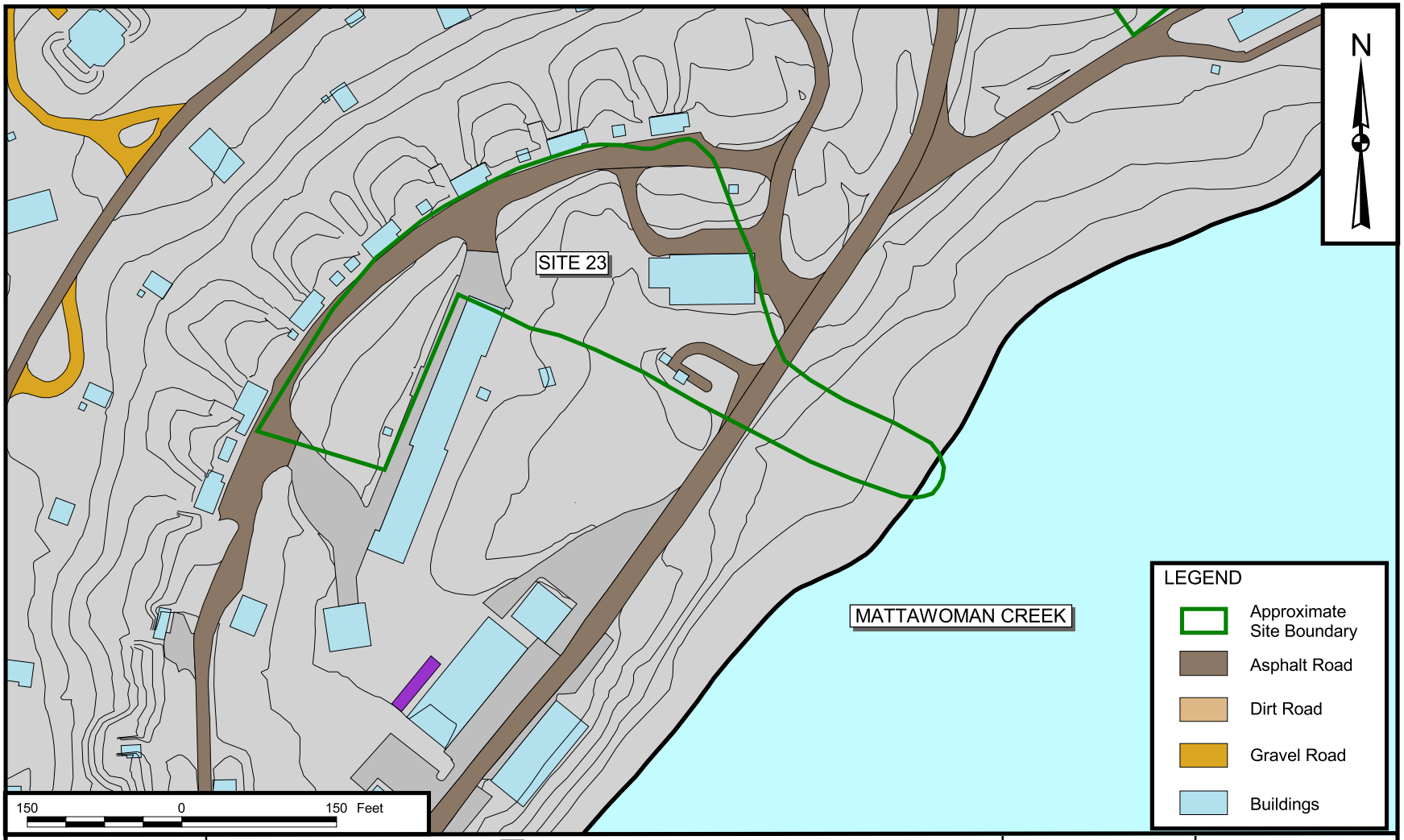

DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NUMBER: —
CHECKED BY: GJL — DATE: 8/7/02	SITE 23 - HYDRAULIC OIL SPILL DISCHARGES FROM EXTRUSION PLANT MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE A-19	REV: 0

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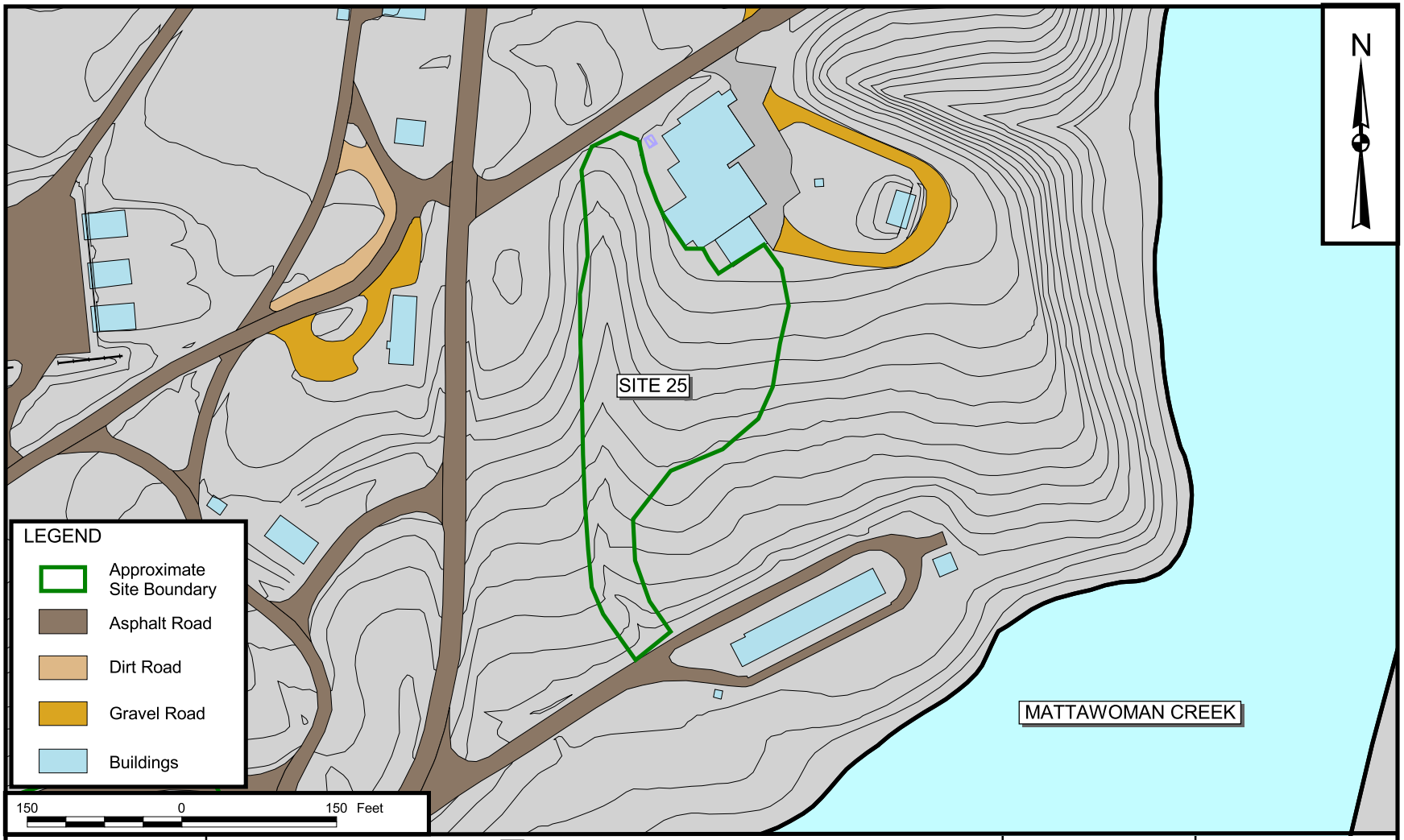

DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NUMBER: —
CHECKED BY: GJL — DATE: 8/7/02	SITE 25 - HYPO DISCHARGE X-RAY BUILDING NO. 2 MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE A-20	REV: 0

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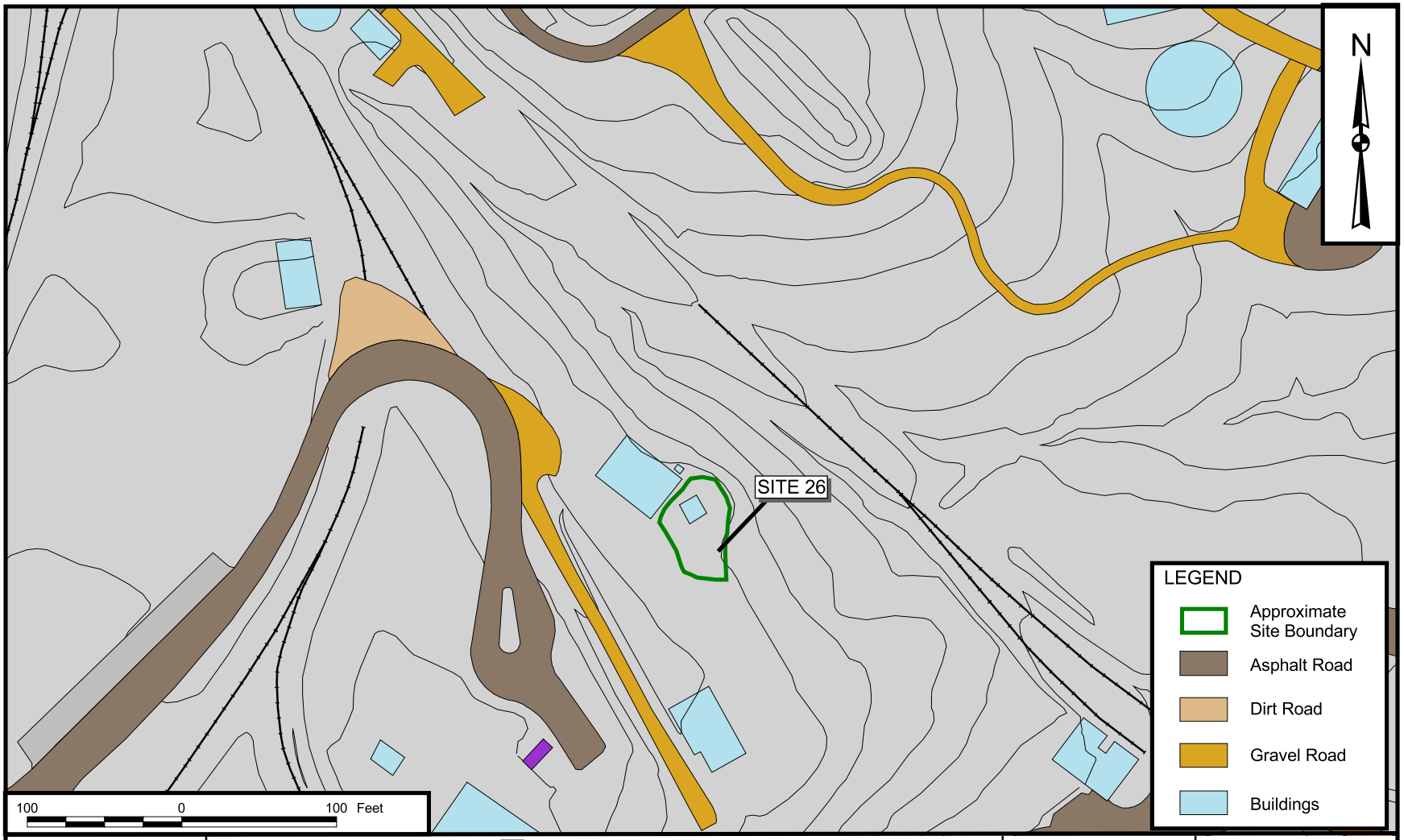

DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NUMBER: —
CHECKED BY: GJL — DATE: 8/7/02	SITE 26 - THERMAL DESTRUCTOR 2 MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE A-21	REV: 0

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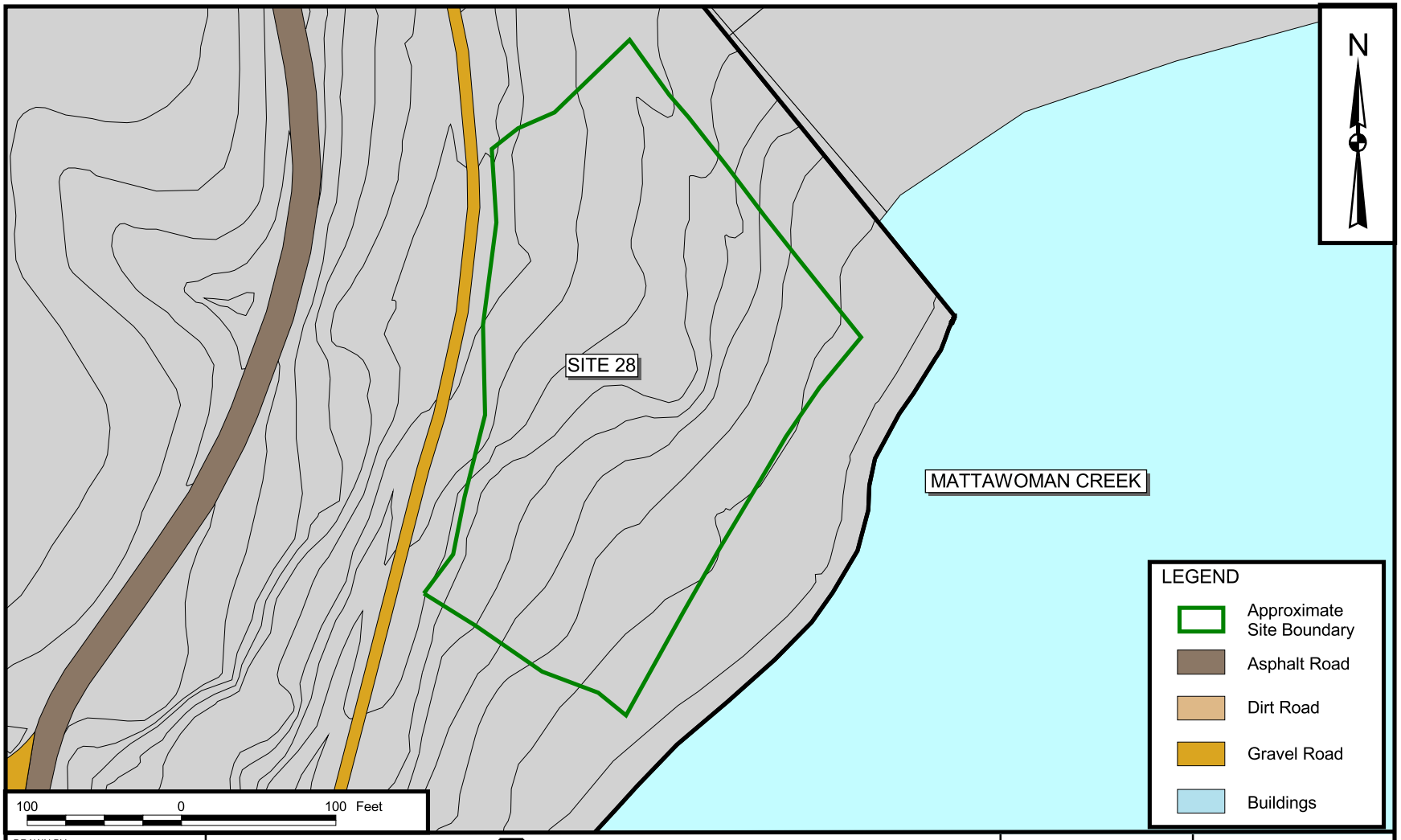

DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NUMBER: —
CHECKED BY: GJL — DATE: 8/7/02	SITE 28 - ORIGINAL BURNING GROUND MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE A-22	REV: 0

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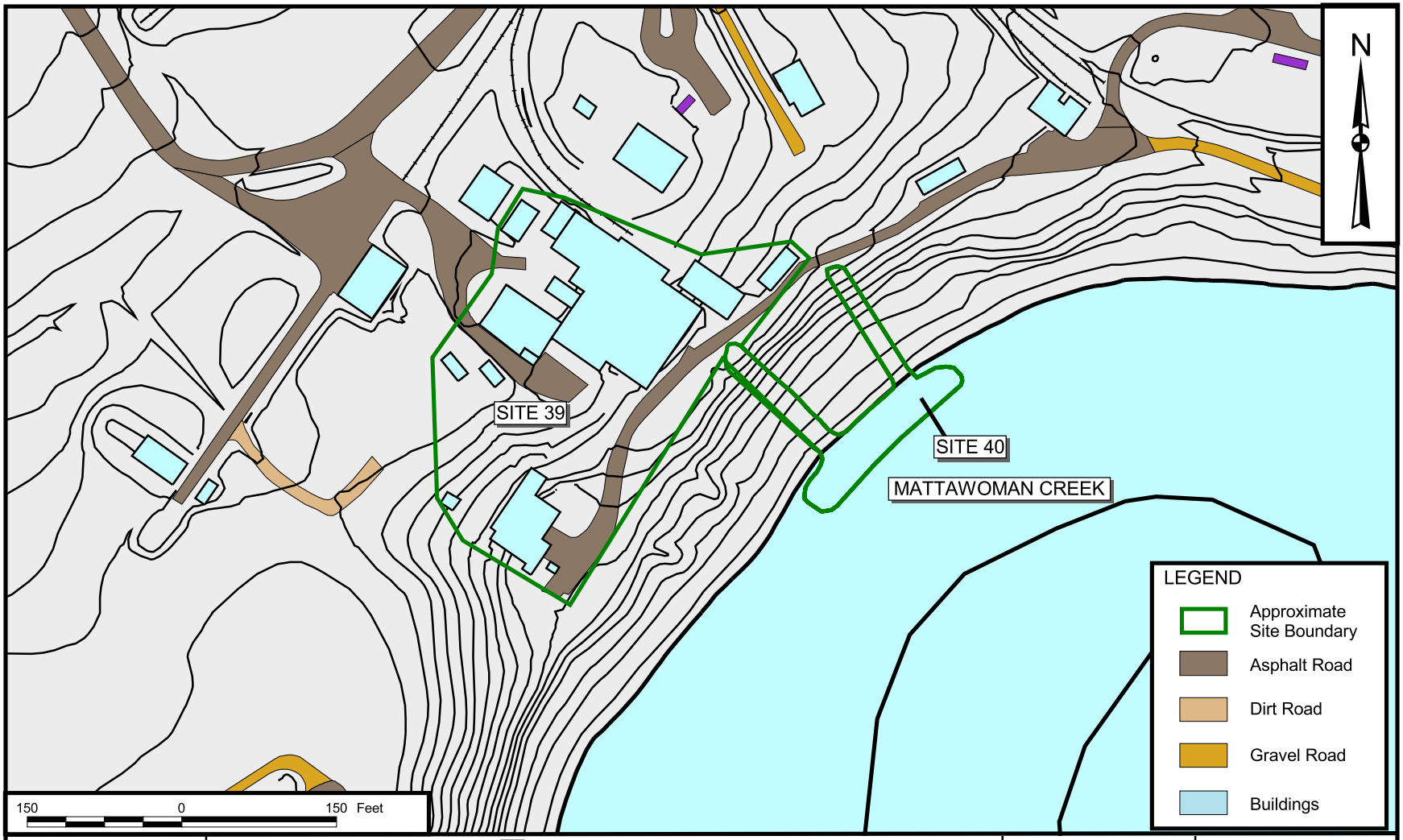

DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NUMBER: —
CHECKED BY: GJL — DATE: 8/7/02	SITE 39 - SILVER RELEASE TO SEDIMENT SITE 40 - SILVER AND PALLDIUM CATALYST IN SEDIMENT MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE A-23	REV: 0

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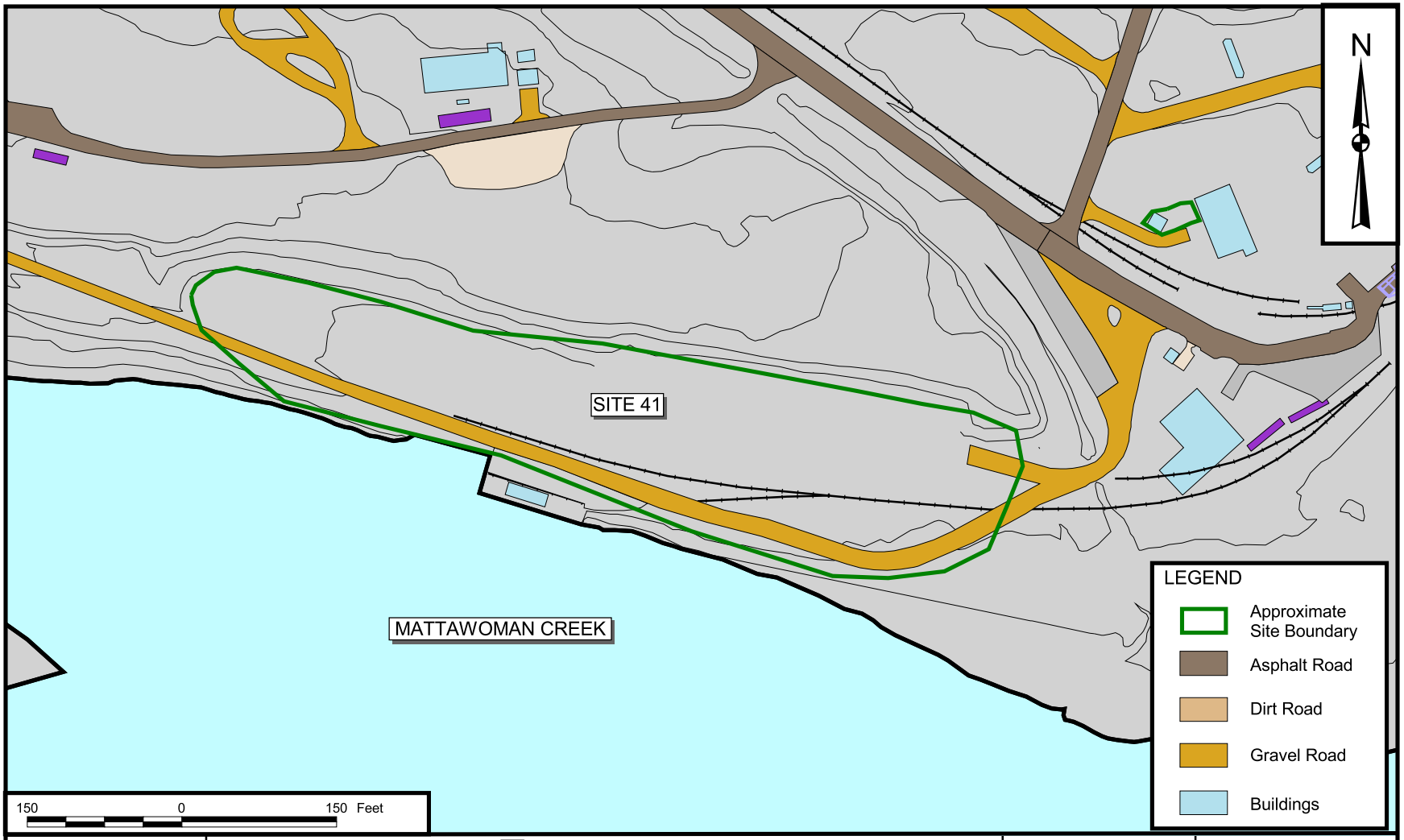

DRAWN BY: K. PEILA — DATE: 8/7/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4019	OWNER NUMBER: —
CHECKED BY: GJL — DATE: 8/7/02	SITE 41 - SCRAP YARD MAIN AREA IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/8/02	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
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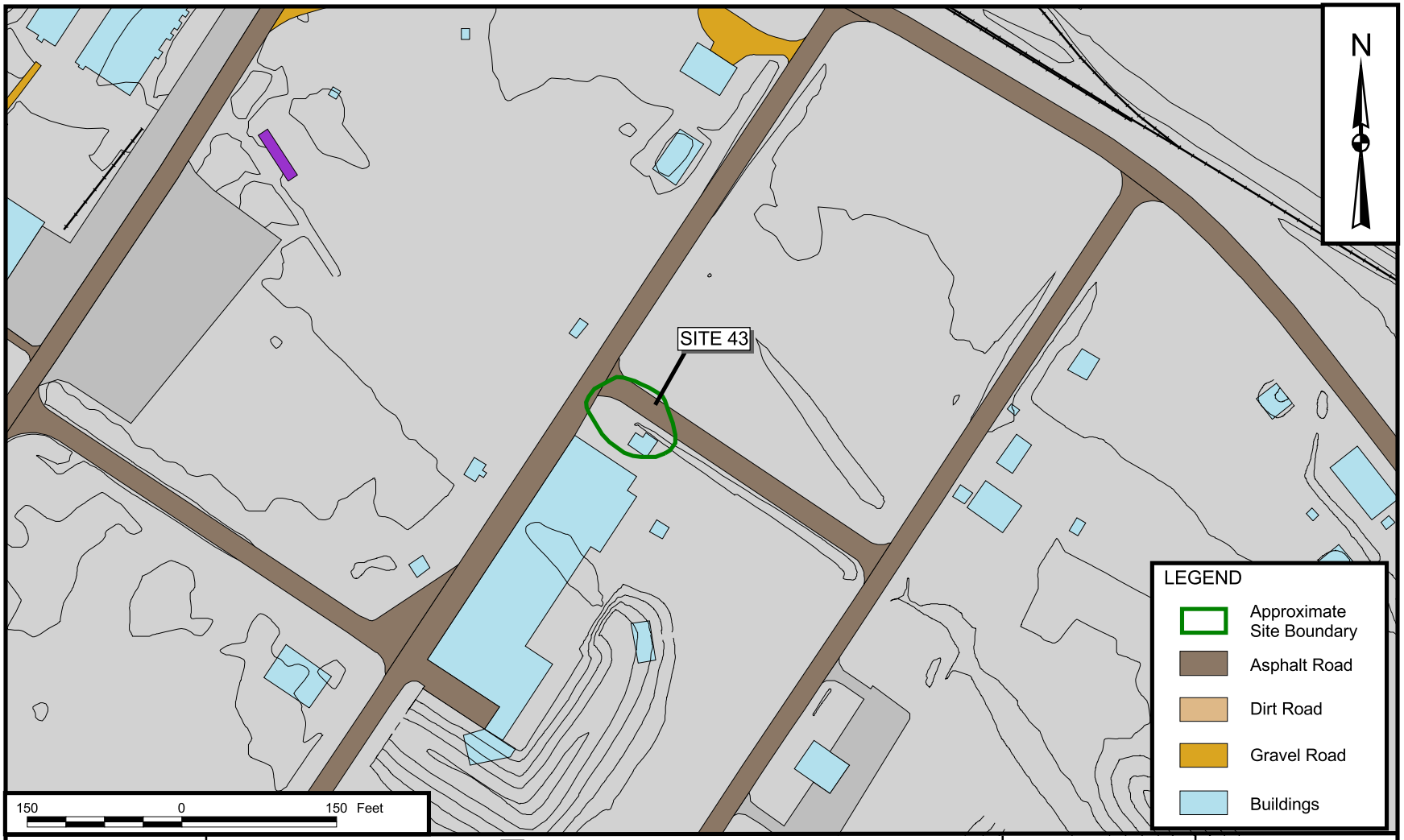

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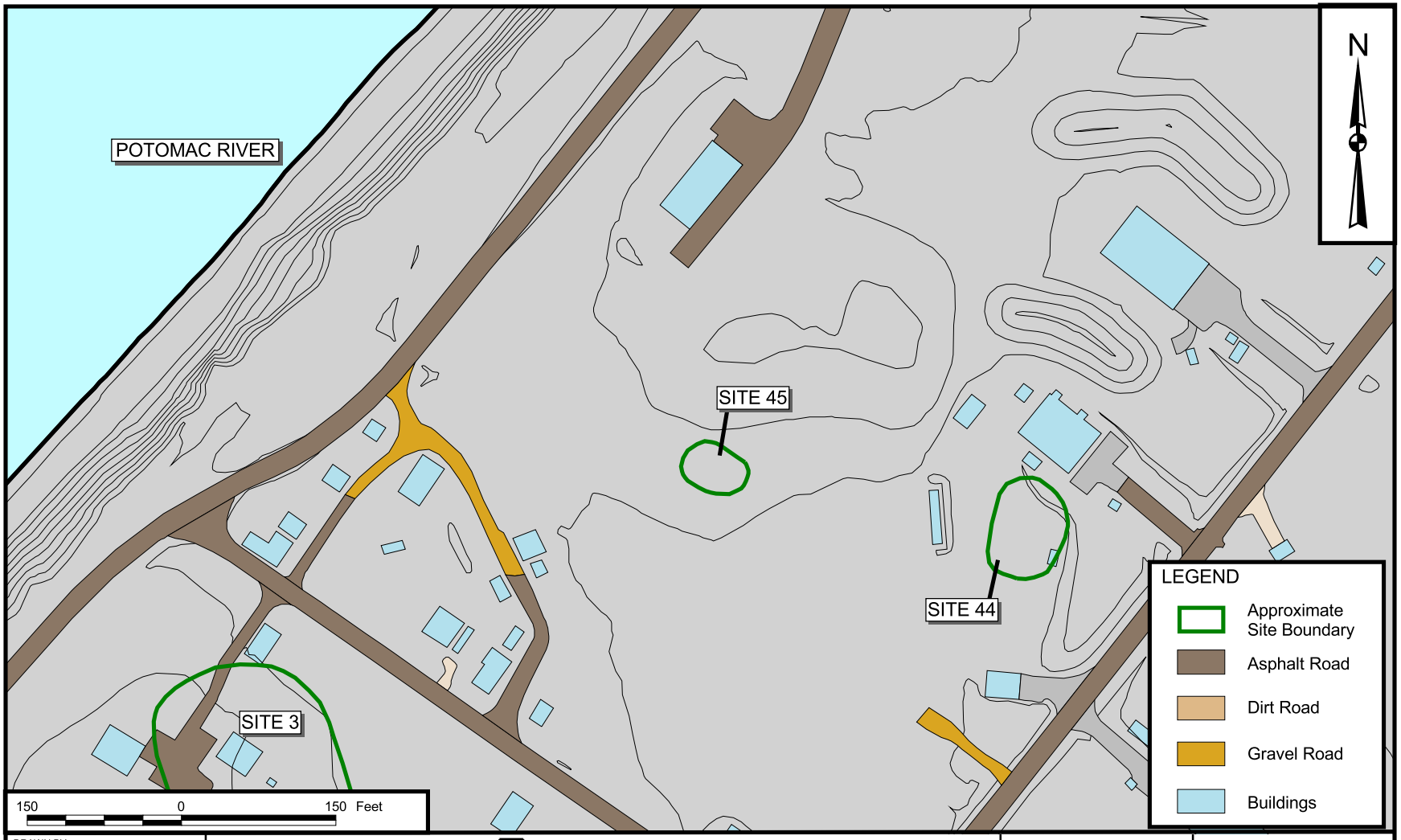

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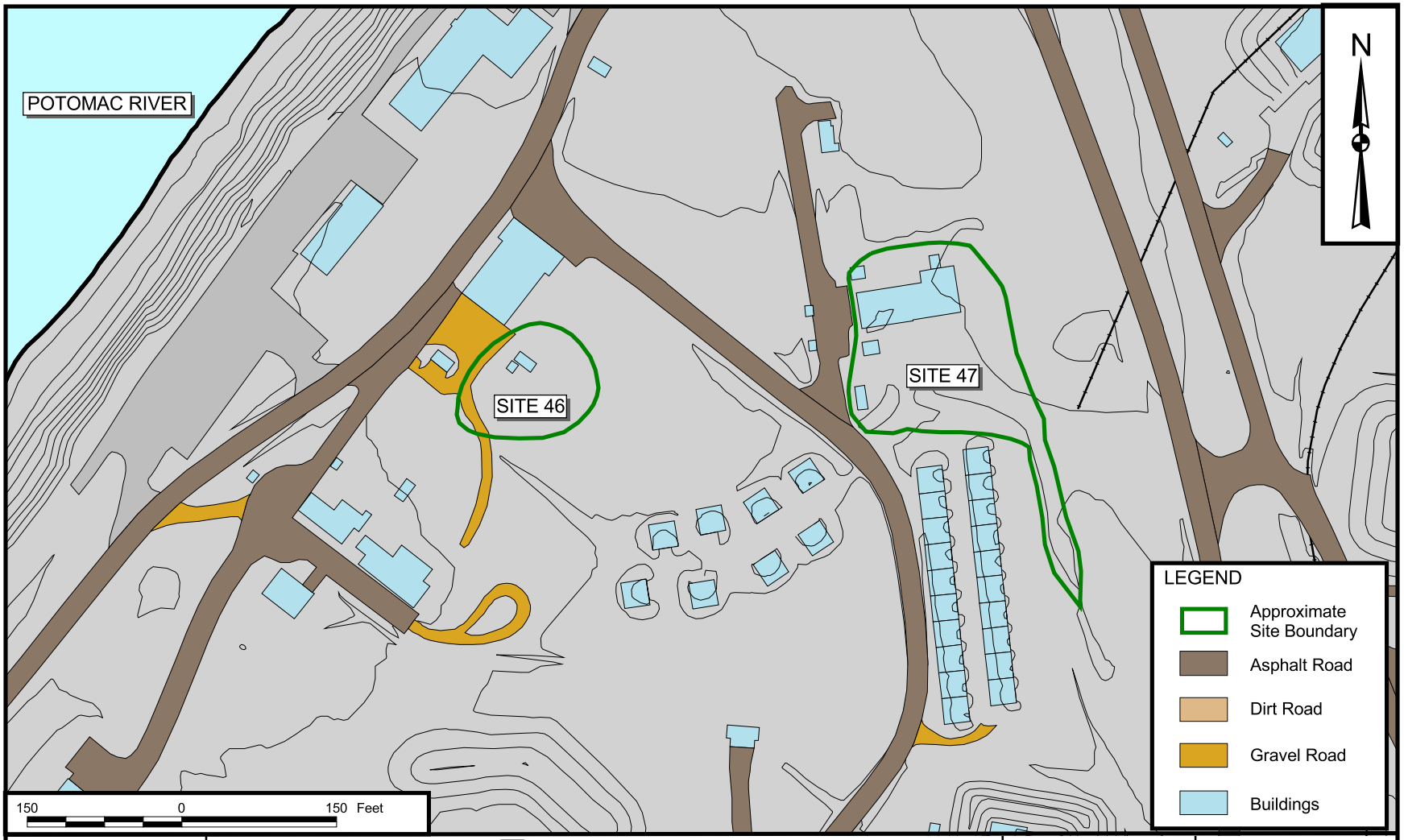

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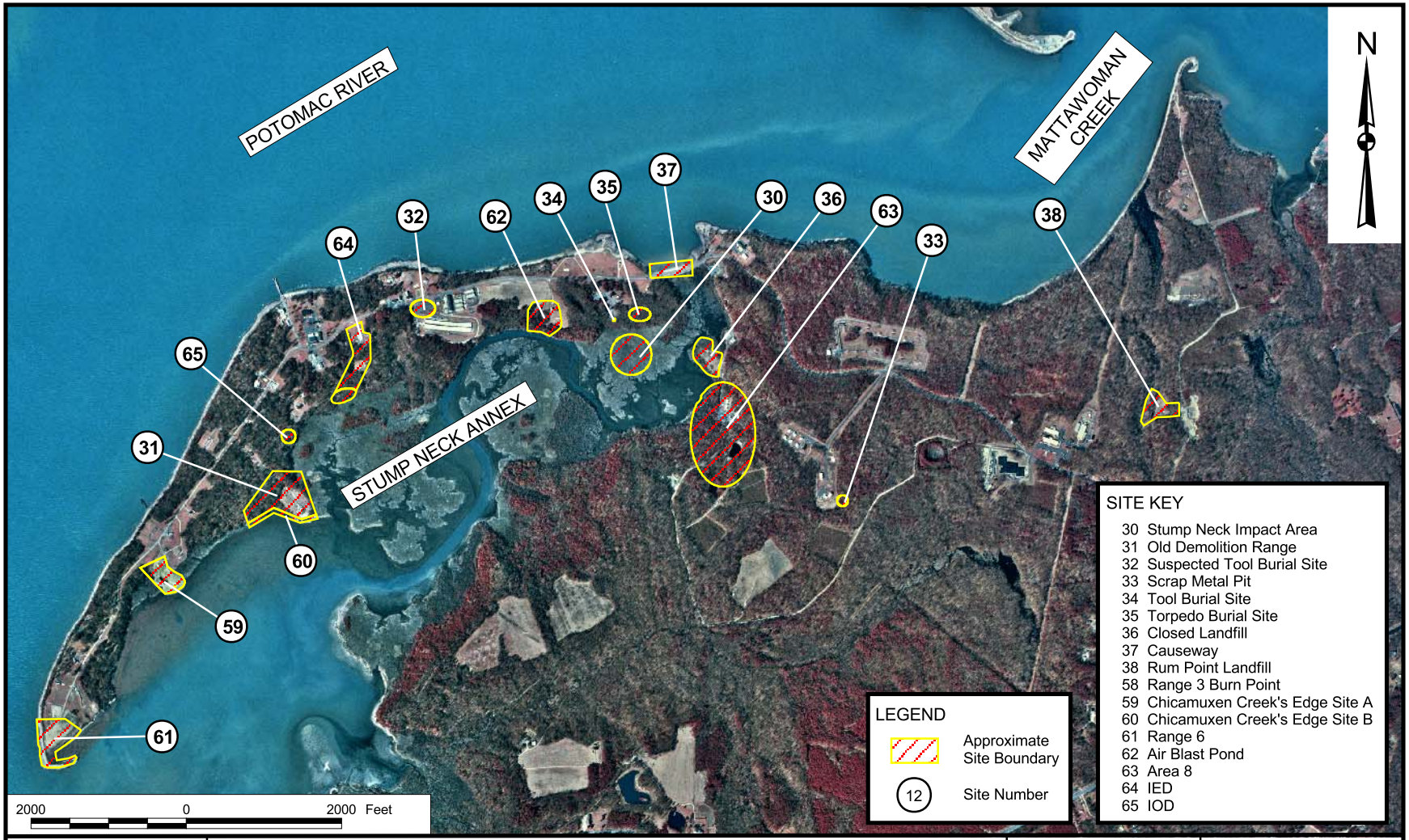
APPENDIX B

IHDIV - STUMP NECK ANNEX SITE FIGURES



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COST/SCHEDULE-AREA		APPROVED BY — DATE —	
SCALE AS NOTED		DRAWING NO. FIGURE B-1	REV 0

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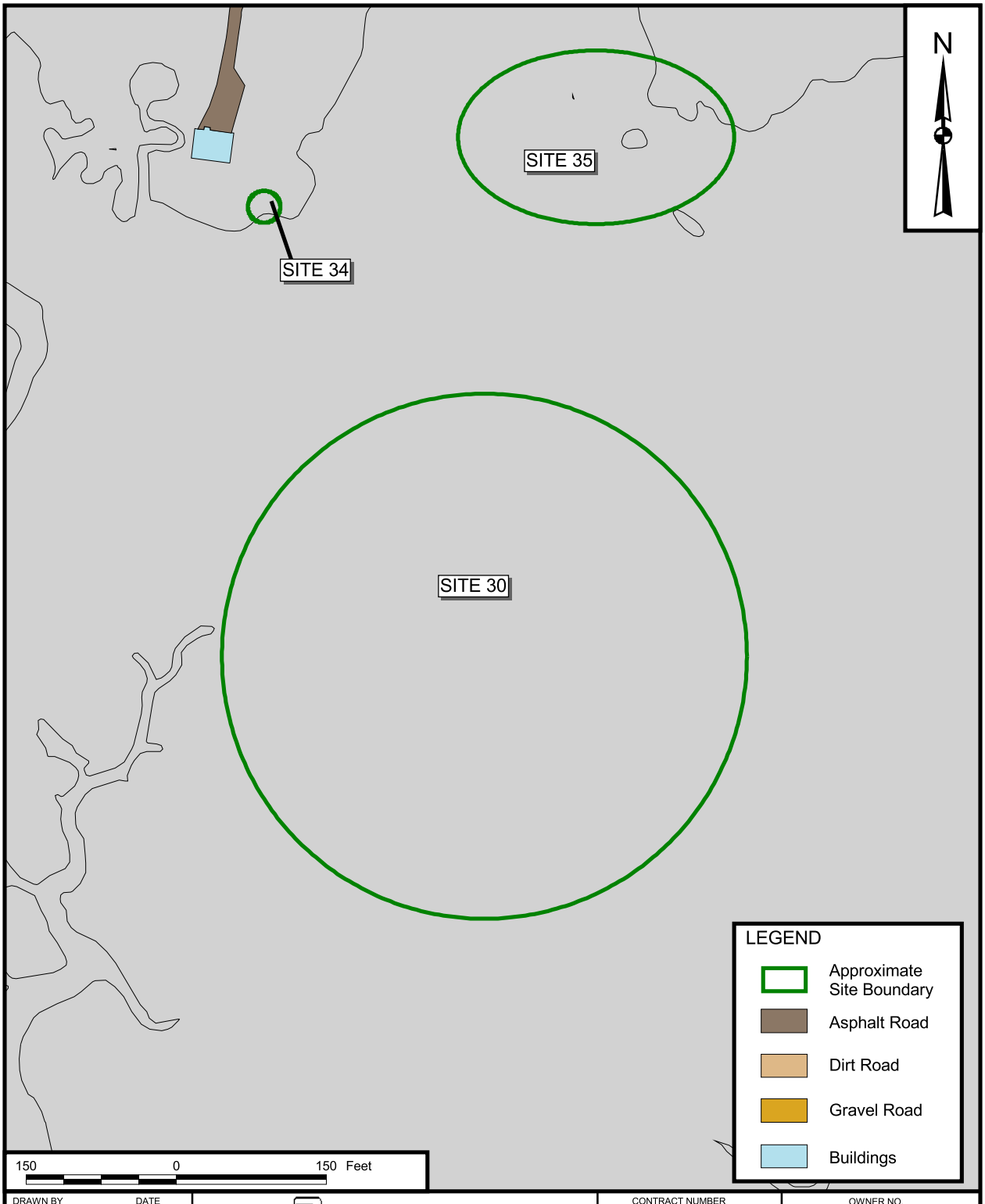

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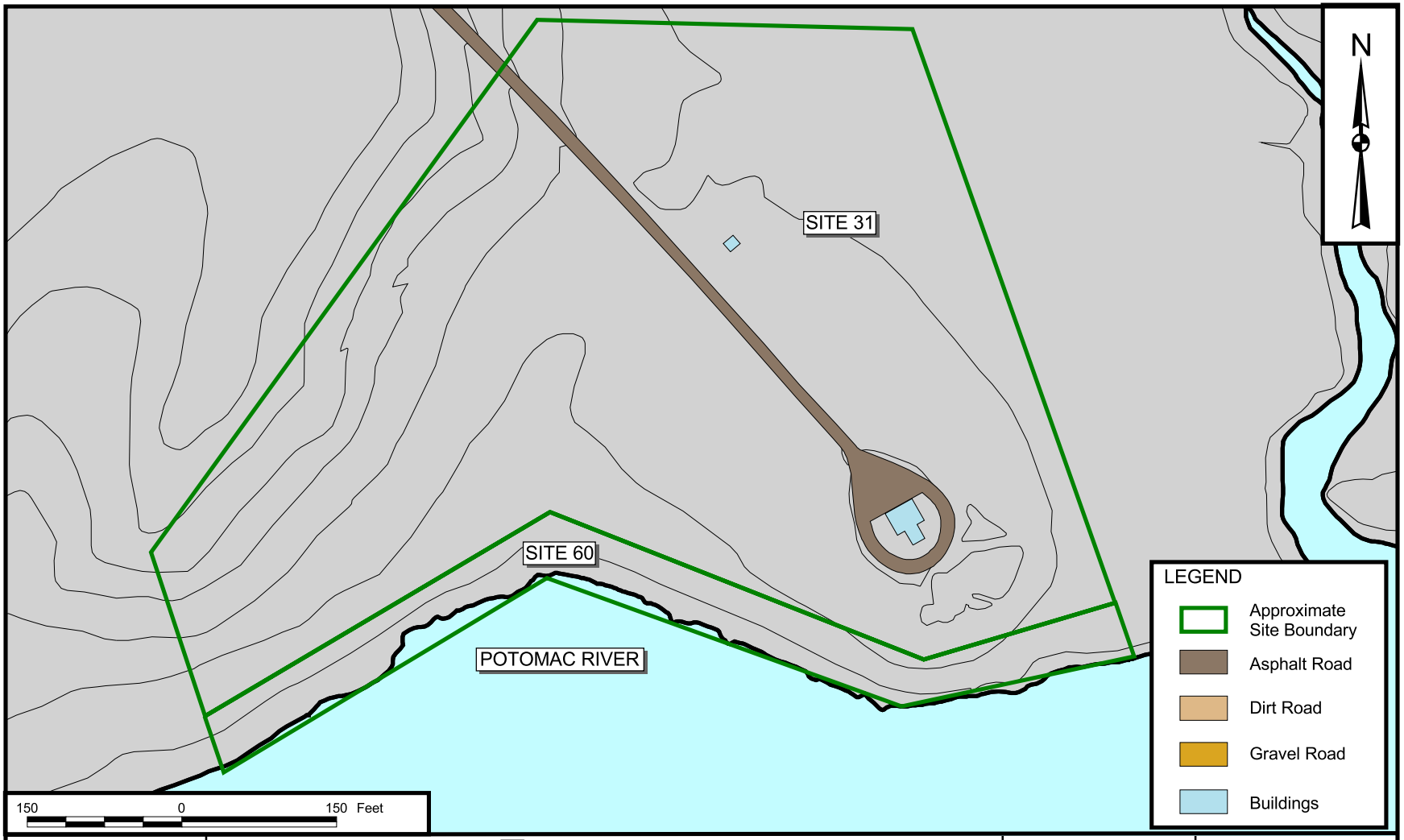

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SCALE AS NOTED		DRAWING NO. FIGURE B-3	REV 0

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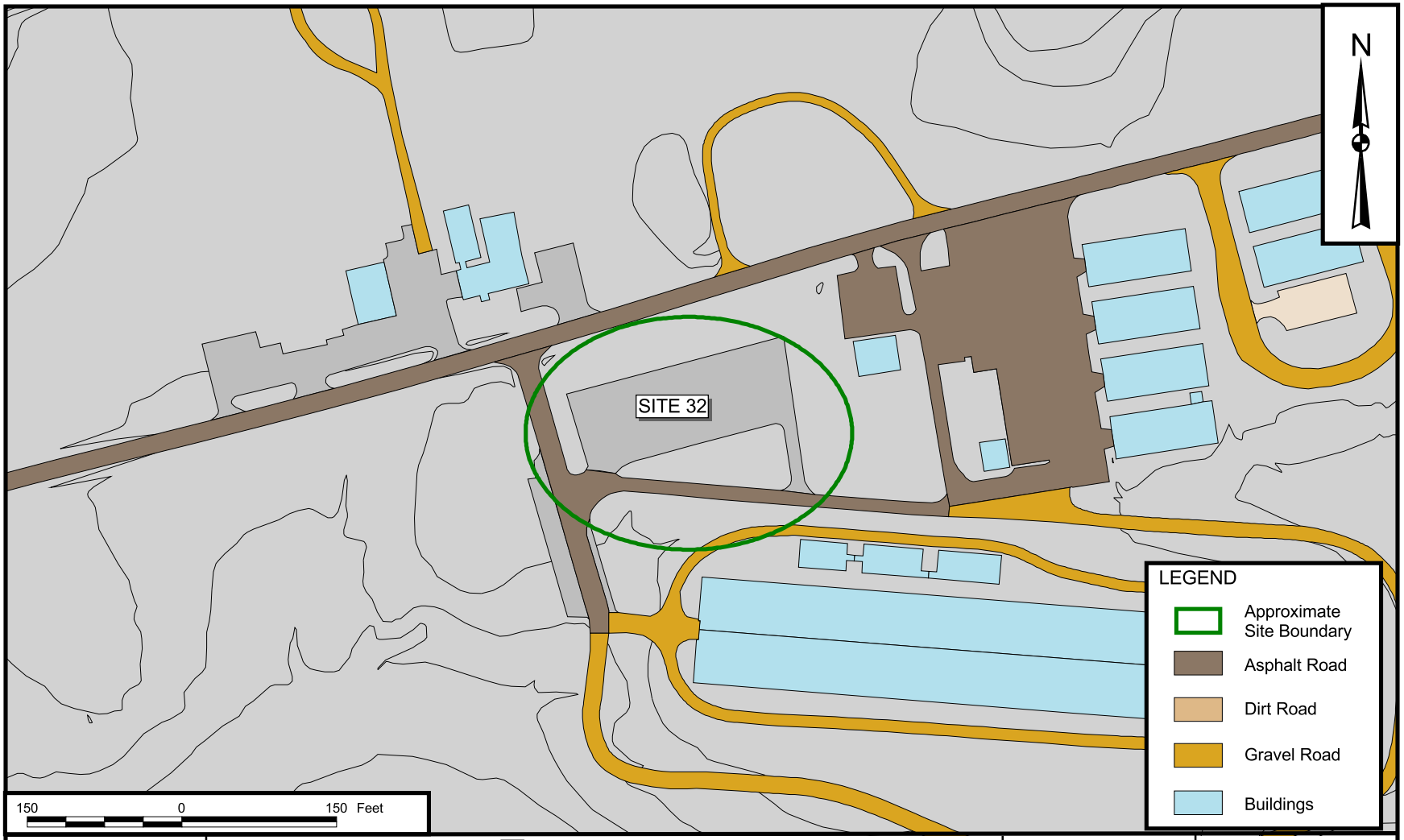

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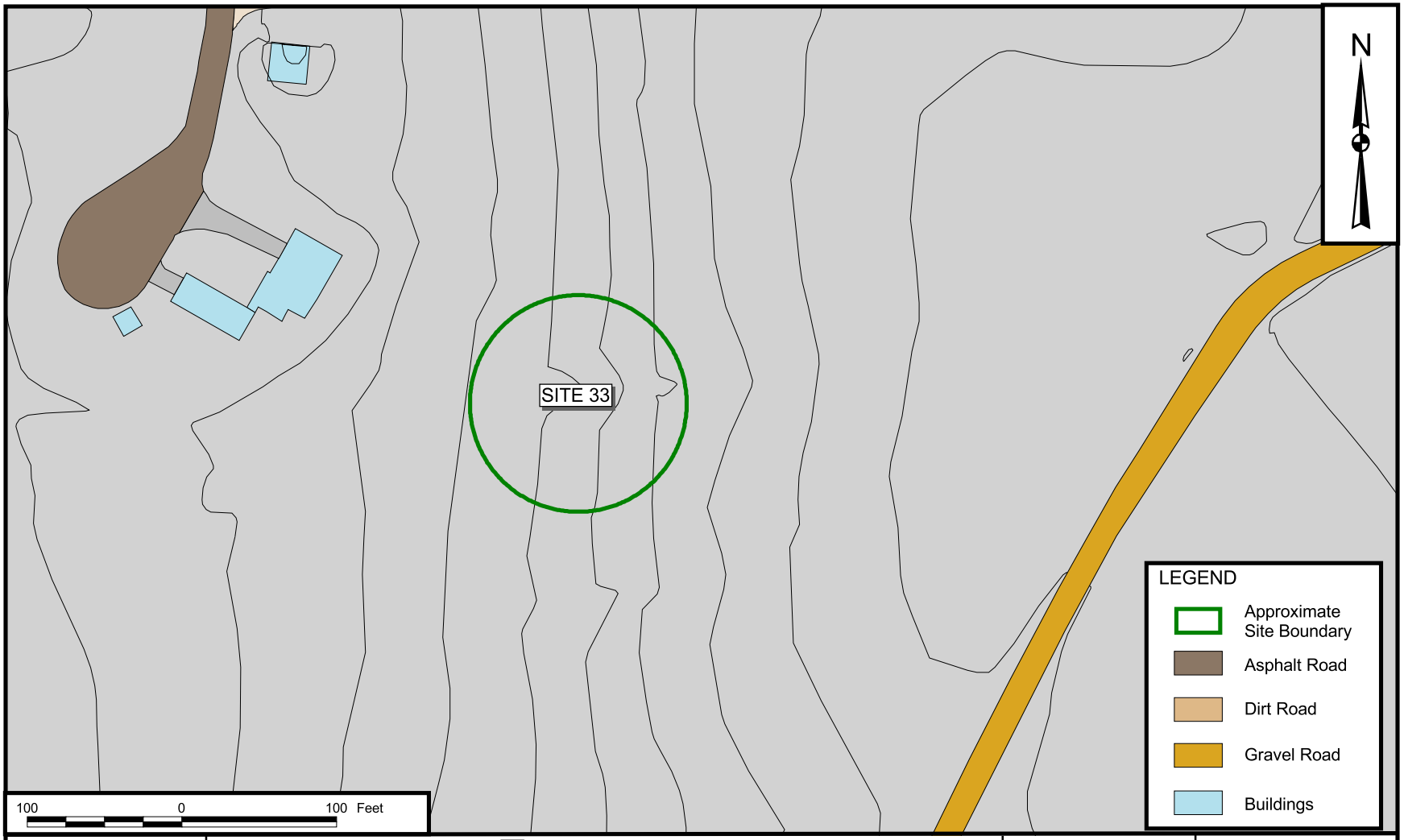

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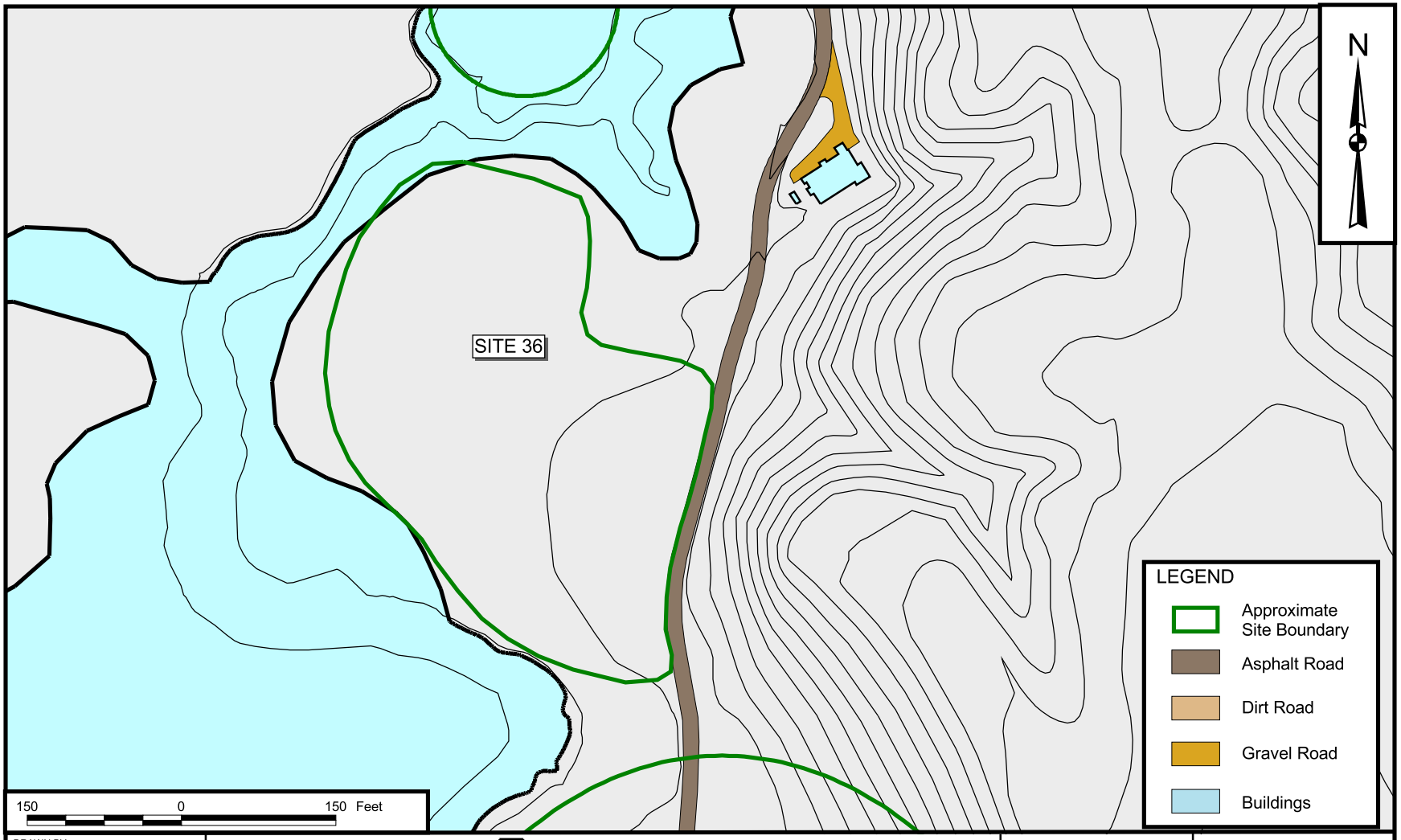

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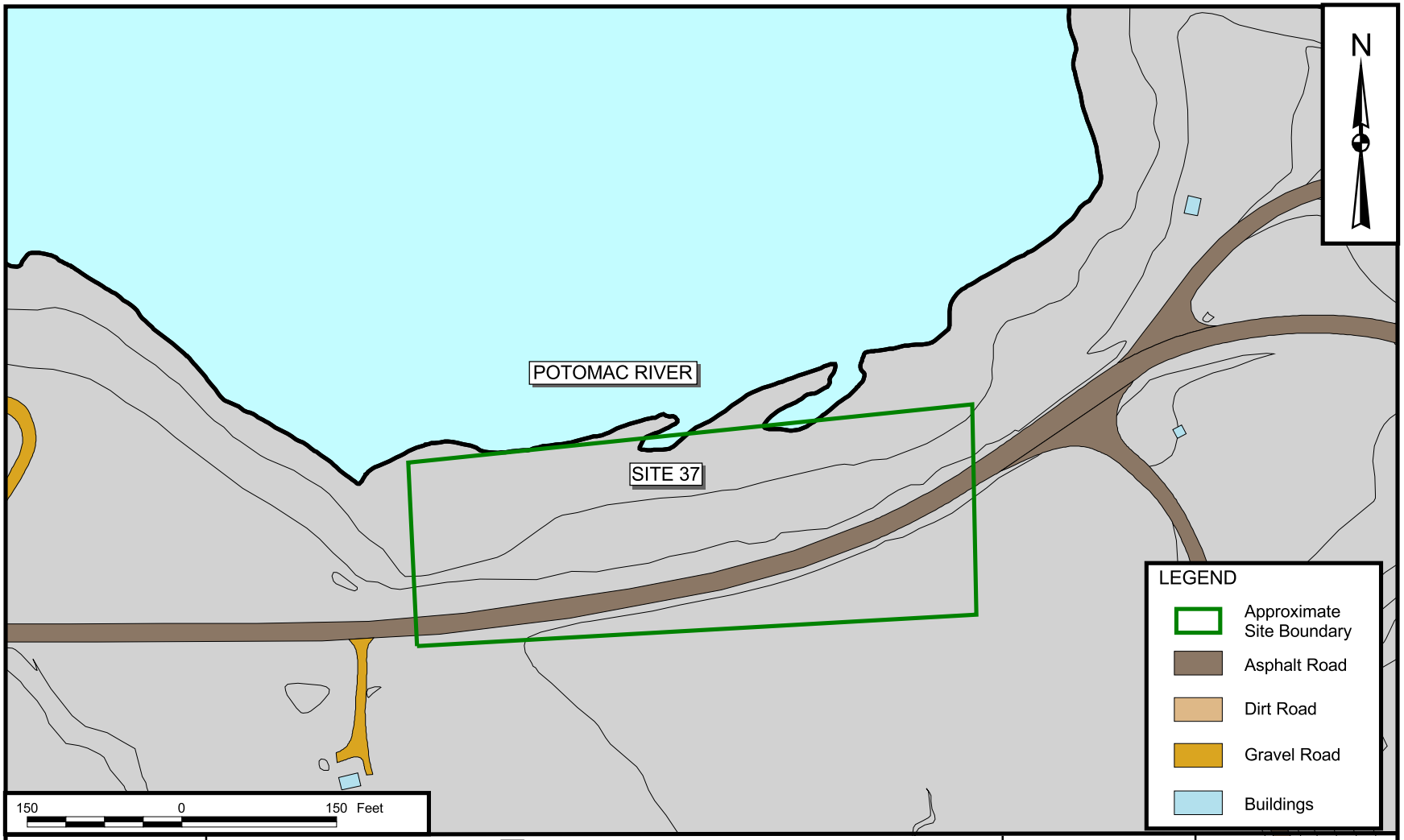

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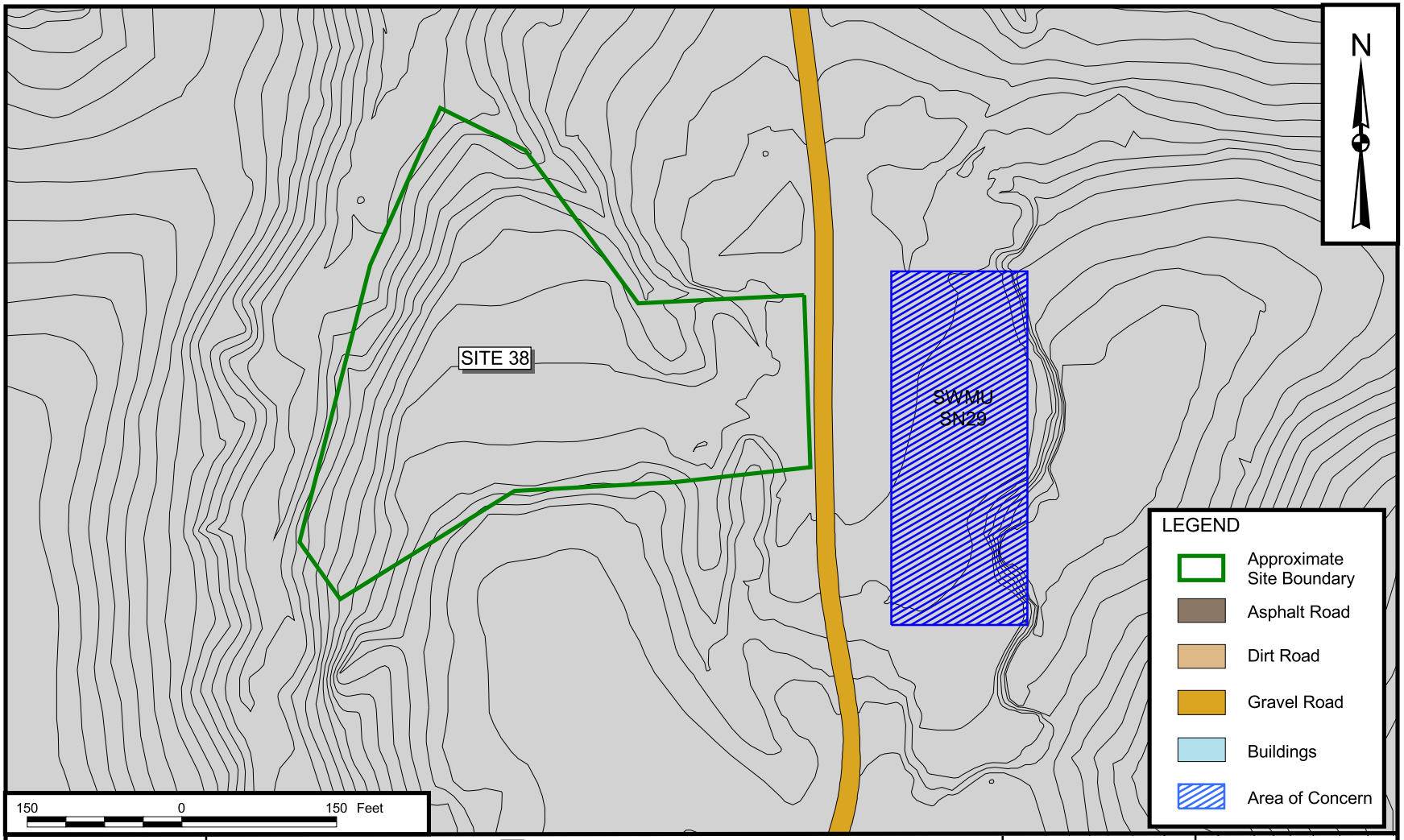

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COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
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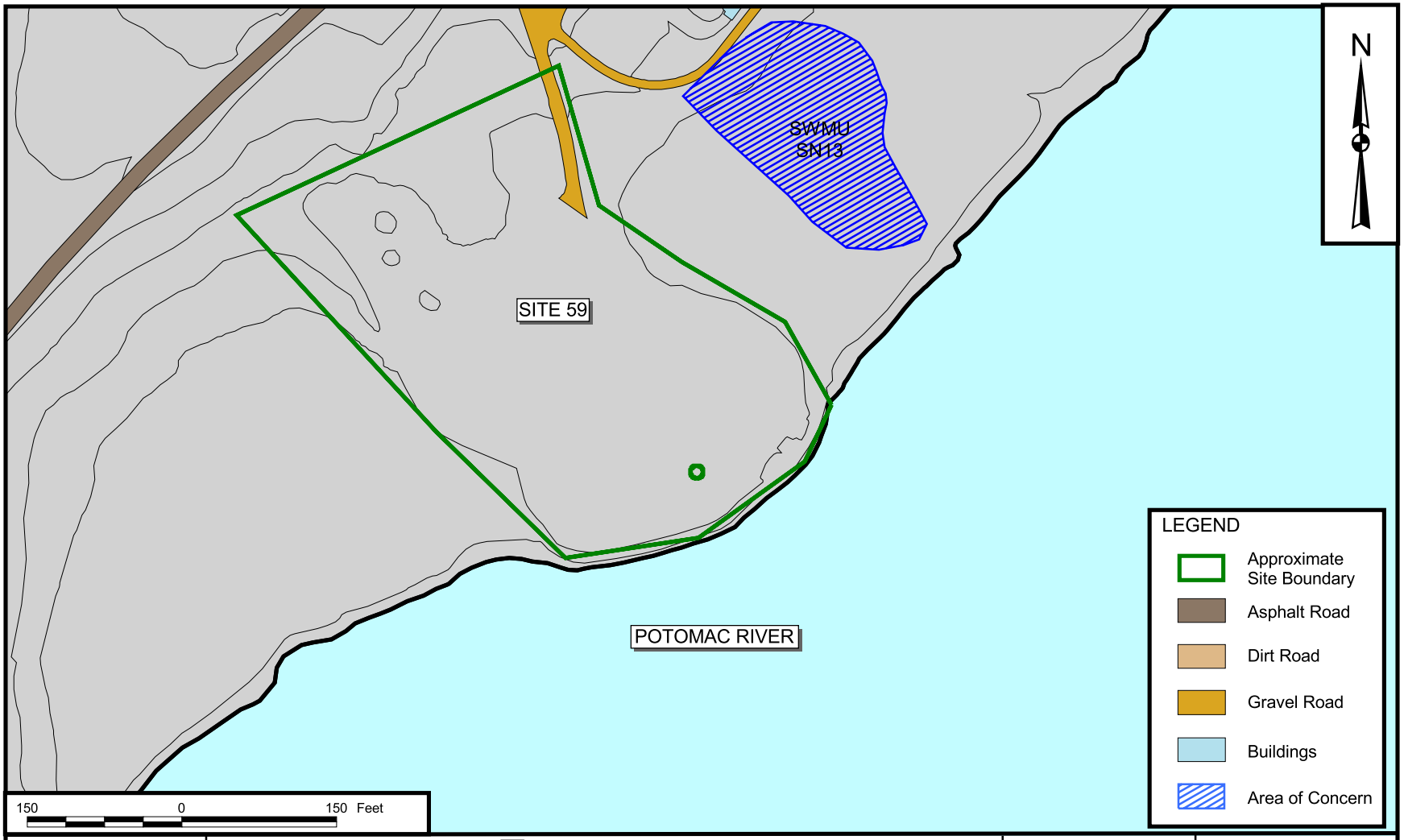

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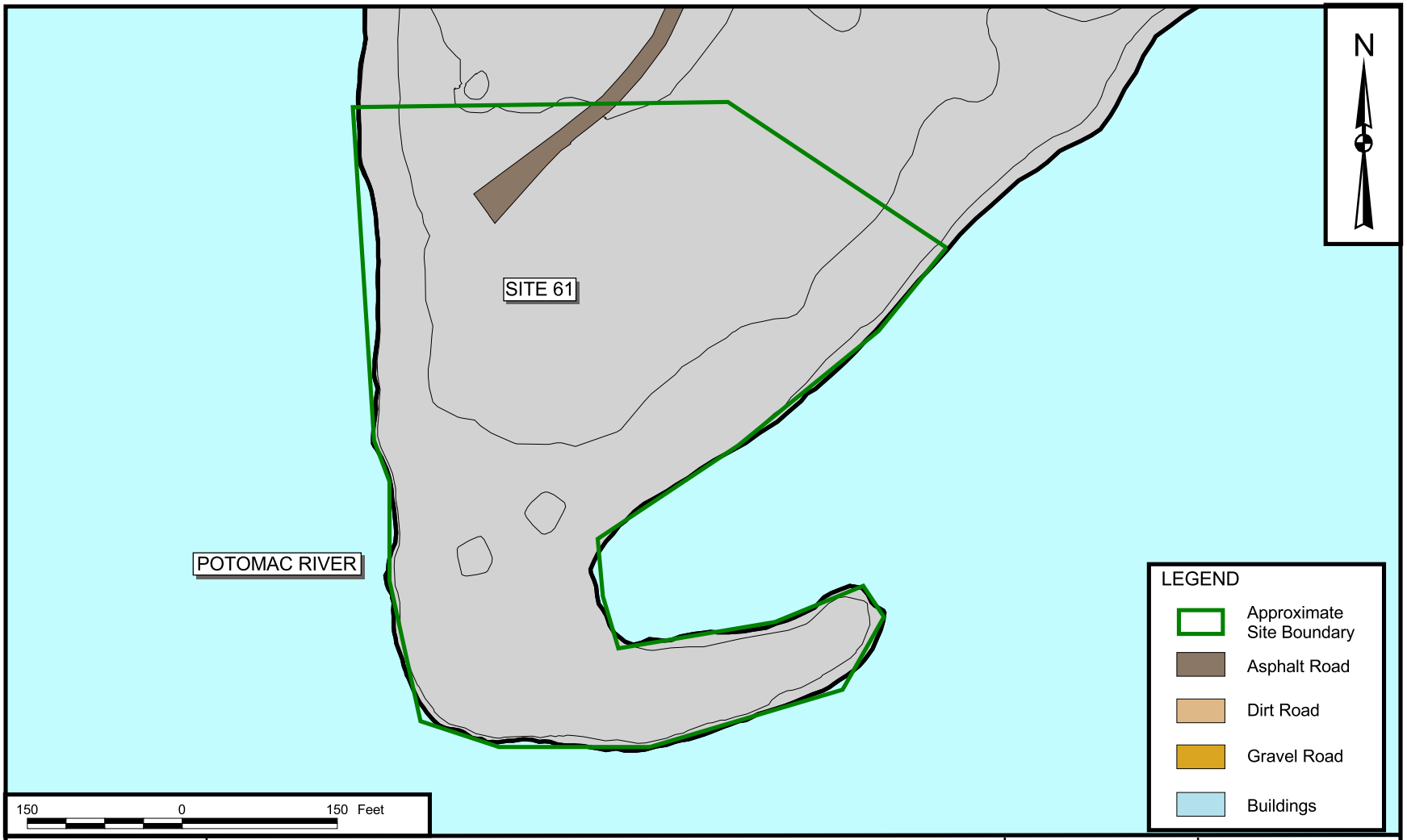

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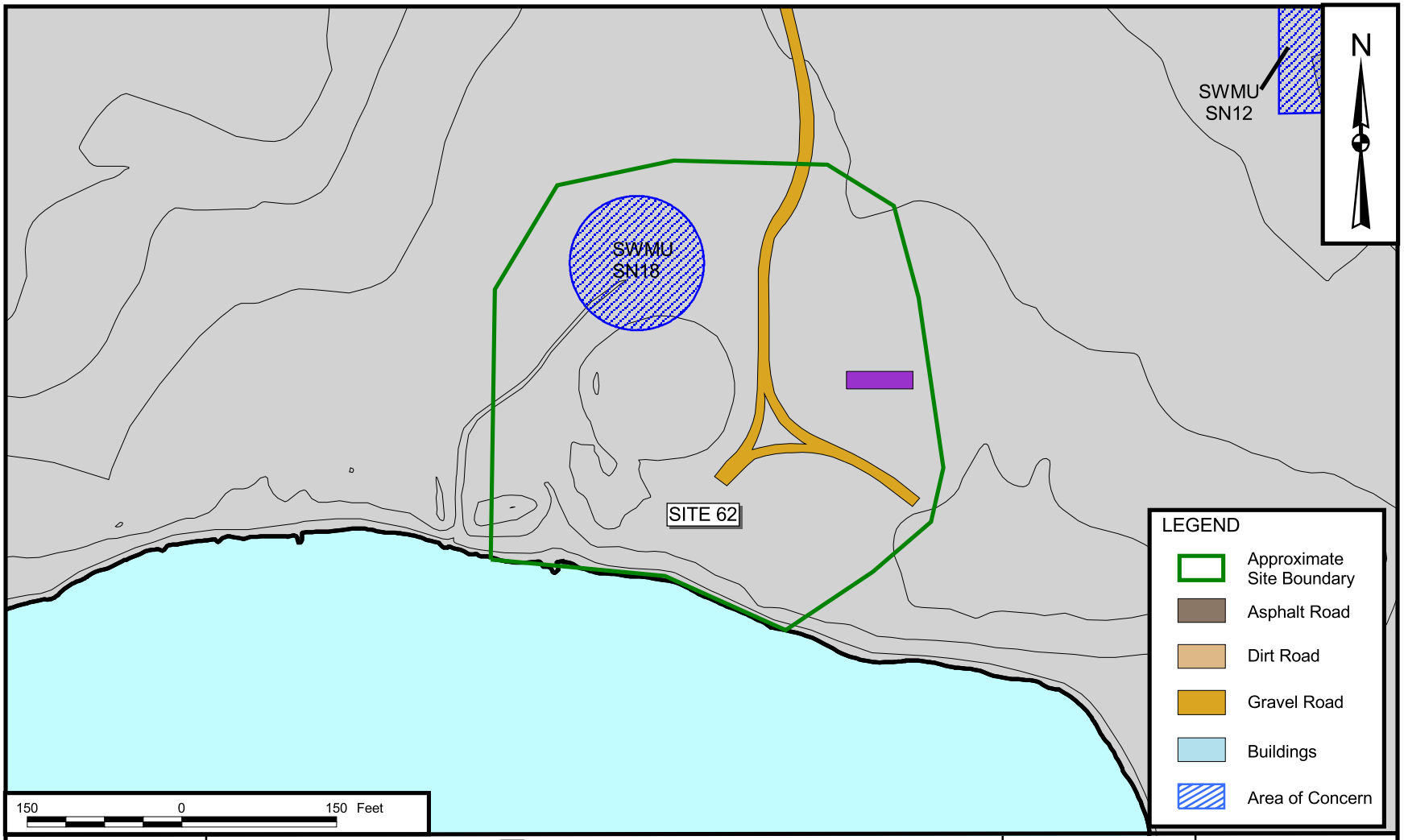

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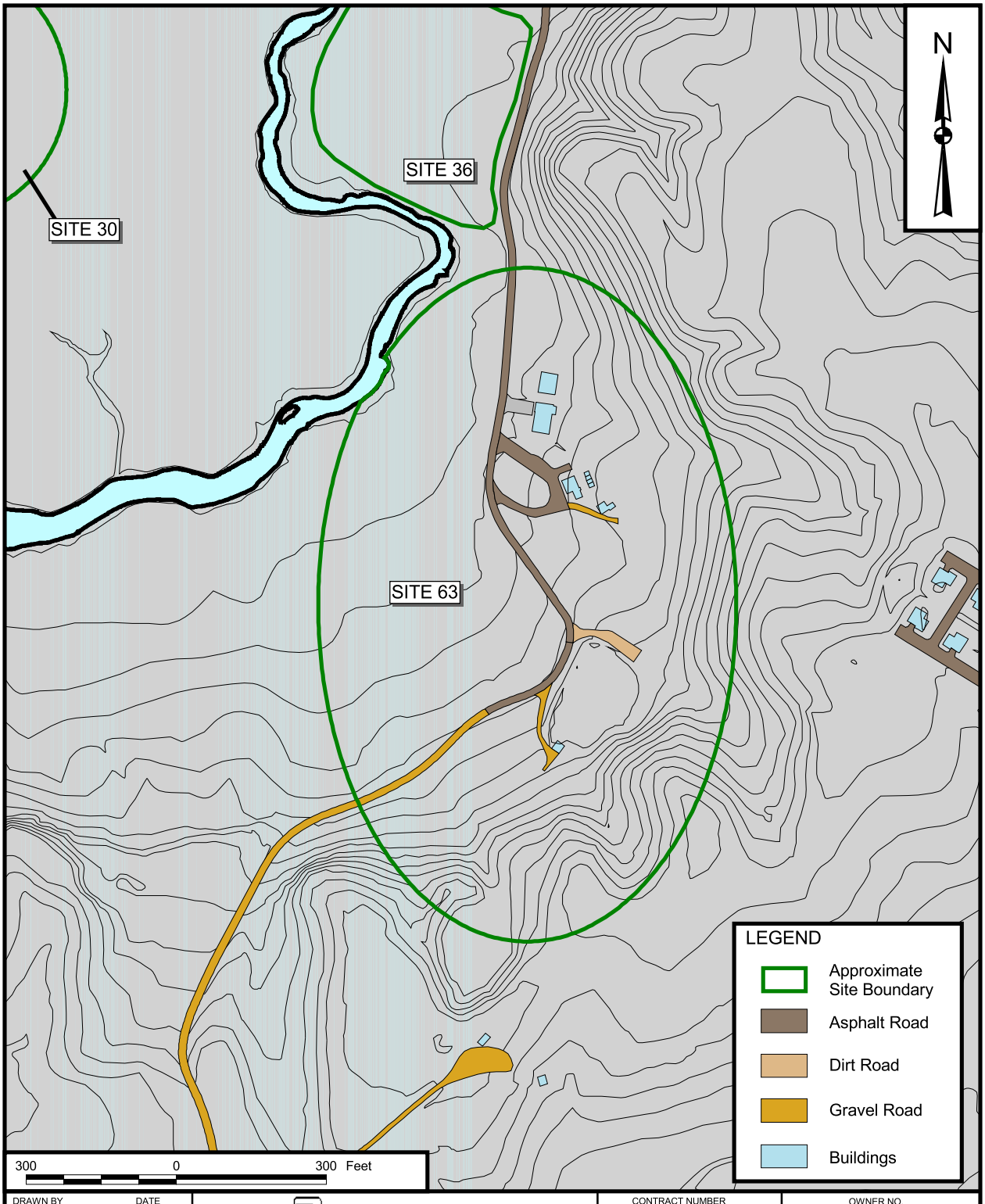

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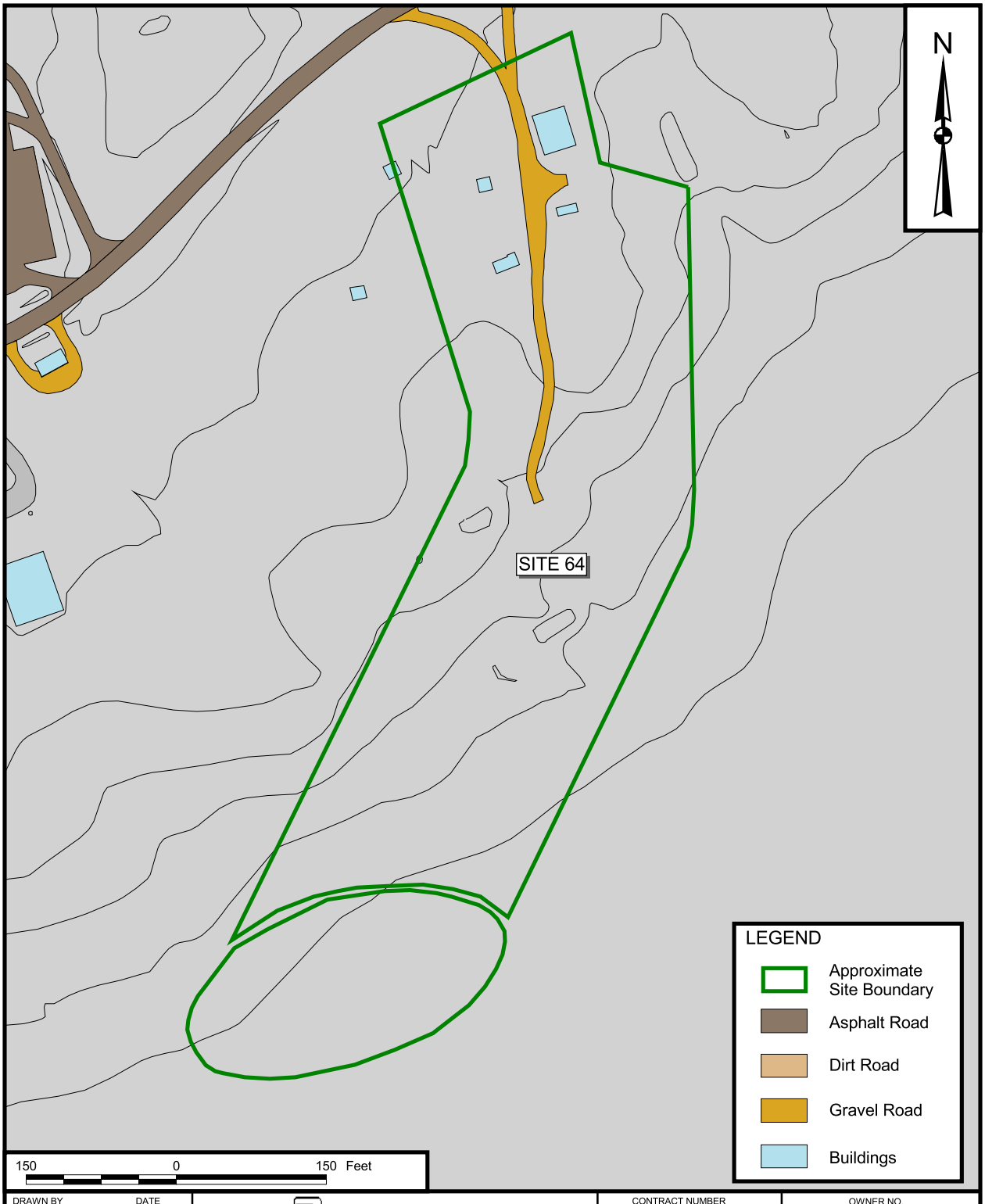

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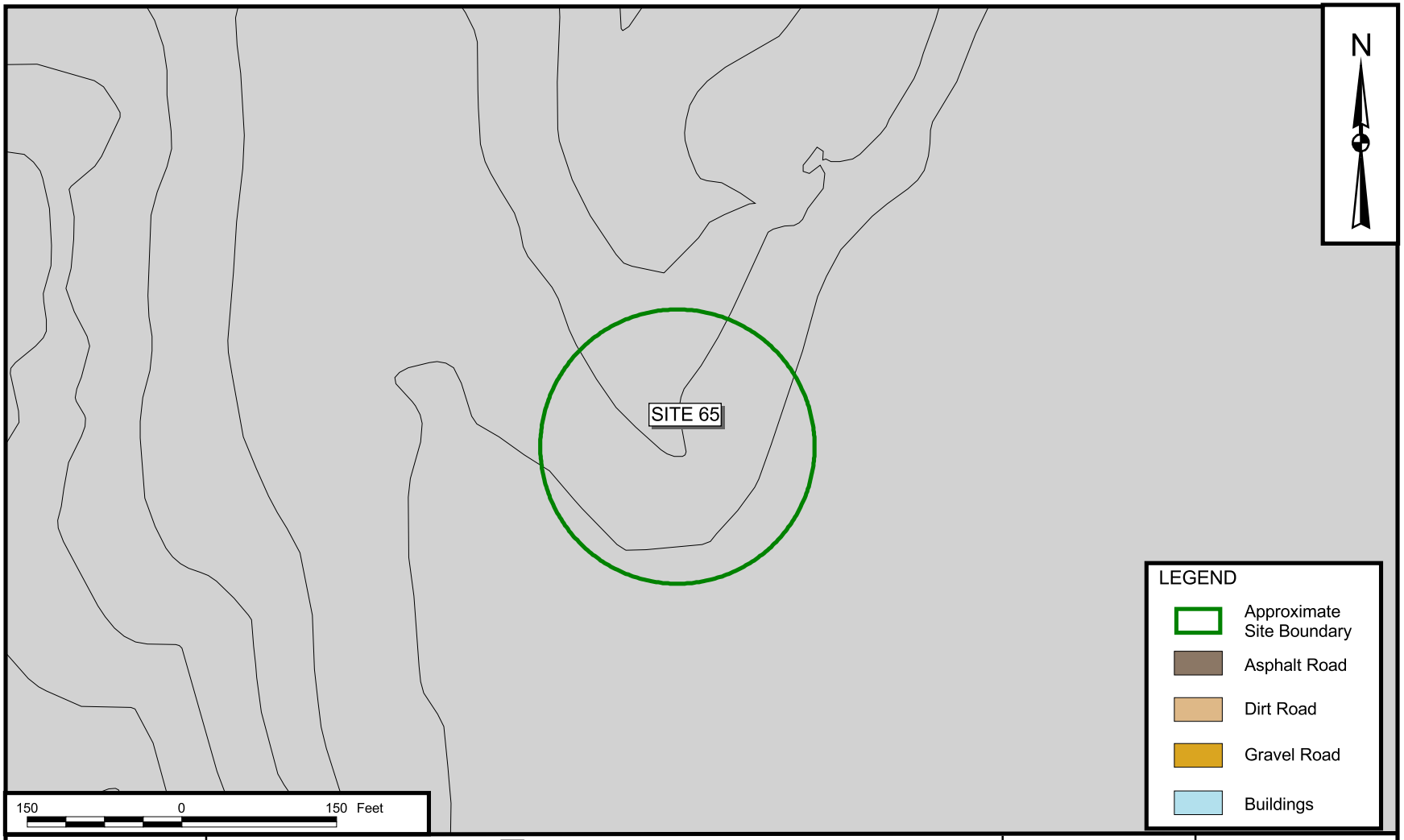

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APPENDIX C

PHOTO LOG

(PROVIDED UNDER SEPARATE COVER)

Pilot Study Work Plan
for
In Situ Bioremediation
at
Site 57 – Former Drum Loading Area
Building 292

Indian Head Division
Naval Surface Warfare Center
Indian Head, Maryland

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command

Contract Number N62467-94-D-0888
Contract Task Order 0805

May 2003

030302/P

PILOT STUDY WORK PLAN
FOR
IN SITU BIOREMEDIATION

AT
SITE 57 – FORMER DRUM LOADING AREA
BUILDING 292

INDIAN HEAD DIVISION
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Engineering Field Activity Chesapeake
1314 Harwood Street, SE
Washington Navy Yard, D.C. 20374-5018

Submitted by:
Tetra Tech NUS, Inc.
600 Clark Avenue, Suite 3
King of Prussia, Pennsylvania 19406-1433

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0805

MAY 2003

PREPARED UNDER THE DIRECTION OF:

for KIM TURNBULL
PROJECT MANAGER
TETRA TECH NUS, INC.
PITTSBURGH, PENNSYLVANIA

APPROVED FOR SUBMISSION BY:

JOHN J. TREPANOWSKI, P.E.
PROGRAM MANAGER
TETRA TECH NUS, INC.
KING OF PRUSSIA, PENNSYLVANIA

TABLE OF CONTENTS

SECTION		PAGE NO.
LIST OF ACRONYMS AND ABBREVIATIONS		**v**
1.0	**INTRODUCTION**	**1-1**
1.1	PURPOSE OF REPORT	1-1
1.2	SCOPE AND OBJECTIVE	1-1
1.3	STATION BACKGROUND	1-1
1.4	DATA QUALITY OBJECTIVES	1-2
1.5	PROJECT ORGANIZATION	1-2
1.6	DOCUMENT ORGANIZATION	1-3
2.0	**PILOT STUDY RATIONALE**	**2-1**
2.1	SITE BACKGROUND	2-1
2.2	HISTORICAL ENVIRONMENTAL DATA	2-1
2.3	PILOT STUDY FIELD INVESTIGATION SCOPE DEVELOPMENT	2-2
2.3.1	Detailed Objective Development	2-2
2.3.2	Data Needs Development	2-3
2.3.3	Investigation Matrix	2-5
3.0	**FIELD INVESTIGATIONS**	**3-1**
3.1	SUBSURFACE SOIL INVESTIGATION	3-1
3.2	GROUNDWATER INVESTIGATION	3-1
4.0	**FIELD OPERATIONS**	**4-1**
4.1	MOBILIZATION/DEMOBILIZATION	4-1
4.2	SOIL BORING / MONITORING WELL INSTALLATION	4-2
4.3	WATER LEVEL MEASUREMENTS	4-2
4.4	HRC INJECTION	4-3
4.5	SITE RESTORATION	4-3
4.6	DECONTAMINATION	4-4
4.7	INVESTIGATION-DERIVED WASTE HANDLING	4-4
4.7.1	Borehole Cuttings	4-4
4.7.2	Drill Cuttings	4-4
4.7.3	Development and Purge Water	4-4
4.7.4	Decontamination Fluids	4-4
4.7.5	Personal Protection Equipment and Miscellaneous Trash	4-4
5.0	**PILOT STUDY SAMPLING PROCEDURES**	**5-1**
5.1	SAMPLING PROCEDURES	5-1
5.1.1	Subsurface Soil Sampling	5-1
5.1.2	Groundwater Sampling	5-1
5.1.3	QA/QC Samples	5-1
5.2	SAMPLE HANDLING	5-2
5.2.1	Field Documentation	5-2
5.2.2	Sample Nomenclature	5-3
5.2.3	Sample Containers, Preservatives, and Holding Times	5-4
5.2.4	Sample Packaging and Shipping	5-5
5.3	SAMPLE CUSTODY	5-5
REFERENCES		**R-1**

TABLE OF CONTENTS (Continued)

APPENDICES

A PROJECT-SPECIFIC HEALTH AND SAFETY PLAN
B PROJECT-SPECIFIC QUALITY ASSURANCE PROJECT PLAN

TABLES

NUMBER

1-1 Integration of DQO Process into Site-Specific Work Plan 1-5
2-1 Development of Data Needs 2-7
2-2 Investigation Matrix 2-8
3-1 Sampling and Analysis Summary 3-3
3-2 Monitoring Well Data Summary 3-4
5-1 Groundwater Field Analyses Biological Activity Indicators 5-7
5-2 Summary of Fixed-Base Laboratory Analyses, Methodology, Bottle Requirements, Preservation Requirements, and Holding Times 5-8

FIGURES

NUMBER

1-1 Facility Location Map 1-7
1-2 Site Location Map 1-9
1-3 Tetra Tech NUS Project Organization Chart 1-11
2-1 Proposed HRC Installation 2-11
2-2 Detailed HRC Installation 2-12
4-1 Monitoring Well Location Map 4-7

LIST OF ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing Materials
B&R Environmental	Brown & Root Environmental
bgs	below ground surface
CLEAN	Comprehensive Long-Term Environmental Action Navy
CTO	Contract Task Order
DCE	dichloroethene
DOT	Department of Transportation
DPT	direct push technology
DQO	data quality objective
EE/CA	Engineering Evaluation/Cost Assessment
EPA	United States Environmental Protection Agency
FOL	field operations leader
FS	Feasibility Study
FSP	Field Sampling Plan
HI	hazard index
HRC	hydrogen release compound
ID	inside diameter
IDW	investigation-derived wastes
IHDIV-NSWC	Indian Head Division, Naval Surface Warfare Center
ILCR	incremental lifetime cancer risk
MCL	Maximum Contaminant Level
mg/kg	milligrams per kilogram
msl	mean sea level
MS/MSD	matrix spike/matrix spike duplicate
NAD	North American Datum
NGVD	National Geodetic Vertical Datum
NSF	National Sanitation Foundation
OD	outside diameter
ORP	oxidation/reduction potential
PPE	personal protection equipment
PVC	polyvinyl chloride
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
RI	remedial investigation
RME	Reasonable Maximum Exposure

RPM	remedial project manager
RSK	Robert S. Kerr Labs
SOP	standard operating procedure
SVE	soil vapor extraction
TBD	to be determined
TCE	trichloroethene
TCL	Target Compound List (EPA's)
TOC	total organic carbon
TtNUS	Tetra Tech NUS, Inc.
µg/kg	micrograms per kilogram
VOC	volatile organic compound

1.0 INTRODUCTION

1.1 PURPOSE OF REPORT

This Pilot Study Work Plan for an investigation at the Indian Head Division, Naval Surface Warfare Center (IHDIV-NSWC), Indian Head, Maryland was prepared by Tetra Tech NUS, Inc. (TtNUS) in response to Contract Task Order (CTO) 0805, under the Comprehensive Long-Term Environmental Action Navy (CLEAN), Contract Number N62467-94-D-0888. The purpose of this Work Plan is to develop and describe the pilot study activities to be conducted at Site 57 – Former Drum Loading Area.

1.2 SCOPE AND OBJECTIVE

TtNUS has been tasked to develop a Work Plan for a pilot study to be conducted at Site 57 – Former Drum Loading Area at IHDIV-NSWC, Indian Head, Maryland. In the pilot study, a hydrogen release compound (HRC) will be injected and evaluated for its effect on groundwater bioremediation of chlorinated volatile organic compounds (VOCs). A previously prepared Remedial Investigation (RI) Report (TtNUS, 2000) determined the need for remedial activities at the site. In the draft Feasibility Study (FS) Report (TtNUS, 2002), in situ bioremediation was determined to be a potentially effective groundwater alternative. The overall objective of the investigation described in this Work Plan is to provide site-specific information for a more detailed evaluation that will include collecting data from a pilot study.

This Work Plan is intended to be abbreviated in its discussion of the investigation and investigation results used in its preparation. This document is not intended to reiterate the details contained in the recently prepared FS report (TtNUS, 2002).

1.3 STATION BACKGROUND

The IHDIV-NSWC is located in northwestern Charles County, Maryland. As shown on Figure 1-1, the IHDIV-NSWC is approximately 25 miles southwest of Washington, D. C. The IHDIV-NSWC is a military facility consisting of the main area on the Cornwallis Neck Peninsula and the Annex on Stump Neck, which is located across Mattawoman Creek. The Stump Neck Annex is not contiguous with the main area and is operated by a tenant. As shown on Figure 1-2, the main area is bounded by the Potomac River to the northwest, west, and south, Mattawoman Creek to the south and east, and the town of Indian Head to the northeast. The location of the Site 57 is shown on Figure 1-2.

The primary mission of IHDIV-NSWC is as follows:

- To provide services in energetics for all warfare centers through engineering, fleet and operational support, manufacturing technology, limited production, and industrial base support.

- To provide research, development, testing, and evaluation of energetic materials, ordnance devices and components, and other related ordnance engineering standards including chemicals, propellants and their propulsion systems, explosives, pyrotechnics, warheads, and simulators.

- To provide support to all warfare centers, military departments, and the ordnance industry for special weapons, explosive safety, and ordnance environmental issues.

- To execute other responsibilities assigned by the Commander of the Station.

1.4 DATA QUALITY OBJECTIVES

This Work Plan has been developed using the data quality objective (DQO) process. The DQO process is a focused, iterative process for developing the data collection strategy to support decision-making. The goal of the process is to conduct investigations in an efficient and effective manner without unnecessary precision and redundancy of data. The seven steps comprising this process are listed in Table 1-1, along with the sections of this Work Plan that address the steps.

1.5 PROJECT ORGANIZATION

The pilot study described in this Work Plan will be performed by TtNUS with support from the Navy. The Navy Remedial Project Manager (RPM) is:

Jeffrey W. Morris (Code C21EC)
Department of the Navy
Engineering Field Activity Chesapeake
1314 Harwood Street, SE
Washington Navy Yard, DC 20374-5018
(202) 685-3279
(202) 433-6193 (FAX)
Email: morrisjw@efaches.navfac.navy.mil

Mr. Shawn Jorgensen will be the primary contact at the Facility:

Mr. Shawn Jorgensen, Code 044SJ
Indian Head Division
Naval Surface Warfare Center
Building D-327, 101 Strauss Avenue
Indian Head, MD 20640-5035
(301) 744-2263
(301) 744-4180 (FAX)
E-mail: jorgensensa@ih.navy.mil

The TtNUS project organization is shown on Figure 1-3.

1.6 DOCUMENT ORGANIZATION

This Work Plan is intended for use in conjunction with the Master Work Plan for IHDIV-NSWC (B&R Environmental, 1997a), which includes the Master Work Plan, the Master Field Sampling Plan (FSP), and the Master Quality Assurance Project Plan (QAPP), each of which provides general information applicable to all sites at IHDIV-NSWC. This Work Plan includes site-specific information to be used for the pilot study at Site 57 – Former Drum Disposal Area. Section 1.0 is the introduction to this site-specific Work Plan and describes the purpose of the document, outlines the scope and objectives of the work, summarizes the background of the Indian Head facility, explains how the DQO process is addressed in this Work Plan, and describes the project organization. Section 2.0 develops the rationale for and outlines the pilot study to be implemented at Site 57. Section 3.0 provides a general overview of pilot study activities to be implemented, and Section 4.0 describes the details regarding the field implementation of the pilot study. Section 5.0 covers the field investigation and sampling procedures.

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TABLE 1-1

INTEGRATION OF DQO PROCESS INTO SITE-SPECIFIC WORK PLAN
SITE 57 – FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

DQO Step[1]	Location in Work Plan Document
1. State the Problem	Section 2.3.2.2, Statement of the Problem Table 2-1, Development of Data Needs
2. Identify the Decision	Section 2.3.2.3, Identify the Decision Table 2-1, Development of Data Needs
3. Identify the Inputs to the Decision	Section 2.3.3.2, Inputs to the Decision Table 2-2, Investigation Matrix: • Investigative Techniques • Sample Locations and Analyses
4. Define the Boundaries of the Study	Section 2.3.2.1, Study Boundaries Table 2-1, Development of Data Needs: • Define Study Boundaries
5. Develop a Decision Rule	Section 2.3.3.3, Decision Rule Table 2-2, Investigation Matrix • Decision Rule
6. Specify Tolerable Limits on Decision Efforts	QAPP (Appendix B)
7. Optimize the Design for Obtaining Data	Section 3.0, Field Investigations Table 2-2, Investigation Matrix

1 Source: EPA, 1994a.

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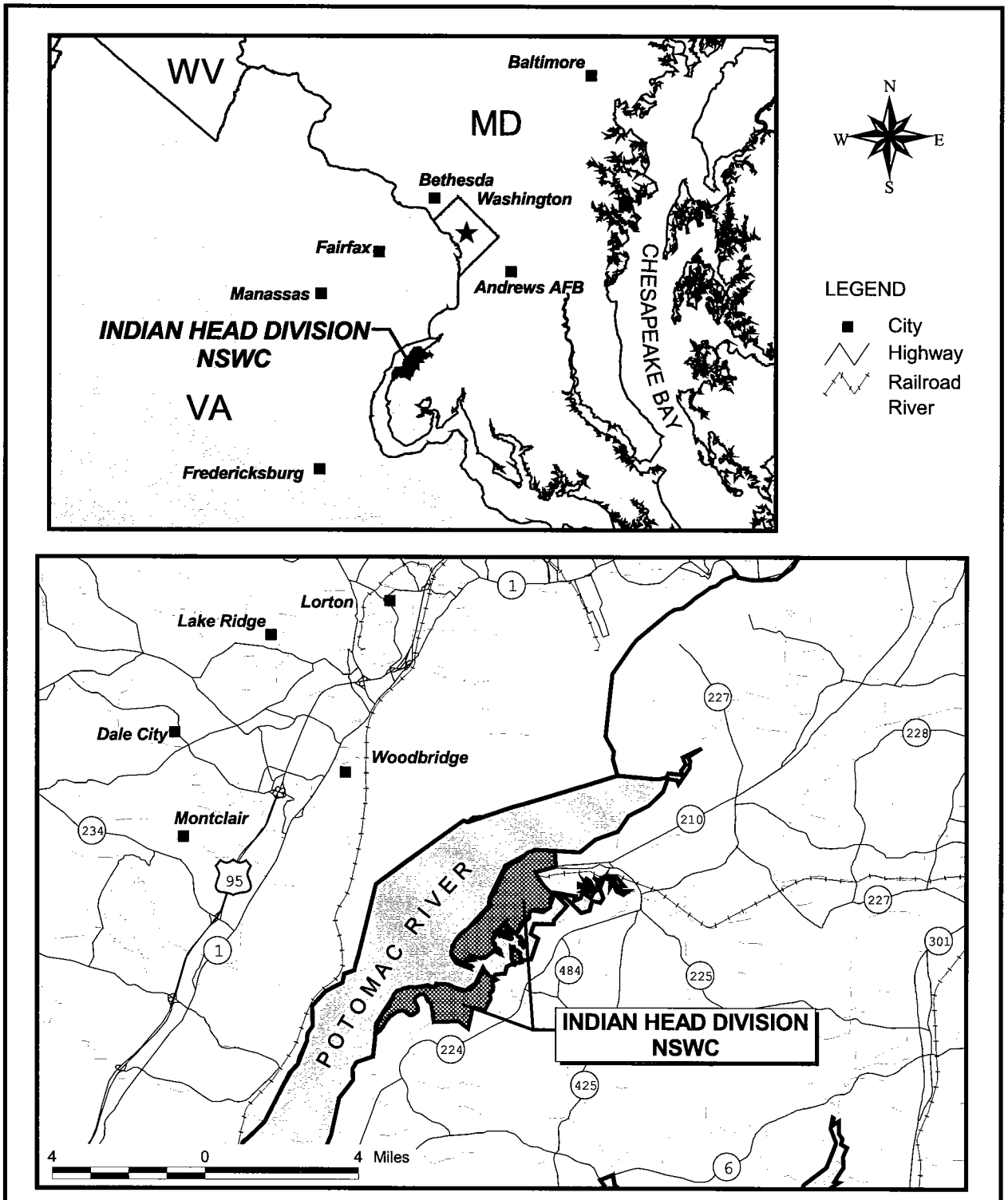

DRAWN BY: J. LAMEY — DATE: 8/2/01	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4020	OWNER NO.: 805
CHECKED BY: GJL — DATE: 8/3/01	FACILITY LOCATION MAP INDIAN HEAD DIVISION, NSWC INDIAN HEAD, MARYLAND	APPROVED BY: GJL — DATE: 8/3/01	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE 1-1	REV: 0

P:\GIS\NSWC_INDIAN_HEAD\SITE_LOCATION.APR SITE LOCATION MAP 11/16/01 KMP

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030302/P

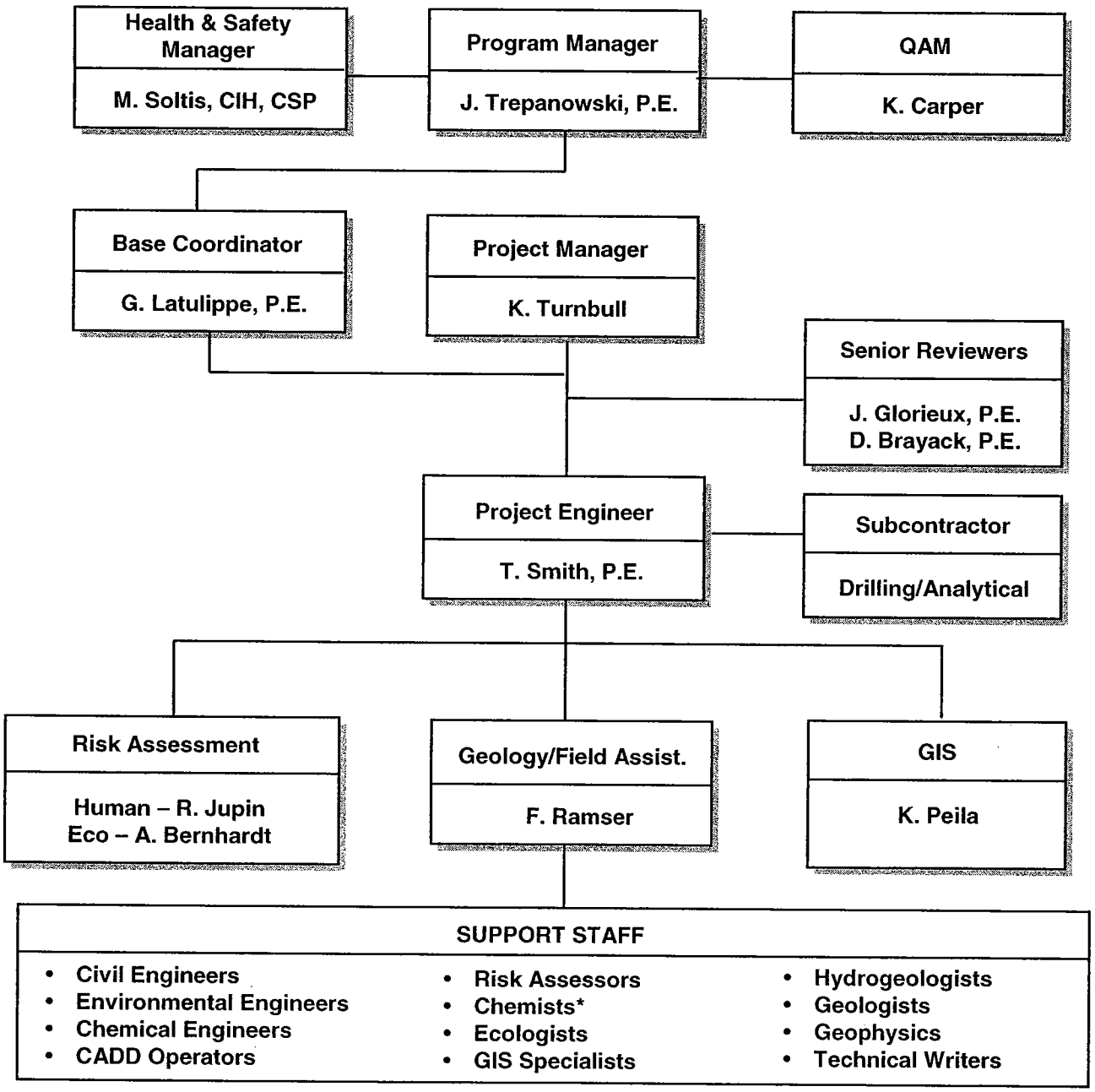
DRAWN BY K. PEILA	DATE 7/26/02	Tetra Tech NUS, Inc.	CONTRACT NUMBER 4019 / OWNER NUMBER —
CHECKED BY GJL	DATE 7/26/02	SITE LOCATION MAP SITE 57 IHDIV - NSWC, INDIAN HEAD, MARYLAND	APPROVED BY GJL / DATE 8/8/02
COST/SCHEDULE-AREA			APPROVED BY — / DATE —
SCALE AS NOTED			DRAWING NO. FIGURE 1-2 / REV 0

1-9

CTO 0805

FIGURE 1-3

TETRA TECH NUS PROJECT ORGANIZATION CHART
PILOT STUDY WORK PLAN FOR IN SITU BIOREMEDIATION
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND



* J. Samchuck will be responsible for data validation.

2.0 PILOT STUDY RATIONALE

This section provides the rationale and development of the site-specific pilot study activities for Site 57 – Former Drum Loading Area.

2.1 SITE BACKGROUND

Site 57 is located south of Building 292 in the southeastern section of the main operation facility of IHDIV-NSWC. The site consists of relatively flat ground surrounded by steep hillsides (Figure 1-2). Surface runoff appears to flow overland to a concrete drainage ditch to the south. This ditch flows into an unnamed stream that eventually discharges to Mattawoman Creek.

Previous operations at Building 292 involved the degreasing of metal parts using trichloroethene (TCE). These operations were reportedly discontinued in 1989. Site 57 also includes Buildings 165 and 496, which are located approximately 150 feet southwest of Building 292 and were reportedly used to store ethyl ether.

2.2 HISTORICAL ENVIRONMENTAL DATA

TCE was first detected in February 1994 in surface water at the industrial wastewater outfall IW-80 which serves the drainage basin that includes Buildings 165, 292, and 496. Since then, the following chronology of environmentally significant events took place:

- July 1994 - Water samples from storm sewer locations located upgradient and downgradient of Building 292 were analyzed for TCE. The downgradient samples were found to contain TCE.

- September 1995 - Soil-gas, soil, groundwater, and storm water samples were collected from Site 57 to verify the presence of TCE. The presence of TCE was verified (B&R Environmental, 1997b).

- October 1996 - A draft Engineering Evaluation/Cost Assessment (EE/CA) document was prepared to determine the most effective approach to address TCE contamination in soil. The document recommended application of the soil vapor extraction (SVE) technology.

- September 1997 - An SVE pilot study was conducted at Site 57 to verify the suitability of the site for application of SVE technology. The pilot study demonstrated that the site is not suitable for SVE (B&R Environmental, 1997b).

- February 1998 - A final EE/CA (B&R Environmental, 1998a) was prepared to evaluate approaches for mitigating the presence of TCE in the discharge through the 24-inch storm sewer as identified in samples collected during previous field work. The final EE/CA recommended rehabilitation of the storm sewer.

- March 1998 - The draft final Site 57 RI work plan (B&R Environmental, 1998b) was prepared to describe the field investigation of Site 57.

- October 1998 - The first sampling event for the Site 57 RI was performed.

- October 1998 - The Site 57 storm sewer was relined between manholes MH-427 and MH-487.

- January 1999 - The second sampling event for the Site 57 RI was performed.

- July 2000 - The RI Report (TtNUS, 2000) was prepared to describe contamination and evaluate related human health and environmental risks at Site 57.

- August 2001 – Pre-FS field activities were conducted to fill data gaps, refine the nature and extent of soil and groundwater contamination, and further define subsurface characteristics.

- May 2002 – The draft FS Report was prepared to evaluate the remediation alternatives.

2.3 PILOT STUDY FIELD INVESTIGATION SCOPE DEVELOPMENT

2.3.1 Detailed Objective Development

As described in Section 1.2, the broad objective of the investigation described in this Work Plan is to support the preparation of an FS by collecting data necessary for a more detailed evaluation of technologies and alternatives for the remediation of Site 57.

The investigative activities necessary to address the broad objective are determined by first defining the set of detailed objectives that must be met. In this document, the detailed objectives have been developed by application of the DQO process mentioned in Section 1.3. The process is documented in the text and is summarized for Site 57 in Table 2-1, Development of Data Needs, and Table 2-2, Investigation Matrix.

Tables 2-1 and 2-2 are arranged to identify how the development of detailed objectives and the scoping of the investigation activities parallel the DQO process. The left side of Table 2-1 illustrates how the site

has been defined to establish the study boundaries. The following four columns focus on the “Statement of the Problem” by listing contamination previously identified, the potential contamination transport routes, potential receptors, and the potential for human health risk. The columns under “Identify the Decision” indicate the potential remedial technology for consideration in addressing the identified problem. The “Data Needs” column on the right side of Table 2-1 shows the question that needs to be answered to allow a more complete evaluation of the site.

Table 2-2 restates the "Data Needs" as "Investigation Objectives." Then, under "Identify Inputs to the Decision," the specific investigative activities for addressing each of the objectives are summarized. The "Decision Rule" column generally indicates the next step if certain conditions should arise.

2.3.2 Data Needs Development

The “Development of Data Needs”, as presented in Table 2-1, comprises four main categories: “Study Boundaries”, “Statement of the Problem”, “Identify the Decision”, and “Data Needs”.

2.3.2.1 Study Boundaries

For the purpose of the pilot study at Site 57, the study boundaries are defined as an area approximately 30 feet wide extending from S57MW003/S57SB002 to S57MW011 (see Figure 2-1).

2.3.2.2 Statement of the Problem

In situ bioremediation was identified in the draft FS as a potentially effective method for groundwater treatment. The statement of the problem establishes the need for site-specific data to evaluate the effectiveness of HRC to treat the groundwater contamination at Site 57. The RI Report (TtNUS, 2000) prepared for Site 57 served as the source of the information shown in Table 2-1.

Based on the RI Report (TtNUS, 2002), an area of subsurface soil centered around soil borings S57SB002 and S57SB006, which are shown on Figure 2-1, is contaminated with TCE [up to 220,000 micrograms per kilogram (µg/kg)]. This area is considered to be a groundwater contaminant source.

The primary groundwater contaminants are chlorinated VOCs (1,1-dichloroethene, cis-1,2-dichloroethene, TCE, tetrachloroethene, vinyl chloride, and chloroform) and ethyl ether. The human health risk assessment in the RI found only one groundwater exposure scenario for which a potential risk exists. Under the Reasonable Maximum Exposure (RME) scenario, the incremental lifetime cancer risk (ILCR) for the hypothetical future lifelong resident (3.5E-03) exceeded the EPA’s target risk

range of 1.0E-04 to 1.0E-06, and the non-carcinogenic hazard index (HI) of the hypothetical future child (1.2E+01) and adult (5.3E+00) residents exceeded the acceptable threshold value.

Although there are no risks from direct exposure of ecological receptors to groundwater, migration of groundwater contaminants to surface water and sediment could result in ecological concerns.

From a human health perspective, the primary soil contaminant is arsenic. The human health risk assessment in the RI examined several exposure scenarios and found one soil scenario for which a potential risk exists for non-residential exposure. Under the RME scenario, the non-carcinogenic HI of the future construction worker was calculated as 1.1, which exceeds EPA's threshold value of 1.0. Elevated concentrations of arsenic in soil [103 milligrams per kilograms (mg/kg)] were limited to a hot spot at boring S57SB007 (shown on Figure 2-1) and, if that sampling point were removed from the database, the HI for the future construction worker would fall below the acceptable threshold value. While treatment of soil for arsenic is not the primary purpose of this Work Plan, the installation of monitoring wells provides an opportunity for soil sampling to more accurately delineate the extent of soil arsenic contamination.

2.3.2.3 Identify the Decision

Identifying the decision typically involves setting the remedial objectives, determining the risk-related or regulatory drivers for taking mitigative action, defining the potential response actions that will provide the necessary mitigation, and identifying potential remedial technologies required to implement the remedial technologies.

This project is designed to provide data useful for the evaluation of HRC injection for enhanced biological treatment to remediate groundwater at Site 57.

Potential human health risks to construction workers result primarily from elevated arsenic contamination in soil near soil boring S57SB007. Removal of a limited volume of arsenic-contaminated soil near boring S57SB007 would reduce the HI to construction workers to a value less than 1.0.

Groundwater south of the southern corner of Building 292 is sufficiently contaminated with chlorinated VOCs and ethyl ether that the water is unsuitable for potable purposes. In situ enhanced biological treatment of groundwater was identified in the draft FS (TtNUS, 2002) as a possible technology for mitigating the level of contamination in the groundwater.

2.3.2.4 Data Needs

The data needs indicated in Table 2-1 are in the form of a question intended to identify the concerns associated with conducting a pilot study to examine the potential remedial technology identified for the site. The question posed in the table is shown as a statement in Table 2-2 under the heading "Investigation Objectives". The locations pertinent to the proposed pilot study are shown on Figure 2-2.

2.3.3 Investigation Matrix

The investigation matrix for Site 57 (Table 2-2) comprises three main categories: "Investigation Objectives," "Identify Inputs to the Decision," and "Decision Rule."

2.3.3.1 Investigation Objectives

The data needs, presented as a question in Table 2-1, is presented as an investigation objective in Table 2-2. The investigative activities identified in the Table 2-2 are intended to address the investigation objectives.

2.3.3.2 Inputs to the Decision

The inputs to the decision have been developed to identify the means by which data will be collected to meet the investigation objectives. The approach for collecting the data is identified in the table under the "Investigative Technique" heading. Subsequent columns in the table describe the locations where the techniques are to be applied and reference the figure where the sample locations are shown. When samples are to be collected for chemical analysis, the final three columns under "Inputs to the Decision" indicate the quantity of samples, the media to be sampled, and the analyses to be performed on the samples.

For Site 57, proposed field activities include the installation and sampling of soil borings, the installation of new monitoring wells, the injection of HRC, and the sampling of new and existing wells.

2.3.3.3 Decision Rules

The final column in Table 2-2 presents the decision rules by which decisions will be made based on the results of the field investigations.

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TABLE 2-1

DEVELOPMENT OF DATA NEEDS
SITE 57 – FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

STUDY BOUNDARIES			STATEMENT OF THE PROBLEM[1]				IDENTIFY THE DECISION				DATA NEEDS
Population Contamina nt Source	**Spatial**	**Temporal**	**Identified Contaminants**	**Potential Transport/ Exposure Pathways**	**Potential Receptors**	**Human Health Risks**	**Remedial Objectives**	**Mitigation Driver**	**Potential Response Action**	**Potential Remedial Technologies**	***Engineering***
Building 292	From Building 292 to MW011 approximately 80 feet south of Building 292.	Conduct field pilot study prior to preparing the draft final FS.	Primary groundwater contaminants are chlorinated VOCs and ethyl ether.	Groundwater ingestion and incidental dermal contact.	Hypothetical future residents.	Incremental Lifetime Cancer Risk =3.5E-03 HI=12 (child), 5.3 (adult)	Remove contaminants present at concentrations greater than their clean-up levels.	Federal Maximum Contaminant Levels.	In situ biological treatment.	In situ enhanced biological treatment using a hydrogen release compound (HRC).	Are the site-specific conditions regarding contaminants and aquifer physical characteristics amenable to enhanced biological treatment under anerobic conditions?

1 Remedial Investigation Report (TtNUS, 2000).

TABLE 2-2

INVESTIGATION MATRIX
SITE 57 – FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND
PAGE 1 OF 3

STUDY BOUNDARIES			INVESTIGATION OBJECTIVES	IDENTIFY INPUTS TO THE DECISION									DECISION RULE
Population: Contaminant Source	Spatial	Temporal		Investigative Technique	Location	Work Plan Figure	DPT Injection Points	New Soil Borings	New Monitoring Wells	Quantity of Samples	Media	Analytical Parameters	
Building 292.	From Building 292 to MW011 approximately 80 feet south of Building 292.	Conduct field pilot study prior to preparing the draft final FS.	Determine whether the site-specific conditions regarding contaminants and aquifer physical characteristics are amenable to enhanced biological treatment using HRC.	Establish additional downgradient groundwater sampling locations by installing two new monitoring wells.	S57SB027/ S57MW024 and S57SB028/ S57MW025	2-2	NA	NA	2	NA	NA	NA	Decreasing contaminant concentrations and the presence of indicators of anaerobic biological activity will indicate that biological remediation is occurring.
				Collect and analyze baseline groundwater samples from new and existing wells prior to HRC injection.	S57MW003, S57MW004, S57MW011, S57MW024, and S57MW 025.	2-2	NA	NA	NA	5	Groundwater	Chlorinated VOCs, ethel ether, Biological Activity Indicators (1) and Competing Electron Acceptors (2)	
				Measure water levels to verify groundwater flow pattern in Pilot Study area.	S57MW003, S57MW004, S57MW011, S57MW024, and S57MW025.	2-1	NA	NA	NA	NA	Groundwater	NA	

TABLE 2-2

INVESTIGATION MATRIX
SITE 57 – FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND
PAGE 2 OF 3

STUDY BOUNDARIES			INVESTIGATION OBJECTIVES	IDENTIFY INPUTS TO THE DECISION									DECISION RULE
Population: Contaminant Source	Spatial	Temporal		Investigative Technique	Location	Work Plan Figure	DPT Injection Points	New Soil Borings	New Monitoring Wells	Quantity of Samples	Media	Analytical Parameters	
Building 292. (continued)	From Building 292 to MW011 approximately 80 feet south of Building 292. (continued)	Conduct field pilot study prior to preparing the draft final FS. (continued)	Determine whether the site-specific conditions regarding contaminants and aquifer physical characteristics are amenable to enhanced biological treatment using HRC.	Measure water levels to verify groundwater flow pattern under Site 57.	All remaining Site 57 monitoring wells.	4-1	NA	NA	2	NA	Groundwater	NA	Decreasing contaminant concentrations and the presence of indicators of anaerobic biological activity will indicate that biological remediation is occurring. (continued)
				Install HRC near the TCE source area and monitor the reduction of contaminant levels and indications of anaerobic biological activity.	Area SSE of S57MW004.	2-2	12	NA	NA	NA	Groundwater	NA	

TABLE 2-2

INVESTIGATION MATRIX
SITE 57 – FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND
PAGE 3 OF 3

STUDY BOUNDARIES			INVESTIGATION OBJECTIVES	IDENTIFY INPUTS TO THE DECISION									DECISION RULE
Population: Contaminant Source	Spatial	Temporal		Investigative Technique	Location	Work Plan Figure	DPT Injection Points	New Soil Borings	New Monitoring Wells	Quantity of Samples	Media	Analytical Parameters	
Building 292. (continued)	From Building 292 to MW011 approximately 80 feet south of Building 292. (continued)	Conduct field pilot study prior to preparing the draft final FS. (continued)	Determine whether the site-specific conditions regarding contaminants and aquifer physical characteristics are amenable to enhanced biological treatment using HRC	Collect and analyze groundwater samples from all MWs in the Pilot Study area at intervals of 1, 2, 4, and 6 months following HRC installation.	S57MW003, S57MW004, S57MW011, S57MW024, and S57MW 025.	2-2	NA	NA	2	20	Groundwater	Chlorinated VOCs, ethyl ether, Biological Activity Indicators (1) and Competing Electron Acceptors (2)	
			Refine the current understanding of the horizontal and vertical extent of the contaminated source area near S57MW004 and S57MW011	During monitoring well installation, collect subsurface soil samples at 4 to 5 feet bgs, 9 to 10 feet bgs, 14 to 15 feet bgs, and 17 to 18 feet bgs.	S57SB027/ S57MW024 and S57SB028/ S57MW025	2-2	NA	2	2	8	Soil	Arsenic, chlorinated VOCs and ethyl ether.	Compare to analytical results from the remedial investigation report to improve current understanding of the source area limits.

1 Biological Activity Indicators include oxidation/reduction potential (ORP), pH, temperature, total organic carbon, alkalinity, ferrous iron, specific conductance, dissolved gases (carbon dioxide, ethane, ethene, hydrogen sulfide, methane, and oxygen), metabolic acids (lactic, pyruvic, acetic, propionic, and butyric) and miscellaneous anions (sulfate, sulfide, nitrate, nitrite, chloride, phosphate).

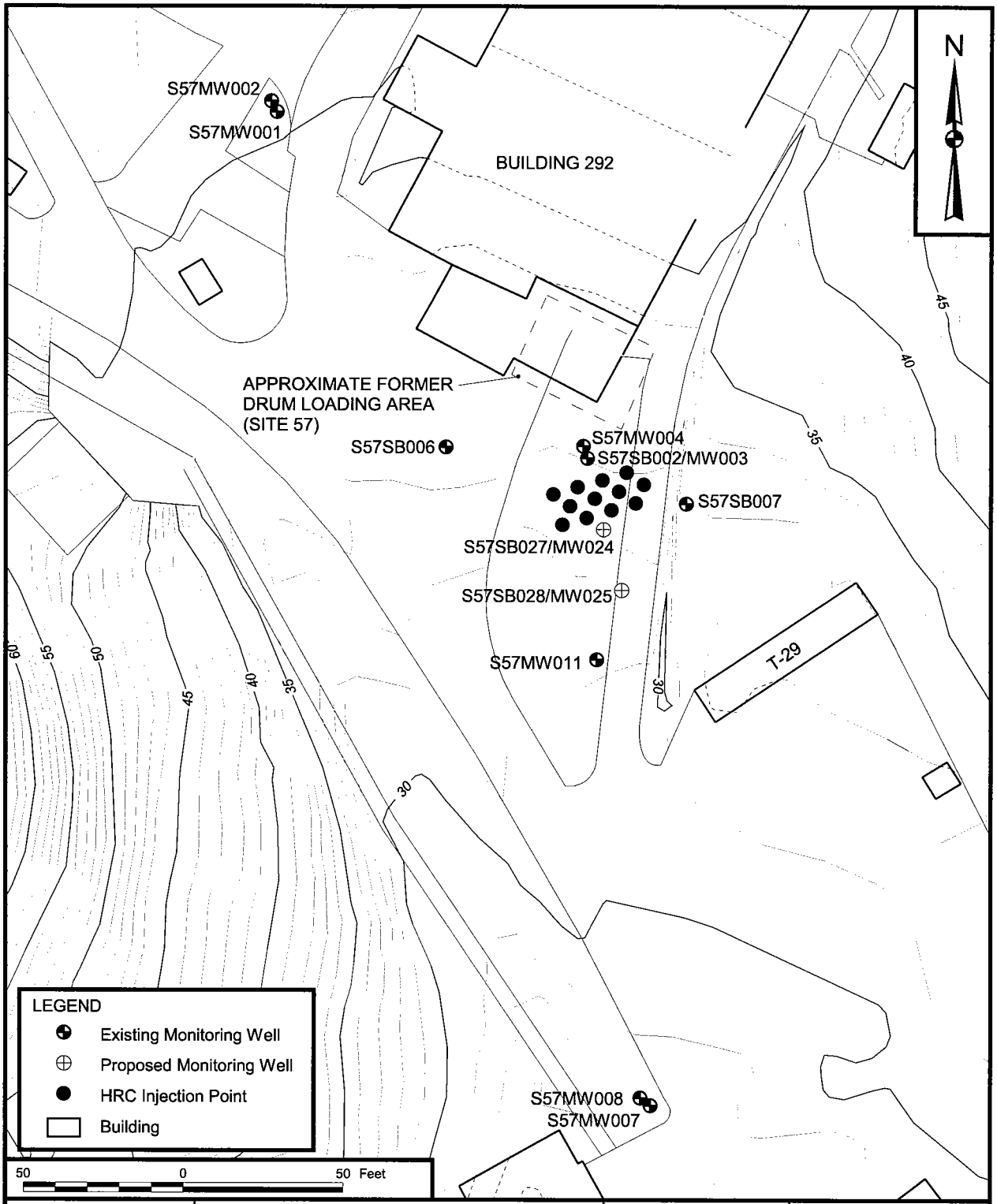
2 Competing Electron Acceptors include manganese and total dissolved iron.

bgs Below ground surface.

NA not applicable.

TCE Trichloroethene.

VOCs Volatile organic compounds.



DRAWN BY: K. PEILA — DATE: 1/30/03	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4020	OWNER NO.: 0805
CHECKED BY: G. LATULIPPE — DATE: 1/30/03	PROPOSED HRC INSTALLATION SITE 57 - FORMER DRUM LOADING AREA IHDIV-NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: G. LATULIPPE — DATE: 1/30/03	
COST/SCHEDULE-AREA		APPROVED BY: — — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE 2-1	REV: 0

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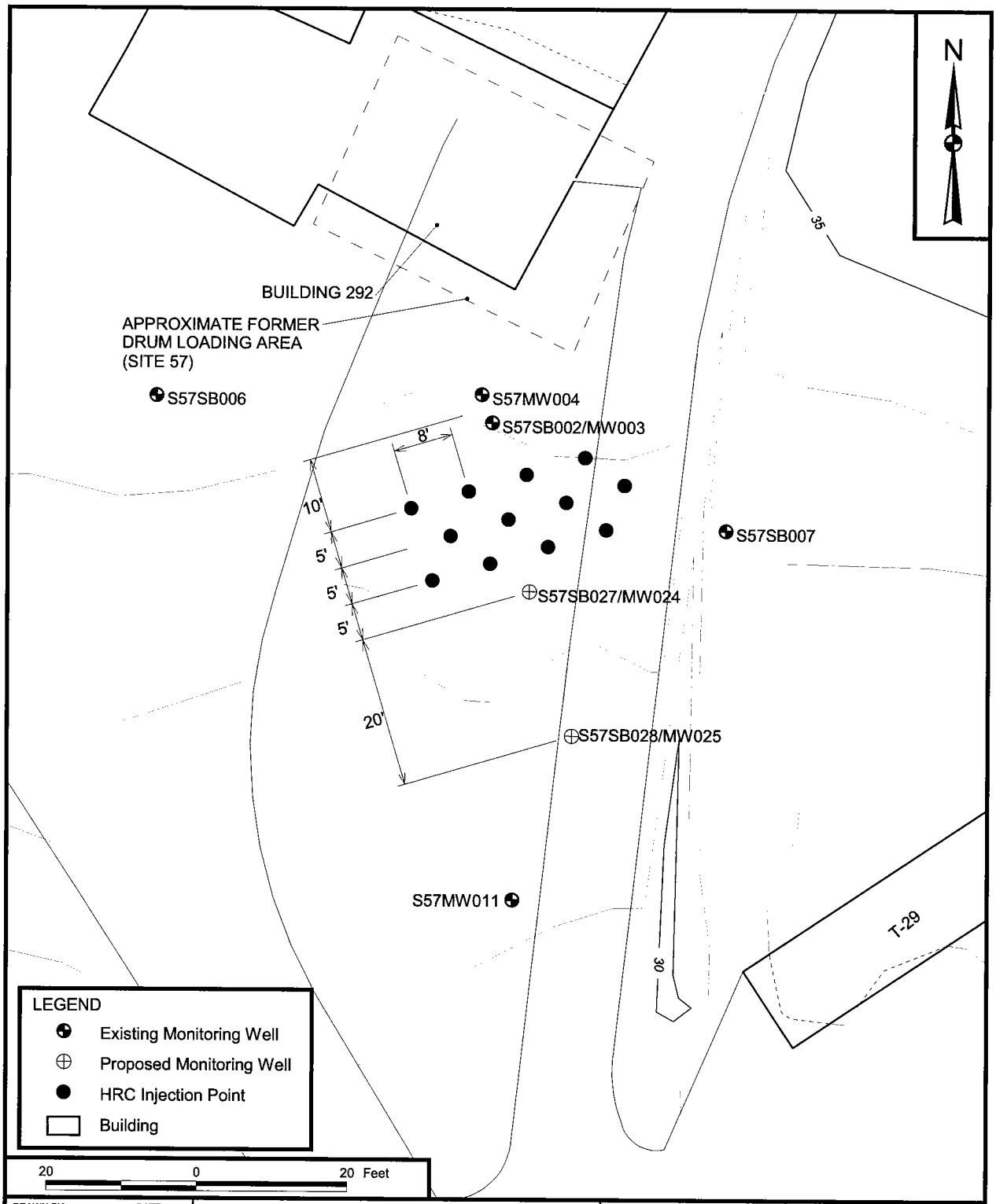

DRAWN BY: K. PEILA — DATE: 1/30/03	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4020	OWNER NO.: 0805
CHECKED BY: G. LATULIPPE — DATE: 1/30/03	DETAILED HRC INSTALLATION SITE 57 - FORMER DRUM LOADING AREA IHDIV-NSWC, INDIAN HEAD, MARYLAND	APPROVED BY: G. LATULIPPE — DATE: 1/30/03	
COST/SCHEDULE-AREA		APPROVED BY: — DATE: —	
SCALE: AS NOTED		DRAWING NO.: FIGURE 2-2	REV: 0

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3.0 FIELD INVESTIGATIONS

This section describes the specific field activities that will be conducted to secure the data from the pilot study required for FS report preparation. Table 2-1 shows the development and identification of data needs for Site 57. Table 2-2 shows the field investigation activities planned for collecting the required data. Table 3-1, Sampling and Analysis Summary, lists the samples planned for collection and the analyses anticipated for each.

Figures 2-1 and 2-2 are the field investigation maps that indicate the locations of existing wells and proposed locations of soil borings, HRC injection points, and new monitoring wells at Site 57. It should be noted, however, that these figures are only presented for planning purposes; sampling locations may be modified to accommodate existing field conditions.

Taken together, these tables and figures are intended to provide a summary of and rationale for the overall pilot study activities.

The following subsections are not intended to reiterate information already presented in the tables and figures. The text that follows is intended to complement the tables and figures by clarifying points not specifically covered by them. This section, along with the tables and figures, provides a comprehensive view of the pilot study.

3.1 SUBSURFACE SOIL INVESTIGATION

As proposed, subsurface soil sampling will consist of collecting soil from four depths at two sampling locations downgradient of the HRC injection area. The subsurface soil samples will be subjected to analyses for chlorinated VOCs plus ethyl ether and arsenic.

3.2 GROUNDWATER INVESTIGATION

As proposed, the groundwater portion of the investigation will consist of installing two new monitoring wells downgradient of the HRC injection points, measuring water levels, and collecting groundwater samples from these new wells and from three existing monitoring wells. Construction data for existing and proposed wells are presented on Table 3-2. Groundwater will be sampled prior to HRC injection to provide a baseline, and at 1, 2, 4, and 6 months after HRC injection. All the collected groundwater samples will be analyzed for chlorinated VOCs plus ethyl ether, field parameters, biological activity indicators, HRC-based electron donors, and end-product dissolved gases.

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TABLE 3-1

SAMPLING AND ANALYSIS SUMMARY
PILOT STUDY WORK PLAN FOR IN SITU BIOREMEDIATION
SITE 57 – FORMER DRUM LOADING AREA
IHDIV-NSWC, INDIAN HEAD, MARYLAND

Location	Sample Designation	LABORATORY ANALYSES										FIELD TESTS						
		Sample Depth (feet bgs)	Chlorinated VOCs plus ethyl ether	Arsenic	Alkalinity (CaCO3)	Dissolved Gases[1]	Iron (Total & Dissolved)	Miscellaneous Anions[2]	Manganese (Total & Dissolved)	Metabolic Acids[3]	TOC	Temperature	pH	Specific Conductivity	Oxidation / Reduction Potential	Dissolved Oxygen	Iron (Ferrous)	Hydrogen Sulfide
SUBSURFACE SOIL																		
S57SB027	S57SB0270104	4 – 5	•	•														
/MW024																		
S57SB027	S57SB0270204	9 – 10	•	•														
/MW024																		
S57SB027	S57SB0270304	14 – 15	•	•														
/MW024																		
S57SB027	S57SB0270404	17 – 18[4]	•	•														
/MW024																		
S57SB028	S57SB0280104	4 – 5	•	•														
/MW025																		
S57SB028	S57SB0280204	9 – 10	•	•														
/MW025																		
S57SB028	S57SB0280304	14 – 15	•	•														
/MW025																		
S57SB028	S57SB0280404	17 – 18[4]	•	•														
/MW025																		
GROUNDWATER																		
Baseline Samples																		
S57MW003	S57MW0030104	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW004	S57MW0040104	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW011	S57MW0110104	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW024	S57MW0240104	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW025	S57MW0250104	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
Month 1 Samples																		
S57MW003	S57MW0030105	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW004	S57MW0040105	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW011	S57MW0110105	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW024	S57MW0240105	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW025	S57MW0250105	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
Month 2 Samples																		
S57MW003	S57MW0030106	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW004	S57MW0040106	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW011	S57MW0110106	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW024	S57MW0240106	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW025	S57MW0250106	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
Month 4 Samples																		
S57MW003	S57MW0030107	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW004	S57MW0040107	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW011	S57MW0110107	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW024	S57MW0240107	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW025	S57MW0250107	NA	•			•	•	•	•	•	•	•	•	•	•	•	•	•
Month 6 Samples																		
S57MW003	S57MW0030108	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW004	S57MW0040108	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW011	S57MW0110108	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW024	S57MW0240108	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•
S57MW025	S57MW0250108	NA	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•

1 Dissolved gases include carbon dioxide, ethane, ethene, and methane.
2 Miscellaneous anions include sulfate, sulfide, nitrate, nitrite, chloride, phosphate.
3 Metabolic Acids include lactic, pyruvic, acetic, propionic, and butyric.
4 Estimated depth. Sample last 1 foot of boring.

bgs = Below ground surface.
VOC = Volatile organic compounds.
TOC = Total organic carbon.
NA = Not applicable.

TABLE 3-2

MONITORING WELL DATA SUMMARY
SITE 57 - FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION, NAVAL SURFACE WARFACE CENTER
INDIAN HEAD, MARYLAND

Existing Wells	Proposed Wells	Ground Elevation[1] (feet msl)	Top of Casing Elevation[1] (feet msl)	Screen Depth (feet bgs)	Screen Elevation[1] (feet msl)	Depth to Ground-water (feet btoc)[2]	Ground-water Elevation[1] (feet msl[2])	North Coordinate [3]	East Coordinate [3]	Average Hydraulic Conductivity (feet per day)
MW003	-	33.83	35.82	Top: 17 Bottom: 22	Top: 16.83 Bottom: 11.83	8.97	26.85	335285.641	1263748.262	3.18
MW004	-	33.91	35.72	Top: 6 Bottom: 16	Top: 27.91 Bottom: 17.91	9.18	26.54	335289.358	1263746.882	15.2
-	MW024	TBD	TBD	Top: 8 Bottom: 18	Top: TBD Bottom: TBD	TBD	TBD	TBD	TBD	TBD
-	MW025	TBD	TBD	Top: 8 Bottom: 18	Top: TBD Bottom: TBD	TBD	TBD	TBD	TBD	TBD
MW007	-	28.17	30.58	Top: 16 Bottom: 26	Top: 12.17 Bottom: 2.17	9.27	21.31	335082.261	1263768.134	0.57
MW008	-	28.09	30.26	Top: 5 Bottom: 15	Top: 23.09 Bottom: 13.09	8.55	21.71	335084.774	1263764.996	9.33
MW011	-	31.61	33.49	Top: 9 Bottom: 19	Top: 22.61 Bottom: 12.61	9.31	24.18	335222.164	1263751.168	0.50

1 Elevation Datum = National Geodetic Vertical Datum (NGVD) 1929.
2 Measurement taken 08/29/01.
3 Coordinate Datum = North American Datum (NAD) 1983.
msl = Mean sea level.
bgs = Below ground surface.
btoc = Below top of casing.
TBD = To be determined.

4.0 FIELD OPERATIONS

A range of site evaluation techniques will be used to collect data during the pilot study at Site 57. The Master FSP (B&R Environmental, 1997a) and Station Standard Operating Procedures (SOPs) describe the general techniques that may be used to collect the environmental samples and field data and to document field activities.

This section provides specific field operations, methods, and procedures that will be conducted for this pilot study field effort.

4.1 MOBILIZATION/DEMOBILIZATION

During soil boring, well installation, and sampling, the field crew will consist of a field operations leader (FOL)/site geologist, a qualified environmental technician, and drilling subcontractor personnel. The technician will be assigned the role of site safety officer for the field activities. During HRC injection, the field crew will consist of an FOL/site geologist and drilling subcontractor personnel. The site geologist will be assigned the role of site safety officer for the field activities. The drilling subcontractor field crew will consist of a Maryland-licensed driller and a helper. Mobilization and demobilization operations will be performed as described in the Master FSP, Section 2.1.1. No work will commence without a Dig Permit from the Public Works Department.

The FOL will coordinate with Base personnel and with a TtNUS subcontractor for the utility clearance of drilling locations.

Security badges will be required for all field crew members in order to gain access to the study area; the badges will be obtained at the pass office (Building 1779). Prior to the arrival of the field crew at the Facility main gate office, the TtNUS project manager will provide to the Facility Environmental Division the names and Social Security numbers of the TtNUS and subcontractor personnel to ensure that the security badges are obtained without delaying the project.

The field crew will be required to attend a hazard control briefing administered by the Environmental Division Point of Contact.

4.2 SOIL BORING / MONITORING WELL INSTALLATION

The following procedures and construction specifications will be used for installing permanent monitoring wells. Additional guidance for well installation can be found in the Master FSP, Section 2.3.1, and Station SOP GH-12.

Permanent monitoring wells will be installed using 6-inch (minimum) outside diameter (OD), 4¼-inch inside diameter (ID) hollow-stem augers with continuous split-spoon sampling [according to American Society for Testing Materials (ASTM) methods] to the bottom of the boring. Monitoring well borings will be drilled to a depth sufficient to position the top of the well screen approximately 2 feet above the water table.

The monitoring wells will be constructed of Schedule 40, flush-jointed, 2-inch ID National Sanitation Foundation (NSF) polyvinyl chloride (PVC) well screen and PVC riser pipe. The well screens will be 10 feet long with a slot size of 0.01 inch and will be supplied with an end cap. After the screen and the riser pipe are in place, the annulus of the boring will be backfilled with clean silica sand (Nos. 20/30 or 20/40 U.S. Standard Sieve size) filter pack from the bottom of the boring to 2 to 3 feet above the top of the well screen. Care shall be taken during installation of the sand pack materials to reduce the potential for bridging. The augers shall be pulled up slowly as the materials are allowed to settle to ensure that an adequate filter pack is installed around the well screen. A bentonite pellet seal (minimum 2-foot thickness) will be installed above the filter pack and will be hydrated using approximately 10 gallons of potable water per vertical foot. If the boring has several feet of standing water preventing the free fall of dry bentonite chips (to be determined in the field by the site geologist), the bentonite seal may be installed by pumping a bentonite slurry into the annular space using a tremie pipe while the augers are still in place. The remaining annulus of the borehole (above the bentonite seal) will be grouted by pumping a cement/bentonite slurry (one 94-pound bag of Portland Type 1 cement, approximately 4 to 6 pounds of bentonite, and 6.5 to 7 gallons of water) through a tremie pipe to the ground surface. The depths of the backfill materials will be constantly monitored during the monitoring well installation with a weighted stainless steel or plastic tape.

4.3 WATER LEVEL MEASUREMENTS

One round of synoptic water level measurements will be taken from all new and existing monitoring wells during the field investigation in accordance with procedures provided in Section 2.4 of the Master FSP and Station SOP GH-02. Site 57 monitoring well locations are shown on Figures 2-1 and 4-1.

4.4 HRC INJECTION

TtNUS will conduct the study using HRC supplied by Regenesis, a vendor. HRC is a compound that provides a steady release of hydrogen to the in situ indigenous anaerobic microbes. The microbes thrive in the hydrogen-rich environment and break down the chlorinated VOCs into non-toxic end products.

HRC will be applied with direct push technology (DPT) equipment. The surface area overlying the contaminated groundwater plume consists of grass and pavement; therefore, no concerns exist with respect to the injection of the HRC to the subsurface using DPT. Some DPT points will need to be driven through the pavement, but this will have no effect on the implementation of this technology. Because the area is easily accessible with no significant tree cover or vegetation, no specific type or size of DPT installation equipment will be required.

The pilot-scale biotreatability test will be conducted just south of S57MW004 (see Figure 2-2). For the pilot study, the area to be treated is estimated at 30 feet by 10 feet. As shown on Figure 2-2, the site-specific grid will have 5-foot spacing between rows and 8-foot spacing within rows, as recommended by the vendor, Regenesis. Twelve DPT injection points are proposed to inject HRC from a depth of 18 feet below ground surface (bgs) up to 8 feet bgs. A minimum of 9.0 pounds of HRC per foot injected through this 10 foot thick zone will result in an estimated total of 1,080 pounds of injected HRC. One DPT rig will be utilized to perform the field work. No clearing is anticipated in the area of the contaminated groundwater plume because there is no tree cover or vegetation.

All injections into the contaminated groundwater plume will be accomplished using DPT. The drive rods will be pushed to the bottom of the contaminated saturated zone, and then HRC will be injected as the rods are withdrawn. The minimum recommended rod size is 0.625-inch ID. Pump selection is limited to the RE Rupe or the Geoprobe GS-2000, based on vendor experience associated with the HRC viscosity and required pressures.

After HRC injection, the hole will be abandoned by forced injection of grout, using a tremie pipe, from the top of the HRC to the ground surface. The grout sealant will consist of Portland Type I cement mixed at a proportion of 6.5 to 7 gallons of water per 94-pound bag of cement.

4.5 SITE RESTORATION

If required as a result of the drilling and sampling activities during the field investigation, site restoration will be performed in accordance with procedures provided in Section 2.1.2 of the Master FSP.

4.6 DECONTAMINATION

Decontamination activities will be conducted during the field investigation in accordance with procedures provided in Section 2.10 of the Master FSP with the following exception: the nitric acid rinse will be omitted, and isopropyl alcohol will be used as the solvent rinse.

4.7 INVESTIGATION-DERIVED WASTE HANDLING

The handling and disposal of investigation-derived waste (IDW) at the Facility are discussed in detail in Section 2.11 of the Master FSP and Station SOP SA-13. The IDW that will be produced during this investigation includes borehole cuttings, drill cuttings from monitoring well installation, development and purge water, decontamination fluids, and personal protective equipment (PPE), including miscellaneous trash.

4.7.1 Borehole Cuttings

The soil removed during subsurface soil sampling activities via borehole drilling or direct-push method will be placed in DOT-approved drums for subsequent disposal, in accordance with Master FSP Section 2.11.

4.7.2 Drill Cuttings

The drill cuttings produced during the installation of the monitoring wells will be disposed in the same manner as described for borehole cuttings.

4.7.3 Development and Purge Water

All development and purge water will be containerized in DOT-approved drums separately from solid materials for subsequent disposal, in accordance with Master FSP Section 2.11.

4.7.4 Decontamination Fluids

Fluids generated during the decontamination of sampling equipment will be disposed in the same manner as described for development and purge water.

4.7.5 Personal Protection Equipment and Miscellaneous Trash

PPE and any miscellaneous trash (i.e., paper towels, disposable trowels free of loose soil, etc.) will be disposed in accordance with Master FSP Section 2.11.

4.8 SURVEYING

TtNUS personnel will survey monitoring wells and HRC injection locations. Planimetric features and topography were previously surveyed during the Site 57 RI. Existing wells within the Facility will be utilized as reference points. Horizontal locations will be surveyed to Maryland State Plane coordinates [North American Datum (NAD), 1983], and vertical elevations will be referenced to 1929 National Geodetic Vertical Datum (NGVD).

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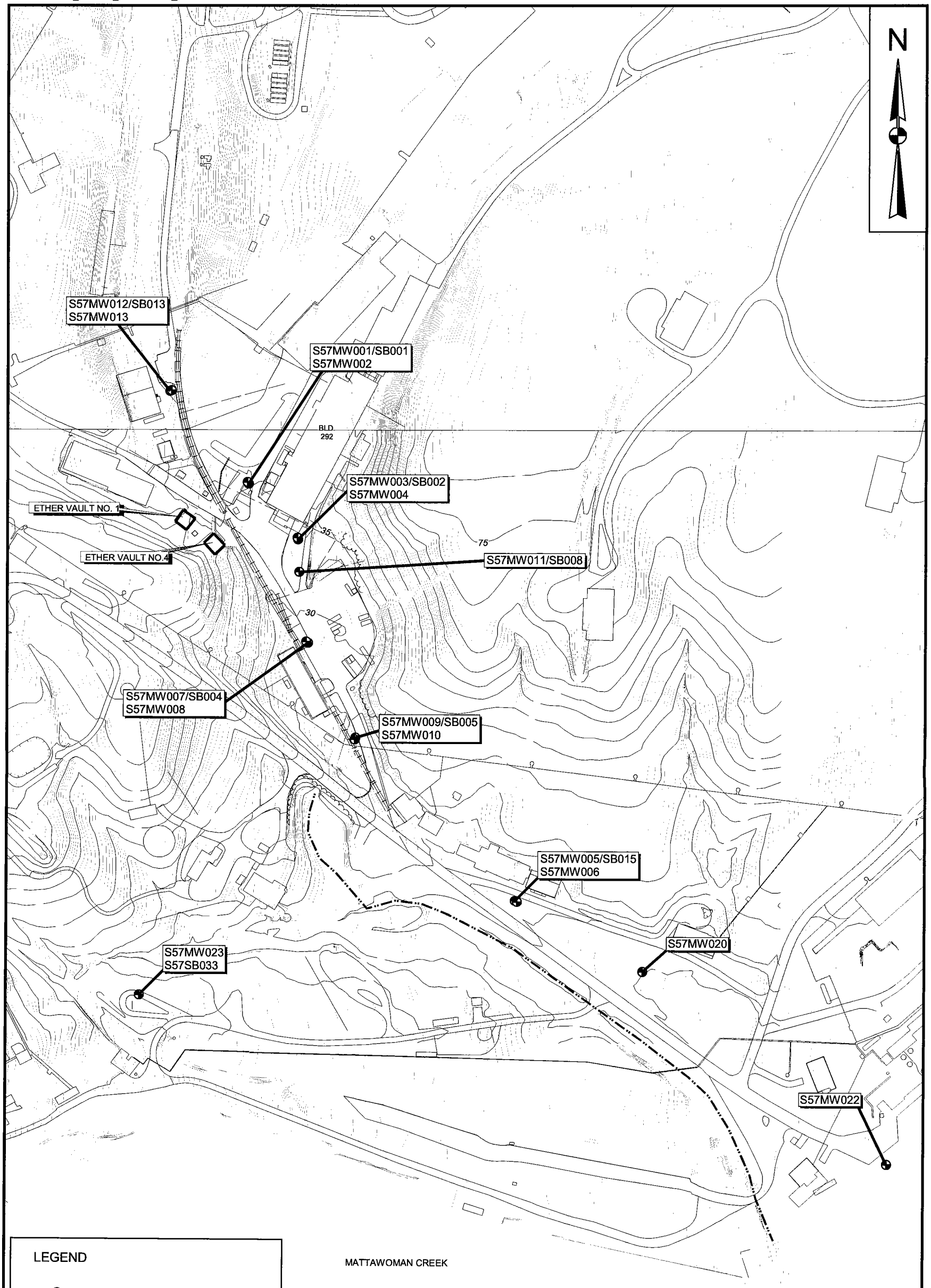
P:\GIS\NSWC_INDIAN_HEAD\7129_SITE57.APR\SITE CONDITIONS MAP LAYOUT 5/16/03 KMP



DRAWN BY: J. BELLONE	DATE: 2/1/00	Tetra Tech NUS, Inc.	CONTRACT NUMBER: 4020 / OWNER NUMBER: 805
CHECKED BY: G. Latulippe	DATE: 2/2/00	MONITORING WELL LOCATION MAP SITE 57 - FORMER DRUM LOADING AREA IHDIV - NSWC INDIAN HEAD, MARYLAND	APPROVED BY: G. LATULIPPE / DATE: 2/2/00
COST/SCHEDULE-AREA			APPROVED BY: — / DATE: —
SCALE: AS NOTED			DRAWING NO.: FIGURE 4-1 / REV: 0

5.0 PILOT STUDY SAMPLING PROCEDURES

This section describes the procedures for pilot study sampling and sample-handling requirements.

5.1 SAMPLING PROCEDURES

This section details the field sampling procedures to be used for the collection of pilot study samples. General field sampling procedures are described in the Master FSP and Station SOPs.

5.1.1 Subsurface Soil Sampling

Subsurface soil samples will be collected using procedures described in the Master FSP, Section 3.1.4.

5.1.2 Groundwater Sampling

Groundwater samples will be collected from monitoring wells in accordance with the low-purge sampling method provided in the Facility SOP SA-01, Section 5.7. A peristaltic pump with 1/4-inch Teflon tubing will be used for well purging and groundwater sample collection. VOC aliquots will be collected from the sampling tube before the water passes through the pump. The VOC sample containers will be filled using the Straw Method as follows:

- A column of water will be drawn into the sampling tubing
- The tubing will be pinched at the input side of the peristaltic pump and withdrawn from the well
- The sample containers will be filled by gravity flow from the tubing

Iron and manganese sample aliquots will be submitted to the laboratory as an unfiltered (total metal) sample and a filtered (dissolved metal) sample in separate containers. The filtered sample will be prepared in the field by passing the groundwater through a high-capacity 0.45-micron filter into a pre-preserved container using the peristaltic pump. Both the unfiltered and filtered samples will be submitted to the laboratory for analysis.

Groundwater samples will be field analyzed as summarized in Table 5-1.

5.1.3 QA/QC Samples

To assure data obtained during the investigation are accurate, various quality assurance/quality control (QA/QC) requirements have been established for fieldwork, laboratory analysis of the collected samples, and validation of the analytical results obtained from the laboratory. Detailed information regarding this

subject is presented in the Master QAPP. Information relevant to this work is presented in the site-specific QAPP in Appendix B.

The field QC samples consist of field duplicates, field blanks, trip blanks, and equipment (rinsate) blanks. Each of these types of field QC samples will undergo the same preservation, analysis, and reporting procedures as the related environmental samples. A detailed description of each type of sample is presented in the Master QAPP in Section 3.6. The frequency and type of field QA/QC samples to be collected for this investigation are as follows:

Type of Sample	Collection Frequency
Field Duplicate	1 per 10 samples per medium
Field Blank	1 per source per sample event
Equipment Rinsate Blank	1 per 20 per sampling equipment

The QC measures the laboratory needs to follow are outlined in detail during the procurement process. It is necessary to collect additional volume for laboratory matrix spike/matrix spike duplicate (MS/MSD) analysis of aqueous samples. All other internal checks will be conducted using the samples provided. The additional aqueous sample required for MS/MSD analysis is three times the volume for VOC analysis. One MS/MSD will be analyzed for every 20 or fewer investigative samples.

Validation of the analytical results is discussed in detail in Section 9.0 of the Master QAPP. One hundred percent of the data for the Pilot Study activities shall be validated in a limited fashion. The validation will be formulated to address only gross non-compliances resulting in the rejection of data and the elimination of false positives in accordance with the U.S. EPA National Functional Guidelines for Organic and Inorganic Data Review (EPA, 1994b) as described in Section 3.3.1 in the Site 57 Pilot Study QAPP (Appendix B).

5.2 SAMPLE HANDLING

This section details sample-handling procedures including field-related considerations concerning the selection of sample containers, preservatives, and allowable holding times for requested analyses. In addition, sample identification, packaging, and shipping will be addressed in this section.

5.2.1 Field Documentation

Field documentation will be conducted as described in the Master FSP Section 3.2.1. Completed chains-of-custody forms will be faxed to the TtNUS project manager on a daily basis.

5.2.2 Sample Nomenclature

Each collected sample will be assigned a unique sample tracking number consisting of a 12-digit alphanumeric code, in accordance with Station SOP CT-02. Any other pertinent information regarding sample identification will be recorded in the field logbooks and on the sample log sheets.

The alphanumeric code to be used in the sample identification system is as follows:

Character Type:

A	=	Alpha
N	=	Numeric
E	=	Either alpha or numeric

(ANN)	(AA)	(EEE)	(NN)	(NN)
[Site]	[Sample Type]	[Location]	[Depth]	[Round]

No dashes are to be used in the sample number.

Site: S57

Sample Type :

SB	=	Subsurface soil sample
MW	=	Groundwater sample

This field may also be used for QA/QC designation:

FB	=	Field blank
RB	=	Rinsate blank
FD	=	Field duplicate
TB	=	Trip blank

Sample location :

EEE	=	Assigned number for each sample location of a particular media; QA/QC samples will be numbered sequentially in the order of collection beginning with 001.

The second rinsate blank collected during the first field effort would be labeled as follows:

S57RB0020001

Sample Depth:

NN = Numbered sequentially in the order the sample is collected from a single location and representing a unique sampling depth at that location.

For example, if two subsurface soil samples (one from 4- to 5-feet depth, and one from 9- to 10-feet depth) are collected for chemical analysis from location number two, they would be designated as follows:

Sample from 4- to 5-feet: S57SB0020001
Sample from 9- to 10-feet: S57SB0020101

Sampling round:

NN = The sampling round is straightforward. It can range from 01 to 99.

Field duplicate samples will be reported blind to the laboratory. The three-digit sample location identifier field will be assigned with the designation "DUP." The sample depth field will be assigned the duplicate number collected for that specific matrix. The time designated on the sample label and chain-of-custody shall be 0000 hours. The location at which the duplicate is collected will be noted on the sample log sheet and in the field notebook.

For example, the third groundwater duplicate sample collected during the fifth field effort would be labeled as follows:

S57GWDUP0305

Additional guidance is provided in the Station SOP CT-02.

5.2.3 Sample Containers, Preservatives, and Holding Times

The EPA User's Guide to the Contract Laboratory Program (EPA, 1986), and the Federal Register (EPA, 1984) address the topics of containers and sample preservations. Table 5-2 provides a summary of the analyses, methodology, bottle requirements, preservation requirements, and holding times for the sampling to be submitted for fixed-base laboratory analysis.

5.2.4 Sample Packaging and Shipping

Samples will be packaged in accordance with the Master FSP Section 3.2.4 and FS SOPs SA-6.1. When the samples are containerized, they will be placed on ice, in a cooler and, within a reasonable period of time, delivered to a local Federal Express office. Sample containers provided by the laboratory are pre-preserved. The FOL will be responsible for completion of the following forms:

- Sample labels
- Chain-of-custody forms
- Chain-of-custody labels

5.3 SAMPLE CUSTODY

Custody of samples must be maintained and documented at all times. Chain of custody begins with the collection of the samples in the field. The Master FSP Section 3.3 and the Station SOP SA-12 provide additional guidance for sample custody procedures. A chain-of-custody form provided by the subcontracted laboratory will be used during the sample-handling process.

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TABLE 5-1

GROUNDWATER FIELD ANALYSES[1]
BIOLOGICAL ACTIVITY INDICATORS
SITE 57 – FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION, NAVAL AIR WARFARE CENTER
INDIAN HEAD, MARYLAND

Parameter	Method/ Reference	Sample Volume, Container, & Preservation
Ferrous Iron	HACH IR-18C	Follow test kit instructions. Analyze immediately at well head. Filter if turbid.
Hydrogen Sulfide	HACH HS-C	Follow test kit instructions. Do not aerate or agitate. Avoid agitation and analyze immediately at well head.
Temperature	Direct-reading meter	100-250 ml in glass or plastic container. Analyze at well head.
Dissolved Oxygen	CHEMetrics – K-7501, K-7512 vacuum vials	Follow test kit instructions. Analyze at well head.
pH	Direct-reading meter	100-250 ml in glass or plastic container. Analyze at well head.
Specific Conductivity	Direct-reading meter	100-250 ml in glass or plastic container. Analyze at well head.
Oxidation/Reduction Potential (ORP)	Direct-reading meter	10-250 ml in glass container filling from the bottom. Do not aerate or agitate. Analyze at well head with flow-through or flow-over cell.

1 Table adapted from overview of the Technical Guidelines for Evaluating Natural Attenuation of Chlorinated Solvents in Groundwater (EPA, 1998).

TABLE 5-2

SUMMARY OF FIXED-BASE LABORATORY ANALYSES, METHODOLOGY, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
SITE 57 – FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND
PAGE 1 OF 2

Analysis	Analytical Method or SOP	Quantity of Samples[1]	Quantity of Containers per Sample	Container Type	Preservation Requirements	Holding Times[2]
SOIL MATRIX						
Chlorinated VOCs and ethyl ether	SW-846 5035/8260B	8	3	EnCore Samplers	Cool to 4°C	48 hours to lab preservation, 14 days to analysis
Arsenic	SW-846 6010B	8	1	4-oz wide-mouth glass	Cool to 4°C ± 2°C	6 months to analysis
WATER MATRIX						
Chlorinated VOCs and ethyl ether	SW-846 8260B	25	3	40-mL VOA vials w/ Teflon septa (Borosilicate glass)	Cool to 4°C ± 2°C HCl to pH $\leq$ 2	14 days to analysis
Manganese and Iron	SW-846 6010B	25	1	500 mL HDPE	HNO_3 to pH $\leq$ 2	6 months to analysis
Manganese and Iron (Dissolved)	SW-846 6010B	25	1	500 mL HDPE	Field filtering; HNO_3 to pH $\leq$ 2	6 months to analysis
Alkalinity (as $CaCO_3$)	EPA 310.1[4]	25	1	1 L HDPE[5]	Cool to 4°C	14 days to analysis
Anions: Chloride (Cl^-), Nitrate (NO_3^-), Nitrite (NO_2^-), Sulfate (SO_4), Orthophosphate	EPA Method 300.0[6]	25	1	1 L HDPE[5]	None required	Cl & SO_4 28 days to analysis; orthophosphate, NO_2 & NO_3 48 hours to analysis.
Sulfide (S^-)	EPA 376.1[7]	25	1	1-liter HDPE	NaOH to pH > 12 Cool to 4°C	7 days to analysis
Methane, Ethane, Ethene, CO_2	RSK[8] SOPs 147 & 175	25	2	40-mL glass, plastic screw cap, foil-faced silicon septum	Cool to 4°C	14 days to analysis
Total Organic Carbon (TOC)	EPA 415.1[9]	25	1	125-mL high-density polyethylene	H_2SO_4 to pH < 2 Cool to 4°C	28 days to analysis

TABLE 5-2

SUMMARY OF FIXED-BASE LABORATORY ANALYSES, METHODOLOGY, BOTTLE REQUIREMENTS, PRESERVATION REQUIREMENTS, AND HOLDING TIMES
SITE 57 – FORMER DRUM LOADING AREA
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Analysis	Analytical Method or SOP	Quantity of Samples[1]	Quantity of Containers per Sample	Container Type	Preservation Requirements	Holding Times[2]
WATER MATRIX (continued)						
Metabolic Acids: Lactic, Pyruvic, Acetic, Propionic, Butyric	Laboratory SOP	25	2	40-mL glass, plastic screw cap, silicon septum	Cool to 4°C	Not Specified

NOTES:

CLP Contract Laboratory Program.
HCl Hydrochloric acid.
HDPE High Density Polyethylene.
HNO_3 Nitric acid.
H_2SO_4 Sulfuric acid.
mL Milliliter.
NaOH Caustic soda/sodium hydroxide.
SOP Standard operating procedure.
VOA Volatile organic analyte.
VOC volatile organic compound.

1 Number does not include QA/QC samples to be analyzed.
2 All holding times are determined from date of collection.
3 EPA CLP, 1999. Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration; ILM04.1.
4 EPA, 1983. Methods for Chemical Analysis of Water and Wastes. Method 310.1.
5 For groundwater, alkalinity and anions samples will be provided in the same 1000 mL bottle
6 EPA, 1983. Methods for Chemical Analysis of Water and Wastes. Method 300.0.
7 EPA, 1983. Methods for Chemical Analysis of Water and Wastes. Method 376.1.
8 RSK = Robert S. Kerr Labs.
9 EPA, 1983. Methods for Chemical Analysis of Water and Wastes. Method 415.1.

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APPENDIX A

PROJECT-SPECIFIC HEALTH AND SAFETY PLAN

Project Specific
Health and Safety Plan
for
Site 57
Indian Head Division
Naval Surface Warfare Center
Indian Head, Maryland

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command
Northern Division Contract No. N62467-94-D-0888
Contract Task Order 0805

May 2003

Rev. 1
May 2003

PROJECT SPECIFIC
HEALTH AND SAFETY PLAN
FOR
SITE 57
INDIAN HEAD DIVISION - NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Engineering Field Activity Chesapeake
Environmental Branch Code 18
Naval Facilities Engineering Command
Washington Navy Yard, Building 212
Washington, D.C. 20374-2121

Submitted by:
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NORTHERN DIVISION CONTRACT NO. N62467-94-D-0888
CONTRACT TASK ORDER 0805

MAY 2003

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TABLE OF CONTENTS

SECTION		PAGE
1.0	**INTRODUCTION**	**1-1**
1.1	AUTHORITY	1-1
1.2	KEY PROJECT PERSONNEL AND ORGANIZATION	1-1
1.3	SITE INFORMATION AND PERSONNEL ASSIGNMENTS	1-3
2.0	**EMERGENCY ACTION PLAN**	**2-1**
2.1	INTRODUCTION	2-1
2.2	EMERGENCY PLANNING	2-1
2.3	EMERGENCY RECOGNITION AND PREVENTION	2-2
2.3.1	Recognition	2-2
2.3.2	Prevention	2-3
2.4	EVACUATION ROUTES, PROCEDURES, AND PLACES OF REFUGE	2-3
2.5	EMERGENCY ALERTING AND ACTION/RESPONSE PROCEDURES	2-4
2.6	EMERGENCY CONTACTS	2-5
2.7	EMERGENCY ROUTES TO HOSPITALS	2-6
2.8	DECONTAMINATION PROCEDURES / EMERGENCY MEDICAL TREATMENT	2-9
2.9	INJURY AND ILLNESS REPORTING	2-9
2.10	PPE AND EMERGENCY EQUIPMENT	2-9
3.0	**SITE BACKGROUND**	**3-1**
3.1	FACILITY HISTORY	3-1
3.2	Site 57 – Former Drum Loading Area Building 292	3-1
4.0	**SCOPE OF WORK**	**4-1**
4.1	HRC INJECTION	4-1
4.2	MULTI MEDIA SAMPLING	4-1
5.0	**TASKS/HAZARDS/ASSOCIATED CONTROL MEASURES SUMMARIZATION**	**5-1**
5.1	GENERAL SAFE WORK PRACTICES	5-1
5.2	DPT SAFE WORK PRACTICES	5-2
5.1.1	Before DPT	5-2
5.1.2	During DPT	5-3
5.1.3	After DPT	5-3
5.3	HRC SAFE WORK PRACTICES	5-3
6.0	**HAZARD ASSESSMENT**	**6-1**
6.1	CHEMICAL HAZARDS	6-1
6.2	PHYSICAL HAZARDS	6-5
6.2.1	Slip, Trip and Fall Hazards	6-5
6.2.2	Strains/Muscle Pulls	6-6
6.3	NATURAL HAZARDS	6-6
6.3.1	Insect Bites and Stings	6-6
6.3.2	Snakes and Other Wild Animals	6-8
6.3.3	Poisonous Plants	6-9
6.3.4	Inclement Weather	6-10

TABLE OF CONTENTS (Continued)

SECTION		PAGE
7.0	**AIR MONITORING**	**7-1**
7.1	INSTRUMENTS AND USE	7-1
7.1.1	Photoionization Detector and Flame Ionization Detector	7-1
7.1.2	Hazard Monitoring Frequency	7-1
7.2	INSTRUMENT MAINTENANCE AND CABILRATION	7-2
8.0	**TRAINING/MEDICAL SURVEILLANCE REQUIREMENTS**	**8-1**
8.1	INTRODUCTORY/REFRESHER/SUPERVISORY TRAINING	8-1
8.1.1	Requirements for B&R Environmental Personnel	8-1
8.1.2	Requirements for Subcontractors	8-1
8.2	SITE-SPECIFIC TRAINING	8-3
8.3	MEDICAL SURVEILLANCE	8-3
8.3.1	Medical Surveillance Requirements for TtNUS Personnel	8-3
8.3.2	Medical Surveillance Requirements for Subcontractors	8-5
8.3.3	Requirements for Field Personnel	8-5
8.4	SUBCONTRACTOR EXCEPTIONS	8-5
9.0	**SITE CONTROL**	**9-1**
9.1	EXCLUSION ZONE	9-1
9.2	CONTAMINATION REDUCTION ZONE	9-1
9.3	SUPPORT ZONE	9-1
9.4	SAFE WORK PERMITS	9-2
9.5	SITE VISITORS	9-4
9.6	SITE SECURITY	9-4
9.7	SITE MAP	9-5
9.8	BUDDY SYSTEM	9-5
9.9	MATERIAL SAFETY DATA SHEET (MSDS) REQUIREMENTS	9-5
9.10	COMMUNICATION	9-5
10.0	**SPILL CONTAINMENT PROGRAM**	**10-1**
10.1	SCOPE AND APPLICATION	10-1
10.2	POTENTIAL SPILL AREAS	10-1
10.3	LEAK AND SPILL DETECTION	10-1
10.4	PERSONNEL TRAINING AND SPILL PREVENTION	10-2
10.5	SPILL PREVENTION AND CONTAINMENT EQUIPMENT	10-2
10.5.1	PPE for Spill Control	10-2
10.6	SPILL CONTROL PLAN	10-2
11.0	**CONFINED-SPACE ENTRY**	**11-1**
12.0	**MATERIALS AND DOCUMENTATION**	**12-1**
12.1	MATERIALS TO BE POSTED AT THE SITE	12-1
13.0	**ACRONYMS / ABBREVIATIONS**	**13-1**

TABLES

NUMBER **PAGE**

2-1 EMERGENCY REFERENCE 2-5
5-1 TASKS/HAZARDS/CONTROL MEASURES 5-3
6-1 CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA 6-2

FIGURES

NUMBER **PAGE**

2-1 Route to Civista Medical Center 2-7
2-1.1 Route to Southern Maryland Hospital Center 2-8
2-2 Emergency Response Protocol 2-10
7-1 Documentation of Field Calibration 7-3
8-1 Training Letter 8-2
8-2 Site-Specific Training Documentation 8-4
8-3 Subcontractor Medical Approval Form 8-6
8-4 Medical Surveillance Letter 8-8
9-1 Safe Work Permit 9-3

ATTACHMENT I ACCIDENT/ILLNESS PROCEDURE AND REPORT FORM
ATTACHMENT II MEDICAL DATA SHEET
ATTACHMENT III SAFE WORK PERMITS
ATTACHMENT IV SOP for Utility LOCATING AND EXCAVATION CLEARANCE
ATTACHMENT V EQUIPMENT INSPECTION CHECKLIST
ATTACHMENT VI OSHA JOB SAFETY POSTER

1.0 INTRODUCTION

The objective of this Health and Safety Plan (HASP) is to provide the minimum safety practices and procedures for Tetra Tech NUS, Inc. (TtNUS) and subcontractor personnel engaged in proposed site activities that are to be conducted at the Site 57 (Former Drum Loading Area Building 292) at the Indian Head Division Naval Surface Warfare Center (IHDIV-NSWC) Indian Head, Maryland.

In order to accomplish the objective, this HASP has been constructed using the latest available information regarding known or suspected chemical contaminants and potential and foreseeable physical hazards associated with the proposed work at the sites identified at the IHDIV-NSWC. This HASP has been designed to be used in accordance with the TtNUS Health and Safety Guidance Manual. The Guidance Manual provides detailed information pertaining to procedures to be performed on site as directed by the HASP, as well as TtNUS standard operating procedures. Both the HASP and the Health and Safety Guidance Manual must be present at the site to comply with the requirements stipulated in the Occupational Safety and Health Administration (OSHA) standard 29 CFR 1910.120.

This HASP has been written to support proposed tasks and techniques associated with the scope of work as presented in Section 4.0. Should the proposed work site conditions and/or suspected hazards change, or if new information becomes available, this document will be modified. Changes to the HASP will be made with the approval of the TtNUS CLEAN Health and Safety Manager (HSM) and the Project Manager (PM). The PM will notify the affected personnel of the changes.

The elements of this HASP are in compliance with the requirements established by OSHA 29 CFR 1910.120, "Hazardous Waste Operations and Emergency Response" (HAZWOPER) and sections of 29 CFR 1926, "Safety and Health Regulations for Construction."

1.1 AUTHORITY

This Contract Task Order (CTO) 0805 and the requirements setforth represent an integral part of an overall effort conducted under the Comprehensive Long - Term Environmental Action Navy (CLEAN) contract, administered through the U.S. Navy Northern Division Naval Facilities Engineering Command, as defined under Contract No. N62467-94-D-0888.

1.2 KEY PROJECT PERSONNEL AND ORGANIZATION

This section defines responsibility for site safety and health for TtNUS and subcontractor employees engaged in on site activities. Personnel assigned to these positions shall exercise the primary

responsibility for the on site health and safety. These persons will be the primary point of contact for any questions regarding the safety and health procedures and the selected control measures.

- The TtNUS Project Manager (PM) is responsible for the overall direction and implementation of health and safety for this project.

- The TtNUS Field Operations Leader (FOL) is responsible for implementation of this HASP with the assistance of an appointed Site Safety Officer (SSO). The FOL manages field activities, executes the work plan, and enforces safety procedures, as applicable to the work plan.

- The SSO supports site activities by advising the FOL on the aspects of health and safety on site. These duties may include the following:

    - Coordinates health and safety activities with the FOL.
    - Selects, inspects, implements, and maintains personal protective equipment.
    - Establishes work zones and control points.
    - Directs and assists in the development of decontamination areas and procedures.
    - Implements air monitoring program in support of on site activities.
    - Verifies training and medical status of on site personnel status in relation to site activities.
    - Implements hazard communication, respiratory protection, and other associated safety and health programs, as necessary.
    - Coordinates emergency services.
    - Provides site-specific training for on site personnel.

- Compliance with these requirements is monitored by the Project Health and Safety Officer (PHSO) and is coordinated through the Health and Safety Manager.

1.3 SITE INFORMATION AND PERSONNEL ASSIGNMENTS

Site Name: Indian Head Division Naval Surface Warfare Center (IHDIV-NSWC) **Address:** Waldorf, Maryland

Site Point of Contact: Shawn Jorgensen **Phone Number:** (301)743-6745

Scheduled Activities: This activity will be divided into a multi-task operation performed sequentially through the execution of the elements as defined in the scope of work (See Section 4.0)

Proposed Dates of Work: March 2003 until completion

Project Team:

TtNUS Management Personnel:	Discipline/Tasks Assigned:
Kim C. Turnbull.	Project Manager (PM)
TBD	Field Operations Leader (FOL)
TBD	Field Geologist
Matthew M. Soltis, CIH, CSP	Health and Safety Manager (HSM)
TBD	Site Safety Officer (SSO)
James K. Laffey	Project Health and Safety Officer (PHSO)

Non-TtNUS Personnel	Affiliation/Discipline/Tasks Assigned

Hazard Assessment (for purposes of 29 CFR 1010.132) for HASP preparation has been conducted by: James K. Laffey

2.0 EMERGENCY ACTION PLAN

2.1 INTRODUCTION

This section has been developed as part of a planning effort to direct and guide field personnel in the event of an emergency. Site activities will be coordinated with the client contact, Shawn Jorgensen. In the event of an emergency which cannot be mitigated using onsite resources, personnel will evacuate to a safe place of refuge and the appropriate emergency response agencies will be notified. It has been determined that the majority of potential emergency situations would be better supported by outside emergency responders. Based on this determination, TtNUS and subcontractor personnel will not provide emergency response support beyond the capabilities of onsite response. Workers who are ill or who have suffered a non-serious injury may be transported by site personnel to nearby medical facilities, provided that such transport does not aggravate or further endanger the welfare of the injured/ill person. The emergency response agencies listed in this plan are capable of providing the most effective response, and as such, will be designated as the primary responders. These agencies are located within a reasonable distance from the area of site operations, which ensures adequate emergency response time. Navy contact Shawn Jorgensen will be notified anytime outside response agencies are contacted. This Emergency Action Plan conforms to the requirements of 29 CFR 1910.38(a), as allowed in 29 CFR 1910.120(l)(1)(ii).

TtNUS will, through necessary services, provide the following emergency action measures:

- Initial stage fire fighting support and prevention
- Initial spill control and containment measures and prevention
- Removal of personnel from emergency situations such as confined space entry
- Initial medical support for injuries or illnesses requiring basic first-aid
- Site control and security measures as necessary

2.2 EMERGENCY PLANNING

Through the initial hazard/risk assessment effort, it is anticipated that emergencies resulting from chemical, physical, or fire hazards are unlikely given the nature of site activities.

Nonetheless, to minimize and eliminate the potential for any emergency situations, emergency planning activities will include the following (which are the responsibility of the FOL):

- Coordinating with local Emergency Response personnel to ensure that TtNUS emergency action activities are compatible with existing emergency response procedures. Base Fire Protection and Emergency Services will be notified of scheduled events and activities. This is most imperative in situations where their services may be required such as confined space entry.

- Establishing and maintaining information at the project staging area (support zone) for easy access in the event of an emergency. This information will include the following:

  - Chemical Inventory (of chemicals used onsite), with Material Safety Data Sheets.
  - Onsite personnel medical records (Medical Data Sheets).
  - A log book identifying personnel onsite each day.
  - Hospital route maps with directions (these should also be placed in each site vehicle).
  - Emergency Notification - phone numbers.

The TtNUS FOL will be responsible for the following tasks:

- Identifying a chain of command for emergency action.

- Educating site workers to the hazards and control measures associated with planned activities at the site, and providing early recognition and prevention, where possible.

- Periodically performing practice drills to ensure site workers are familiar with incidental response measures.

- Providing the necessary equipment to safely accomplish identified tasks.

2.3 EMERGENCY RECOGNITION AND PREVENTION

2.3.1 Recognition

Emergency situations that may be encountered during site activities will generally be recognized by visual observation. To adequately recognize chemical exposures, site personnel must have a clear knowledge of signs and symptoms of exposure associated with site contaminants. This information is provided in Table 6-1. Tasks to be performed at the site, potential hazards associated with those tasks and the recommended control methods are discussed in detail in Sections 5.0 and 6.0. Additionally, early recognition of hazards will be supported by periodic site surveys to identify any situation predisposed to an emergency. The FOL will be responsible for performing surveys of work areas prior to initiating site operations and periodically while operations are being conducted. Survey findings will be documented by

the FOL in the site logbook, however, site personnel will be responsible for reporting hazardous situations. Where potential hazards exist, TtNUS will initiate control measures to prevent adverse effects to human health and the environment.

The above actions will provide early recognition for potential emergency situations, and allow TtNUS to initiate necessary control measures. However, if the FOL determines that control measures are not sufficient to eliminate the hazard, TtNUS will withdraw from the site and notify the appropriate response agencies listed in Table 2-1.

2.3.2 Prevention

TtNUS and subcontractor personnel will minimize the potential for emergencies by following this HASP, the Health and Safety Guidance Manual, and applicable OSHA regulations. Periodic site surveys of work areas and correction of any identified deficiencies prior to the commencement of that day's activities by the FOL will also assist in prevention of illness/injuries when hazards are recognized early and control measures initiated.

2.4 EVACUATION ROUTES, PROCEDURES, AND PLACES OF REFUGE

An evacuation will be initiated whenever recommended hazard controls are insufficient to protect the health, safety or welfare of site workers. Specific examples of conditions that may initiate an evacuation include, but are not limited to the following: severe weather conditions; fire or explosion; and evidence of personnel overexposure to potential site contaminants.

In the event of an emergency requiring evacuation, personnel will immediately stop activities and report to the designated safe place of refuge unless doing so would pose additional risks. When evacuation to the primary place of refuge is not possible, personnel will proceed to a designated alternate location and remain until further notification from the TtNUS FOL. Safe places of refuge will be identified prior to the commencement of site activities by the FOL and will be conveyed to personnel as part of the pre-activities briefing session. This information will be reiterated during daily safety meetings and indicated on the Safe Work Permits. Whenever possible, the safe place of refuge will also serve as the telephone communications point for that area. During an evacuation, personnel will remain at the refuge location until directed otherwise by the TtNUS FOL or the on-site Incident Commander of the Emergency Response Team. The FOL will perform a head count at this location to account for and to confirm the location of site personnel. Emergency response personnel will be immediately notified of any unaccounted personnel. The FOL will document the names of personnel onsite (on a daily basis) in the site Health and Safety Logbook. This information will be utilized to perform the head count in the event of an emergency.

Evacuation procedures will be discussed during the pre-activities training session, prior to the initiation of project tasks. Evacuation routes from the site and safe places of refuge are dependent upon the location at which work is being performed and the circumstances under which an evacuation is required. Additionally, site location and meteorological conditions (i.e., wind speed and direction) may dictate evacuation routes. As a result, assembly points will be selected and communicated to the workers relative to the site location where work is being performed. Evacuation should always take place in an upwind direction from the site and away from water bodies.

2.5 EMERGENCY ALERTING AND ACTION/RESPONSE PROCEDURES

TtNUS personnel will likely be working in close proximity to each other during planned site activities. Site personnel will initiate emergency notification to onsite personnel by voice commands, hand signals, vehicle horns, or line of site communication to alert site personnel of an emergency. When project tasks are performed simultaneously on different sites, radios will be used to communicate emergency situations and request assistance. The Fire Department will provide rescue services, if needed, during confined space entry operations. The details for notification must be documented in the permit.

If an emergency warranting evacuation occurs, the following procedures are to be initiated:

- Initiate the evacuation via appropriate and/or available communication method (hand signals, voice commands, etc.).
- Report to the designated refuge point.
- Once non-essential personnel are evacuated, appropriate response procedures will be enacted to control the situation.
- Describe to the FOL (serving as the Incident Coordinator) pertinent incident details.

In the event that site personnel cannot mitigate the hazardous situation, the FOL will enact emergency notification procedures to secure additional assistance in the following manner:

Contact pertinent emergency contacts listed in Table 2-1 and report the incident. Give the emergency operator the location of the emergency, the type of emergency, the number of injured, and a brief description of the incident. Stay on the phone and follow the instructions given by the operator. The operator will then notify and dispatch the proper emergency response agencies.

2.6 EMERGENCY CONTACTS

Prior to initiating field activities, personnel will be thoroughly briefed on the emergency procedures to be followed in the event of an accident. Table 2-1 provides a list of emergency contacts and their associated telephone numbers. This table must be posted where it is readily available to site personnel. Facility maps should also be posted showing potential evacuation routes and designated meeting areas.

TABLE 2-1
EMERGENCY REFERENCE
SITE 57 – INDIAN HEAD DIVISION - NSWC

AGENCY	TELEPHONE
EMERGENCY (fire, ambulance, rescue, police)	911
Site Point of Contact Shawn Jorgensen	(301)744-2263
Navy Remedial Project Manager Jeffrey W. Morris	(202) 685-3279
Hospital: Civista Medical Center	(301) 609-4000
Hospital: Southern Maryland Hospital	(301) 868-8000
National Capital Poison Center	(800) 222-1222
Chemtrec	(800) 424-9300
National Response Center	(800) 424-8802
TtNUS, Pittsburgh Office	(412) 921-7090
Health and Safety Manager Matthew M. Soltis, CIH, CSP	(412) 921-8912
Project Health and Safety Officer James K. Laffey	(412) 921-8678
Project Manager Kim C. Turnbull	(412) 921-8945

2.7 EMERGENCY ROUTES TO HOSPITALS

The closest hospital to the IHDIV-NSWC is the Civista Medical Center in La Plata, Maryland. The alternate hospital is Southern Maryland Hospital in Clinton, Maryland. Maps showing the proximity of the IHDIV-NSWC to both of the hospitals are included as Figure 2-1 and 2-1A. Directions and maps to both Civista Medical Center and Southern Maryland Hospital are provided below:

Civista Medical Center
701 East Charles Street,
La Plata, MD 20646
(301) 609-4000

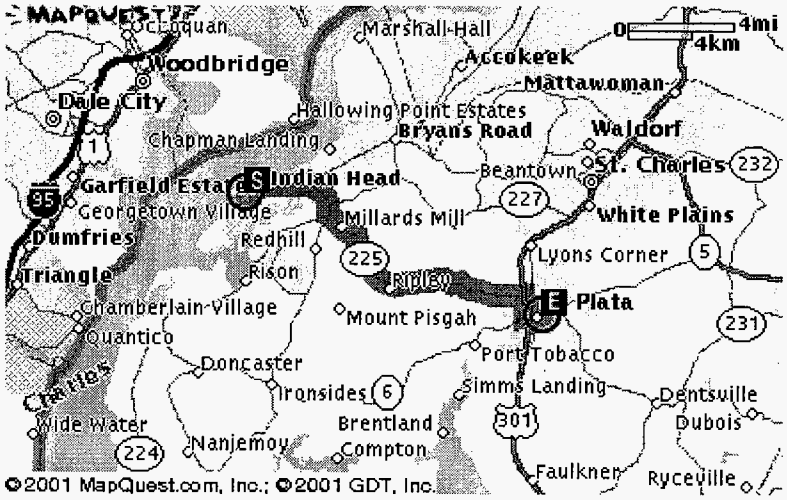
Exit the facility **[S]** and proceed South on Bensville Road (Rt. 228) for approximately 3 miles. At the junction of Bensville and Billingsley Road take a left onto Billingsley Road. Proceed on Billingsley Road for approximately 5 miles to the junction of Route 301. Proceed South on Route 301 to La Plata, Maryland (approximately 6 miles). The hospital is on the right, about 1/2 block past the railroad tracks. **[E]**

Southern Maryland Hospital
7503 Surratts Road
Clinton, Maryland 20735
(301) 868-8000

Exit the facility **[S]** proceed North on Bensville Road (Rt. 228) for approximately 1 mile. Take a left onto Bealle Hill Road and proceed North for approximately 1.5 miles. At the junction of Rt. 373 turn right onto Rt. 373. Follow until intersection with Branch Ave. (MD Route 5). Turn left on Branch Ave., right on Surratts Road. The hospital is just past the Colony South Hotel . **[E]**

Figure 2-1

Route To Civista Medical Center



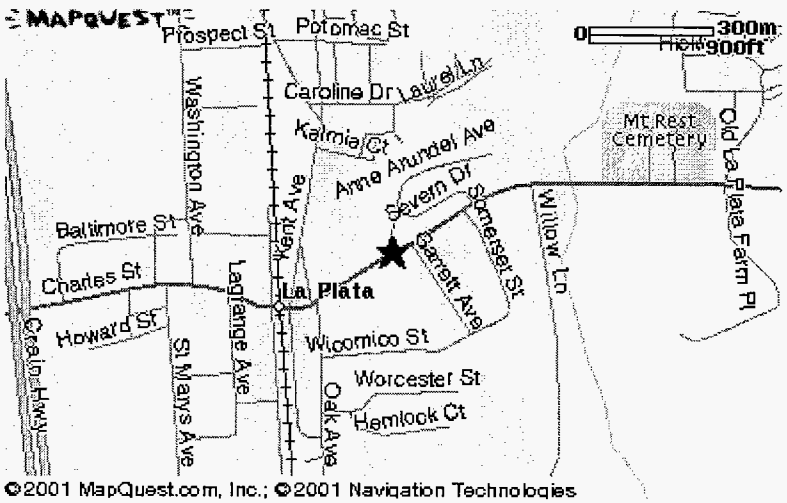
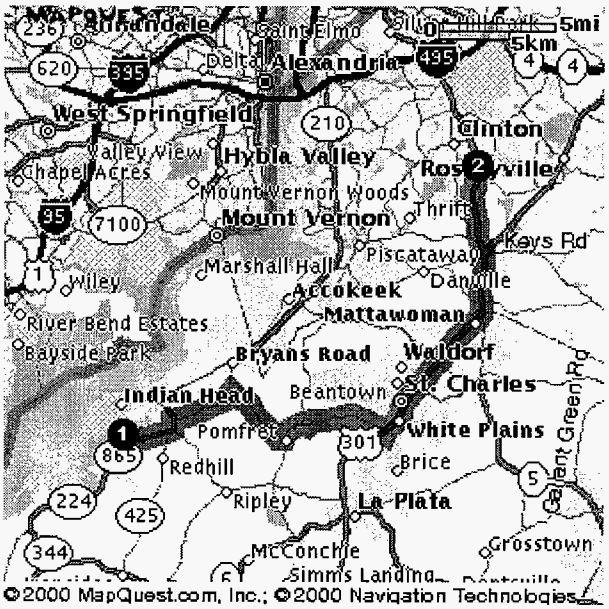
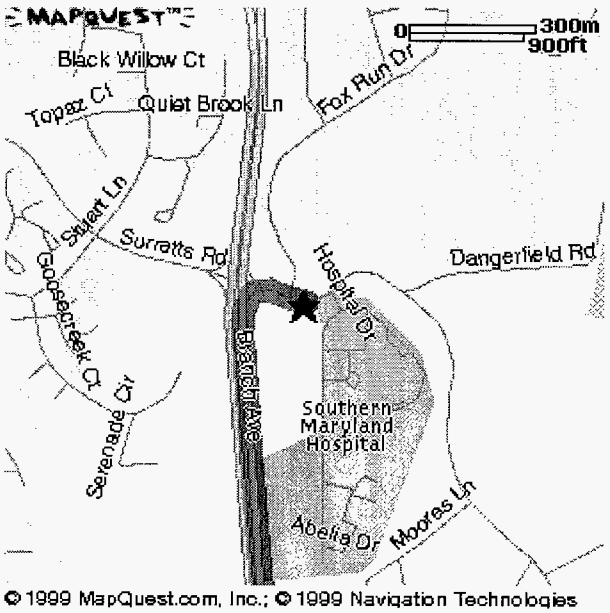


Figure 2-1.1

Route To Southern Maryland Hospital Center





2.8 DECONTAMINATION PROCEDURES / EMERGENCY MEDICAL TREATMENT

During any site evacuation, decontamination procedures will be performed only if doing so does not further jeopardize the welfare of site workers. Decontamination will not be performed if the incident warrants immediate evacuation. However, it is unlikely that an evacuation would occur which would require workers to evacuate the site without first performing the necessary decontamination procedures.

TtNUS personnel will perform removal of personnel from emergency situations and may provide initial medical support for injury/illnesses requiring only first-aid level support. Medical attention above that level will require assistance and support from the designated emergency response agencies. Attachment I provides the procedure to follow when reporting an injury/illness, and the form to be used for this purpose. If the emergency involves personnel exposures to chemicals, follow the steps provided in Figure 2-2.

2.9 INJURY AND ILLNESS REPORTING

Any pertinent information regarding allergies to medications or other special conditions will be provided to medical service personnel. This information is listed on Medical Data Sheets filed onsite (see Attachment II) If an exposure to hazardous materials has occurred, provide hazard information from Table 6-1 to medical service personnel. As soon as possible, Navy contact Shawn Jorgensen must be informed of any incident or accident that requires medical attention.

2.10 PPE AND EMERGENCY EQUIPMENT

A first-aid kit, eye wash units (or bottles of disposable eyewash solution) and a fire extinguisher will be maintained onsite and shall be immediately available for use in the event of an emergency. This equipment will be located in the field office or site vehicle. Personnel identified within the field crew with bloodborne pathogen and first-aid training will be the only personnel permitted to offer first-aid assistance.

FIGURE 2-2

EMERGENCY RESPONSE PROTOCOL

The purpose of this protocol is to provide guidance for the medical management of injury situations.

In the event of a personnel injury or accident:

- Rescue, when necessary, employing proper equipment and methods.
- Give attention to emergency health problems -- breathing, cardiac function, bleeding, and shock.
- Transfer the victim to the medical facility designated in this HASP by suitable and appropriate conveyance (i.e. ambulance for serious events)
- Obtain as much exposure history as possible (a Potential Exposure report is attached).
- If the injured person is a Tetra Tech NUS employee, call the medical facility and advise them that the patient(s) is/are being sent and that they can anticipate a call from the WorkCare physician. WorkCare will contact the medical facility and request specific testing which may be appropriate. WorkCare physicians will monitor the care of the victim. Site officers and personnel should not attempt to get this information, as this activity leads to confusion and misunderstanding.
- Call WorkCare at 1-800-455-6155 and enter Extension 109, being prepared to provide:
  - Any known information about the nature of the injury.
  - As much of the exposure history as was feasible to determine in the time allowed.
  - Name and phone number of the medical facility to which the victim(s) has/have been taken.
  - Name(s) of the involved Tetra Tech NUS, Inc. employee(s).
  - Name and phone number of an informed site officer who will be responsible for further investigations.
  - Fax appropriate information to WorkCare at (714) 456-2154.
- Contact Corporate Health and Safety Department (Matt Soltis) and Human Resources Department (Marilyn Duffy) at 1-800-245-2730.

As data is gathered and the scenario becomes more clearly defined, this information should be forwarded to WorkCare.

WorkCare will compile the results of data and provide a summary report of the incident. A copy of this report will be placed in each victim's medical file in addition to being distributed to appropriately designated company officials.

Each involved worker will receive a letter describing the incident but deleting any personal or individual comments. A personalized letter describing the individual findings/results will accompany this generalized summary. A copy of the personal letter will be filed in the continuing medical file maintained by WorkCare.

FIGURE 2-2 (continued)
WORKCARE

POTENTIAL EXPOSURE REPORT

Name: _____ Date of Exposure: _____

Social Security No.: _____ Age: _____ Sex: _____

Client Contact: _____ Phone No.: _____

Company Name: _____

I. Exposing Agent

Name of Product or Chemicals (if known):_____

_____

Characteristics (if the name is not known)

Solid Liquid Gas Fume Mist Vapor

II. Dose Determinants

What was individual doing?_____

How long did individual work in area before signs/symptoms developed? _____

Was protective gear being used? If yes, what was the PPE? _____

Was their skin contact? _____

Was the exposing agent inhaled?_____

Were other persons exposed? If yes, did they experience symptoms? _____

III. Signs and Symptoms (check off appropriate symptoms)

Immediately With Exposure:

Burning of eyes, nose, or throat
Tearing
Headache
Cough
Shortness of Breath
Chest Tightness / Pressure
Nausea / Vomiting
Dizziness
Weakness

Delayed Symptoms:

Weakness
Nausea / Vomiting
Shortness of Breath
Cough
Loss of Appetite
Abdominal Pain
Headache
Numbness / Tingling

IV. Present Status of Symptoms (check off appropriate symptoms)

Burning of eyes, nose, or throat
Tearing
Headache
Cough
Shortness of Breath
Chest Tightness / Pressure
Cyanosis
Nausea / Vomiting
Dizziness
Weakness
Loss of Appetite
Abdominal Pain
Numbness / Tingling

Have symptoms: (please check off appropriate response and give duration of symptoms)
Improved: _____ Worsened: _____ Remained Unchanged: _____

V. Treatment of Symptoms (check off appropriate response)

None: _____ Self-Medicated: _____ Physician Treated: _____

3.0 SITE BACKGROUND

3.1 FACILITY HISTORY

The IHDIV-NSWC is located in northwestern Charles County, Maryland, approximately 25 miles southwest of Washington, DC. The IHDIV-NSWC is a military facility consisting of the main area on the Cornwallis Neck Peninsula and the Annex on Stump Neck. The main area is bounded by the Potomac River to the northwest, west, and south, Mattawoman Creek to the south and east, and the town of Indian Head to the northeast. Stump Neck Annex is located across Mattawoman Creek. The Stump Neck Annex is not contiguous with the main area and is operated by a tenant. The primary mission of IHDIV-NSWC is to provide services in energetics, ordnance devices and components, and other related ordnance engineering standards, including chemicals, propellants, and their propulsion systems, explosives, pyrotechnics, warheads, and simulators. The United States Environmental Protection Agency (EPA) added IHDIV-NSWC to the National Priorities List (NPL) in September 1995, pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. There are 48 sites at the main facility currently included in the IHDIV-NSWC Installation Restoration (IR) Program. Activities conducted under this HASP will occur at Site 57 (Former Drum Loading Area).

3.2 SITE 57- FORMER DRUM LOADING AREA BUILDING 292

Site 57 the Former Drum Loading Area is located south of Building 292 in the southeastern section of the main operation facility of IHDIV-NSWC. The site consists of relatively flat ground surrounded by steep hillsides. Surface runoff appears to flow overland to a concrete drainage ditch to the south. This ditch flows into an unnamed stream that eventually discharges to Mattawoman Creek.

Previous operations at Building 292 invloved degreasing of metal parts using trichloroethene (TCE). These operations were reportedly discontinued in 1989. Site 57 also includes Buildings 165 and 496, which are located approximately 15 feet southwest of Building 292 and were reportedly used to store ethyl ether.

4.0 SCOPE OF WORK

This section of the HASP addresses proposed activities that are to be conducted at Site 57 IHDIV-NSWC. This is a pilot study where a hydrogen release compound (HRC®) will be injected into the ground and evaluated for its effect on groundwater bioremediation. The activities to be conducted as part of the scope of work include mobilization/demobilization, HRC injection(using Direct Push Technology), multi-media sampling including subsurface soil and groundwater sampling and decontamination activities. Table 5-1, provides information related to each of these tasks that are to be performed as part of the scope of work. If other tasks, other than those identified, are to be performed at the site, this HASP will be modified.

- Mobilization/demobilization
- Multi-media sampling, including
  - Subsurface soil
  - Groundwater
- Well Installation and abandonment of temporary monitoring wells
- HRC® Injection
- Decontamination of sampling equipment
- IDW management which includes the containerization, labeling, staging, monitoring, and final deposition of Investigation Derived Wastes (IDW).
- Land Surveying

4.1 HRC INJECTION

TtNUS will conduct the study using HRC supplied by Regenesis, a vendor. HRC is a compound that provides a steady release of hydrogen to the in situ indigenous anaerobic microbes. The microbes thrive in the hydrogen-rich environment and break down the chlorinated VOCs into non-toxic end products.

HRC will be applied with direct push technology (DPT) equipment. Drive rods will be pushed to the bottom of the contaminated saturated zone and then HRC will be injected as the rods are withdrawn. The surface area overlying the contaminated groundwater plume consists of grass and pavement; therefore, no concerns exist with respect to the injection of the HRC to the subsurface using DPT. Some DPT points will need to be driven through the pavement, but this will have no effect on the implementation of this technology. Because the area is easily accessible with no significant tree cover or vegetation, no specific type or size of DPT installation equipment will be required.

The area to be treated is estimated at 30 feet by 10 feet. The site-specific grid will have 5-foot spacing between rows and 8-foot spacing within rows. Twelve DPT injection points are proposed to inject HRC from a depth of 18 feet below ground surface (bgs) up to 8 feet bgs. A minimum of 9.0 pounds of HRC per foot injected through this 10 foot thick zone will result in an estimated total of 1,080 pounds of injected HRC. One DPT rig will be utilized to perform the field work. No clearing is anticipated in the area of the contaminated groundwater plume because there is no tree cover or vegetation.

After HRC injection, the hole will be abandoned by forced injection of grout, using a tremie pipe, from the top of the HRC to the ground surface. The grout sealant will consist of Portland Type I cement mixed at a proportion of 6.5 to 7 gallons of water per 94-pound bag of cement.

4.2 MULTI MEDIA SAMPLING

Subsurface soil sampling will consist of collecting soil from four depths at two sampling locations downgradient of the HRC injection area. The groundwater portion of the investigation will consist of installing two new monitoring wells downgradient of the HRC injection points, measuring water levels, and collecting groundwater samples from these new wells and from three existing monitoring wells.

5.0 TASKS/HAZARDS/ASSOCIATED CONTROL MEASURES SUMMARIZATION

Table 5-1 of this section serves as the primary portion of the site-specific HASP and identifies the tasks that are to be performed as part of the scope of work. This table will be modified and incorporated into this document as new or additional tasks are performed at the site. The anticipated hazards, recommended control measures, air monitoring recommendations, required Personal Protective Equipment (PPE), and decontamination measures for each site task are discussed in detail. This table and the associated control measures shall be changed, if the scope of work, contaminants of concern, or other conditions change.

Through using the table, site personnel can determine which hazards are associated with each task and at each site, and what associated control measures are necessary to minimize potential exposure or injuries related to those hazards. The table also assists field team members in determining which PPE and decontamination procedures to use as well as proper air monitoring techniques.

As discussed earlier, a Health and Safety Guidance Manual accompanies this table and HASP. The manual is designed to further explain supporting programs and elements for other site-specific aspects as required by 29 CFR 1910.120. The Guidance Manual should be referenced for additional information regarding decontamination activities, emergency response, hazard assessments, hazard communication program, medical surveillance, PPE, site control measures, standard work practices, and training requirements. Many of Tetra Tech NUS' SOPs are also provided in this Guidance Manual.

Safe Work Permits issued for sampling activities (See Section 10.10) will use elements defined in Table 5-1 as it's primary reference. Partially completed Safe Work Permits are found in Attachment III of this HASP. The FOL in completing the Safe Work Permit will add additional site-specific information. In situations where the Safe Work Permit is more conservative than the direction provided in Table 5-1 due to the incorporation of site-specific elements, the Safe Work Permit will be followed.

5.1 GENERAL SAFE WORK PRACTICES

In addition to the task-specific work practices identified on Table 5-1, follow these safe work practices when conducting work involving known and unknown site hazards. These safe work practices establish a pattern of general precautions and measures for reducing risks associated with hazardous site operations.

- Eating, drinking, chewing gum or tobacco, taking medication, or smoking is permitted in the support zone only.

- Wash hands and face thoroughly upon leaving a contaminated or suspected contaminated area. A thorough shower and washing must be conducted as soon as possible if excessive skin contamination occurs.
- Avoid contact with potentially contaminated substances by walking around puddles, pools, mud, or other such areas. Avoid, whenever possible, kneeling on the ground or leaning or sitting on equipment. Do not place monitoring equipment on potentially contaminated surfaces.
- Be familiar with and adhere to the instructions in the site-specific HASP.
- Be aware of the location of the nearest telephone and emergency telephone numbers.
- Attend briefings on anticipated hazards, equipment requirements, Safe Work Permits, emergency procedures, and communication methods before going on site.
- Rehearse unfamiliar operations prior to implementation.
- Maintain visual contact with each other and with other on-site team members by remaining in close proximity in order to assist each other in case of emergency.
- Establish appropriate Safety Zones including Support, Contamination Reduction, and Exclusion Zones.
- Minimize the number of personnel and equipment in contaminated areas (such as the Exclusion Zone). Non-essential vehicles and equipment should remain within the Support Zone.
- Establish appropriate decontamination procedures for leaving the site.
- Immediately report injuries, illnesses, and unsafe conditions, practices, and equipment to the Site Safety Officer (SSO).
- Observe coworkers for signs of toxic exposure and heat or cold stress.
- Inform co-workers of potential symptoms of illness, such as headaches, dizziness, nausea, or blurred vision.

5.2 DPT SAFE WORK PRACTICES

The following Safe Work Practices are to be followed when working in or around DPT Operations. Prior to intrusive investigation techniques check the SOP for Utility Locating and Excavation Clearance found in Attachment IV of this HASP.

5.2.1 Before DPT

- Identify underground utilities and buried structures before DPT.
- A Competent Person (the SSO or designee) will inspect rigs, prior to the acceptance of the equipment at the site and prior to the use of the equipment. Repairs or deficiencies identified will be corrected prior to use. The inspection will be accomplished using the Equipment Inspection Checklist provided

in Attachment V. Inspection frequencies will be once every shift or following repairs.

- The work area around the point of operation will be graded to the extent possible to remove any trip hazards.
- The DPT operator helper will establish an equipment staging and lay-down plan in order to keep the work area clear of clutter and slips, trips, and fall hazards.
- Potentially contaminated tooling will be wrapped in polyethylene sheeting for storage and transport to the centrally located decontamination unit.

5.2.2 During DPT

- Secure frayed or loose clothing, hair, and jewelry when working with DPT equipment.
- Minimize contact to the extent possible with contaminated tooling and environmental media.
- Support functions (sampling and screening stations) will be maintained a minimum distance from the rig of the height of the mast plus five feet to remove these activities from within physical hazard boundaries.
- Only qualified operators and knowledgeable ground crew personnel will participate in the operation of the DPT.
- Minimize contact with potentially contaminated tools and media and to minimize lifting hazards, multiple personnel should move auger flights and other heavy tooling.
- Only personnel absolutely essential to the work activity will be allowed in the exclusion zone. Site visitors will be escorted.

5.2.3 After DPT

- Equipment used within the exclusion zone will undergo a complete decontamination and evaluation by the SSO to determined cleanliness prior to moving to the next location, exiting the site, or prior to down time for maintenance.
- Motorized equipment will be fueled prior to the commencement of the days activities. During fueling operations the equipment will be shutdown and bonded to the fuel provider.
- When not in use rigs will be shutdown, emergency brakes set, and wheels chocked.
- Areas will be restored to equal or better condition than original to remove any contamination brought to the surface and to remove any physical hazards. Where these hazards cannot be removed the areas will be barricaded to minimize the impact on field crews working in the area.

5.3 HRC SAFE WORK PRACTICES

See Attachment VI for safe work practices and a material safety data sheet for HRC.

TABLE 5-1
TASKS/HAZARDS/CONTROL MEASURES
INDIAN HEAD DIVISION NAVAL SURFACE WARFARE CENTER

Tasks/Operation/ Locations	Anticipated Hazards	Recommended Control Measures	Air Monitoring Type/Action Levels	Personal Protective Equipment	Decontamination Procedures
Mobilization/ Demobilization Surveying activities are also included in this task.	***Chemical hazards:*** 1) Exposure to potential site contaminants is not anticipated during this activity. However, chemicals brought on site in support of field activities are to be identified, logged, accompanied by an appropriate MSDS, properly stored, and evaluated for purposes of hazard communication. ***Physical hazards:*** Potential physical hazards associated with this task may include: 2) Lifting (muscle strains and pulls) 3) Pinches and compressions 4) Slip, trips, and falls 5) Contact/entanglement with moving machinery 6) Vehicular and foot traffic 7) Noise ***Natural hazards*** 8) Insect/animal bites or stings, poisonous plants, etc.	1)To eliminate potential chemical hazards associated with this task ensure the following: - A chemical inventory list is generated for chemicals brought on site (Complete Section 5.0 of the Tetra Tech NUS Health and Safety Guidance Manual). - Material Safety Data Sheets must be available for chemicals brought on site. - Materials are stored in accordance with recommended practices and according to compatibility (See MSDS for storage and compatibility recommendations). The FOL and/or the SSO will preview work locations in an effort to identify, barricade, and/or remove physical and biological hazards prior to the commitment of any personnel, equipment, or other resources. 2) Use machinery or multiple personnel for heavy lifts. - Use proper lifting techniques. - Lift with your legs, not your back, bend your knees move as close to the load as possible, and ensure good hand holds are available. - Minimize the horizontal distance to the center of the lift to your center of gravity. Minimize turning and twisting when lifting as the lower back is especially vulnerable at this time. Break lifts into steps if the vertical distance (from the start point to the placement of the lift) is excessive. Plan your lifts – Place heavy items on shelves between the waist and chest; lighter items on higher shelves. Periods of high frequency lifts or extended duration lifts should provide sufficient breaks to guard against fatigue and injury. In determining whether you can lift an item several factors must be considered, these are as follows: - Maximum weight lifted by a single person should not exceed 70 pounds. Items over 70 pounds or the amount you feel you can confidently lift up to 70 pounds should define a point where assistance in the lift is sought. - Level of demand – Weight + frequency & duration. - Area available to maneuver the lift. - Area of the lift – Work place clutter, slippery surfaces - Overall physical condition 3) Use pinch bars or other equipment to keep hands from the point of operation. 4) Preview and prepare work locations where unstable/uneven terrain exists. Barricade excavations/embankments deeper than 2 feet from access closer than two feet from the edge from foot and vehicular traffic. 5) Equipment to be used on site will be - Inspected in accordance with OSHA, and manufacturers design. The inspection will include the completion of the Equipment Inspection Checklist (Attachment V) documenting the review and acceptance/failure of safety devices, guards, emergency. - Operated by certified operators, and knowledgeable ground crew, as applicable. - Establish safe zones of approach. - Secure loose articles to avoid possible entanglement. 6) Identify access/egress routes and locations to within established areas of operation. - Work areas will be demarcated and proper signage placed in accordance with Site Control provisions stated in Section 9.1. - Equipment capable of self-propelled movement will be equipped with movement alarms as applicable. 7) As a general rule of thumb, if you need to raise your voice to be heard while engaged in conversation with someone who is within 2 feet of your position you may be exposed to excessive noise levels and should employ hearing protection. 8) Avoid insect nesting areas, employ repellents. Report potential hazards to the SSO. Frequently inspect clothing and persons during and after activities in wooded areas for ticks and other vectors	Not required during mobilization/demobilization.	Mobilization/demobilization activities is intended to initiate and proceed in Level D protection Level D - (Minimum Requirements) - Standard field attire (Sleeved shirt; long pants; or coveralls) - Steel toe safety shoes - Safety glasses - *Hardhat (when overhead hazards exists, or identified as an operation requirement)* - *Reflective vest for high traffic areas* - *Hearing protection for high noise areas, or as directed on an operation by operation scenario.* **Note:** The Safe Work Permit(s) (See Attachment III) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task.	As potential site contaminants are not anticipated as part of this task, personal decontamination is not required. Equipment arriving/leaving the site will be inspected prior to permitting this equipment to enter or exit the site. The SSO will inspect the equipment and give the clearance to allow the equipment to pass. Failure to pass inspection will prohibit entering or exiting the site as applicable. Equipment which fails the inspection will have to be decontaminated again to a level acceptable to the SSO prior to passage on or off site. Equipment permitted to pass on/off site will be documented using an Equipment Inspection Checklist (Attachment V) indicating the equipment serial number, description, brief history of the other sites the equipment has been on, and the results of the inspection.

TABLE 5-1
TASKS/HAZARDS/CONTROL MEASURES
INDIAN HEAD DIVISION NAVAL SURFACE WARFARE CENTER

Tasks/Operation\ Location	Anticipated Hazards	Recommended Control Measures	Air Monitoring	Personal Protective Equipment *(Items in italics are optional as the FOL or SSO require)*	Decontamination Procedures
Soil Boring/Monitoring Well Installation/ Abandonment, and HRC Bio-degraduation using DPT techniques.	***Chemical hazards:*** 1) Air and particulate borne contaminants consist of low levels of 1,2-DCE, TCE and methylene chloride. See Table 6-1 for more information on these specific contaminants of concern. 2) Handling HRC/grout 3) Transfer of contamination into clean areas or onto persons ***Physical hazards:*** 4) Contact/entanglement with rotating equipment 5) Noise 6) Contact with underground or overhead utilities 7) Lifting 8) Slips, trips, and falls 9) Vehicular and foot traffic 10) Ambient temperature extremes (heat stress) ***Natural hazards:*** 11) Insect/animal bites or stings, poisonous plants, etc.	1) Use real-time monitoring instrumentation, action levels, personal sampling, and identified PPE to control exposures to potentially contaminated media (e.g., air, water, soils, etc.). Any generation of dusts should be minimized to the greatest extent possible. If airborne dusts are observed, area wetting methods will be used. If area wetting methods are not feasible, upgraded levels of protection or termination of activities will be used to minimize exposure to excessive airborne dusts. 2) Although HRC is manufactured as food-grade material that is safe to ingest, field personnel should take precautions while handling and applying HRC. Carefully review manufactures instructions and plan out activities prior to implementation. Should be stored in plastic lined steel, plastic, glass, aluminum, stainless steel, or reinforced fiberglass containers. Avoid strong oxidizing agents, bases and acids. Wear appropriate PPE and avoid contact with skin. See Appendix VI of this HASP. 3) Decontaminate equipment and supplies between drilling events as well as prior to leaving the site. 4) Equipment to be used will be - Inspected in accordance with Federal safety and transportation guidelines, OSHA (1926.600,.601,.602), and manufacturers design and documented as such using Equipment Inspection Checklist (Attachment V) - Operated by certified operators and knowledgeable ground crew. - Only manufacturer approved equipment may be used in conjunction with equipment repair procedures In addition to the equipment considerations, the following standard operating procedures will be employed: - Hydraulic masts or other projecting devices shall be at least 20 feet from overhead power sources and a minimum of 3 feet from underground utilities. - Hand signals will be established prior to the commencement of the operation. - A remote sampling device must be used to sample drill cuttings near rotating tools - Only manufacturer-approved equipment may be used in conjunction with equipment repair procedures (e.g., flight connectors). - Work areas will be kept clear of clutter. - Secure loose articles to avoid possible entanglement during coring activities. - Self-propelled equipment shall be equipped with movement warning systems. - Personnel will be instructed in the location and operations of the emergency shut-off device(s). This device will be tested initially (and then periodically) to ensure its operational status. - Areas will be inspected prior to the movement of the drill rig and support vehicles to eliminate any physical hazards. This will be the responsibility of the FOL and/or SSO. - The drill rig and support vehicles will be moved no closer than 3 feet to unsupported side-walls of excavations and embankments. 5) Excessive noise levels will be mitigated through the use of hearing protection. Any piece of equipment or operation that has the potential to generate excessive noise levels (You must raise your voice to speak to someone within two feet of where you are standing) will require hearing protection. 6) Utility clearances shall be obtained in writing prior to subsurface activities. The locations of underground utilities will be identified and marked prior to subsurface investigations. Where the clearance cannot be obtained in a reasonable period, or not located, drilling shall proceed with extreme caution using a magnetometer for periodic downhole and by hand (using a hand auger) to at least 6 feet. 7) Employ machinery or multiple personnel for heavy lifts. - Use proper lifting techniques. Use proper lifting techniques. - Lift with your legs, not your back, bend your knees move as close to the load as possible, and ensure good hand holds are available. - Minimize the horizontal distance to the center of the lift to your center of gravity. Minimize turning and twisting when lifting as the lower back is especially vulnerable at this time. Break lifts into steps if the vertical distance (from the start point to the placement of the lift) is excessive. Plan your lifts – Place heavy items on shelves between the waist and chest; lighter items on higher shelves. Periods of high frequency lifts or extended duration lifts should provide sufficient breaks to guard against fatigue and injury. In determining whether you can lift an item several factors must be considered, these are as follows: - Maximum weight lifted by a single person should not exceed 70 pounds. Items over 70 pounds or the amount you feel you can confidently lift up to 70 pounds should define a point where assistance in the lift is sought. 8) Preview work locations for unstable/uneven terrain. 9) Traffic and equipment considerations are to include the following: - Establish safe zones of approach - Self-propelled equipment shall be equipped with movement warning systems. - Personnel working in high equipment traffic areas are required to wear reflective vests for high visibility. - Use safety belts and follow the site traffic rules. 10) Wear appropriate clothing for weather conditions. Provide acceptable shelter and liquids for field crews. Additional information regarding cold/heat stress concerns is provided in section 4 of the Health and Safety Guidance Manual. 11) Wear appropriate clothing and PPE. Avoid potential nesting areas and suspicious vegetation (poison ivy, poison oak, etc.). When feasible and necessary use commercially available insect repellants. Refer to the Health and Safety Guidance Manual for additional information regarding ticks and Lyme's disease.	**It is anticipated that potential contaminant concentrations at sample locations will not represent an inhalation hazard.** A Photoionization Detector w/ 11.7 eV UV lamp source, or a Flame Ionization Detector, will be used to monitor for applicable site contaminants. Source (borehole and monitoring well) monitoring will be conducted at regular intervals determined by the SSO. The SSO will also monitor the breathing zone (BZ) of potentially affected employees, with the following guidance: **VOCs Screening** A direct reading Photoionization Detector (PID) with a 11.7 eV lamp (Primary), or a Flameionization Detector (FID) (Secondary/Back-up), will be used to screen samples and to detect the presence of any potential volatile organics. Source monitoring of the breathing zone in the soil boring area will be conducted at regular intervals to be determined by the SSO. Positive sustained results at a source or downwind location(s) which may impact operations crew will require the following actions: - Monitor the breathing zone of at-risk and downwind employees. Any sustained readings (greater than 1 minute in duration) above 25 ppm in the breathing zone of the at-risk employees requires site activities to be suspended and site personnel to retreat to an unaffected area. - Work may only resume if airborne readings in worker breathing zone return to below 25 ppm. If elevated readings in worker breathing zone persist, the PHSO and HSM will be contacted to determine necessary actions and levels of protection. Site contaminants may adhere to or be part of airborne dusts or particulates generated during site activities. Generation of dusts should be minimized to avoid inhalation of contaminated dusts or particulates. Evaluation of dust concentrations will be performed by observing work conditions for visible dust clouds. Potential exposure to contaminated dust will be controlled using water suppression, by avoiding dust plumes, or evacuating the operation area until dust subsides.	Subsurface operations are to be initiated in Level D protection. Level D protection constitutes the following minimum protection - Standard field attire (Sleeved shirt; long pants) - Tyvek coveralls and disposable boot covers if surface contamination is present or if the potential exists for soiling work attire. - Nitrile rubber or natural rubber gloves with surgical style inner gloves - Steel toe safety shoes - Safety glasses - Hardhat - *Reflective vest for high traffic areas* - *Hearing protection for high noise areas, as directed by the SSO.* When handling HRC the following PPE will be worn: - Splash goggles or full face shield - Vinyl or Rubber gloves - *Tyvek suit* - *Boot covers* - *Hearing protection for high noise areas, as directed by the SSO.* **Excessive chemical contaminant concentrations impacting field crews during this task are not anticipated.** **Note:** The Safe Work Permit(s) (See Attachment III) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task. A separate safe work permit is written for the HRC	**Personnel Decontamination** will consist of a soap/water wash and rinse of outer protective equipment. This decontamination function may be subdivided into two locations: -Gross contamination of outer boots and outer gloves will be removed at a satellite location near the operation. -Final wash and rinse will take place at the centralized decontamination pad. The sequential procedure is as follows: Stage 1: Equipment drop, remove outer protective wrapping; Decon personnel will wipe down the outer shell and pass hand equipment through as necessary. Stage 2: Soap/water wash and rinse of outer boots and gloves Stage 3: Soap/water wash and rinse of the outer splash suit, as applicable Stage 4: Disposable PPE will be removed and bagged. Stage 5: Wash face and hands Stage 6: Depending on ambient conditions, you may be required to report for medical evaluation. This evaluation consists of pulse, breathing rate, oral temperature, and body weight. This medical screening will be performed when ambient conditions dictate and during periods of acclimatization. **Equipment Decontamination** - Heavy equipment decontamination will take place at a centralized decontamination pad utilizing a steam cleaner. Heavy equipment will have the wheels and tires cleaned along with any loose debris removed, prior to transporting to the central decontamination area. Site vehicles will have restricted access to exclusion zones, and have their wheels/tires sprayed off as not to track mud onto the roadways servicing this installation. Roadways shall be cleared of any debris resulting from the onsite activity. The FOL or the SSO will be responsible for evaluating equipment arriving on-site, leaving the site, and between locations. No equipment will be authorized access, exit, or movement to another location without this evaluation.

TABLE 5-1
TASKS/HAZARDS/CONTROL MEASURES
INDIAN HEAD DIVISION NAVAL SURFACE WARFARE CENTER

Task/Operation/ Location	Anticipated Hazards	Recommended Control Measures	Air Monitoring Type/Action Levels	Personal Protective Equipment *(Items in italics are optional as the FOL or SSO require)*	Decontamination Procedures
Multi-media sampling subsurface soil, ground water and Investigative Derived Waste (IDW) sampling.	***Chemical hazards:*** 1) Air and particulate borne contaminants consist of low levels of 1,2-DCE, TCE and methylene chloride. See Table 6-1 for more information on these specific contaminants of concern. 2) Transfer of contaminants into clean areas or onto persons ***Physical hazards:*** 3) Noise 4) Lifting (muscle strains and pulls) 5) Pinches and compressions 6) Slip, trips, and falls 7) Vehicular and foot traffic ***Natural hazards:*** 8) Insect/animal bites or stings, poisonous plants, etc.	1) Use real-time monitoring instrumentation, action levels, personal sampling, and identified PPE to control exposures to potentially contaminated media (e.g., air, water, soils, etc.). Although not anticipated, generation of any dusts should be minimized to the greatest extent possible. If airborne dusts are observed, area wetting methods will be used. If area wetting methods are not feasible, upgraded levels of protection or termination of activities will be used to minimize exposure to excessive airborne dusts. 2) Restrict the cross use of equipment and supplies between sampling locations without first going through a suitable decontamination. 3) Due to operational and contributory activities in and about work areas, generated noise levels may be excessive. Noise control will be facilitated through the use of hearing protection. -As a general rule of thumb, anytime you must raise your voice to speak to someone to be heard within 2 feet of where you are standing the potential exists that sound pressure levels may be excessive. 4) Employ machinery or multiple personnel for heavy lifts. Use proper lifting techniques. 5) Use pinch bars or other equipment to remove hands from the point of operation, when acquiring samples. 6) Preview work locations for unstable/uneven terrain. 7) Traffic and equipment considerations are to include the following: - Establish safe zones of approach - Personnel working in high equipment traffic areas are required to wear reflective vests for high visibility. - Employ safety belts and follow the site traffic rules. 8) Avoid insect nesting areas. Use insect repellents when necessary. Report potential hazards to the SSO.	**It is anticipated that potential contaminant concentrations at sample locations will not represent an inhalation hazard.** A direct reading Photoionization Detector (PID) with a 11.7 eV lamp (Primary), or a Flameionization Detector (FID) (Secondary/Back-up), will be used to screen samples and to detect the presence of any potential volatile organics. Source monitoring of the sample collection area will be conducted at regular intervals to be determined by the SSO. Positive sustained results at a source or downwind location(s) which may impact operations crew will require the following actions: - Monitor the breathing zone of at-risk and downwind employees. Any sustained readings (greater than 1 minute in duration) above 25 ppm in the breathing zone of the at-risk employees requires site activities to be suspended and site personnel to retreat to an unaffected area. - Work may only resume if airborne readings in worker breathing zone return to below 25 ppm. If elevated readings in worker breathing zone persist, the PHSO and HSM will be contacted to determine necessary actions and levels of protection. Site contaminants may adhere to or be part of airborne dusts or particulates generated during site activities. Generation of dusts should be minimized to avoid inhalation of contaminated dusts or particulates. Evaluation of dust concentrations will be performed by observing work conditions for visible dust clouds. Potential exposure to contaminated dust will be controlled using water suppression, by avoiding dust plumes, or evacuating the operation area until dust subsides.	Level D protection will be utilized for the initiation of sampling activities. Level D - (Minimum Requirements) - Standard field attire (long sleeve shirt; long pants) - Tyvek coveralls and disposable boot covers if surface contamination is present or if the potential for soiling work attire exists. - Nitrile, natural rubber, or surgical style gloves for soil and groundwater sampling - Steel toe safety shoes - Safety glasses - Hardhat (when overhead hazards exists, or identified as a operation requirement) - *Reflective vest for high traffic areas* - *Hearing protection for high noise areas, or as directed on an operation by operation scenario.* **Excessive chemical contaminant concentrations impacting field crews during this task are not anticipated.** **Note:** The Safe Work Permit(s) (See Attachment III) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task.	**Personal decontamination** will vary based on the type of sampling conducted. These are as follows: Supporting subsurface investigations at the drill rig. Decontamination will be the same as prescribed for the drilling activity Upon completion of the sampling dedicated trowels, tubing, etc. will be bagged for transport back to the central decontamination area. PPE (gloves) will be removed and also bagged for disposal. Handi-Wipes or similar product will be used to clean hands prior to moving to the next location. **Equipment Decontamination** Equipment used in remote sampling locations will be brought back to the central decontamination area for decontamination and re-use or decontamination and gross removal of contamination prior to disposal. **Sampling Equipment Decontamination** Sampling equipment will be decontaminated as per the requirements in the Sampling and Analysis Plan and/or Work Plan. Equipment used in the exclusion zone will require a complete decontamination between locations and prior to removal from the site. **Note:** Field screening instruments will be wrapped to minimize the necessary decontamination except for wiping down parts which are necessary to expose to the external environment. The equipment reference above is largely directed at hand tools. Decontamination of equipment (sampling and hand tools) will proceed as indicated in the Sampling and Analysis Plan and/or Work Plan.

TABLE 5-1
TASKS/HAZARDS/CONTROL MEASURES
INDIAN HEAD DIVISION NAVAL SURFACE WARFARE CENTER

Task/Operation/ Location	Anticipated Hazards	Recommended Control Measures	Air Monitoring	Personal Protective Equipment	Decontamination Procedures
Decontamination of sampling and heavy equipment	***Chemical hazards:*** 1) Air and particulate borne contaminants consist of low levels of 1,2-DCE, TCE and methylene chloride. See Table 6-1 for more information on these specific contaminants of concern. - Decontamination fluids - Liquinox (detergent) ***Physical hazards:*** 3) Lifting (muscle strains and pulls) 4) Noise 5) Flying projectiles 6) Vehicular and foot traffic 7) Ambient temperature extremes (heat stress) 8) Slips, trips, and falls	1) and 2) Employ protective equipment to minimize contact with site contaminants and hazardous decontamination fluids. Obtain manufacturer's MSDS for any decontamination solvents used onsite. Use appropriate PPE as identified on MSDS. Chemicals used must be listed on the Chemical Inventory for the site, and site activities must be consistent with the Hazard Communication section of the Health and Safety Guidance Manual (Section 5). 3) Use multiple persons where necessary for lifting and handling sampling equipment for decontamination purposes. - Stacks (drill flights) will be secured to prevent falling during decontamination and drying activities. 4) Wear hearing protection when operating pressure washer. 5) Use appropriate eye and face protective equipment (safety glasses underneath a face shield) when operating pressure washer. Other personnel must be restricted from the area. 6) Traffic and equipment considerations are to include the following: - Establish safe zones of approach - Secure loose articles to avoid possible entanglement. - Equipment shall be equipped with movement warning systems. - Use safety belts and follow the site traffic rules. 7) Wear appropriate clothing for weather conditions. Provide acceptable shelter and liquids for field crews. Additional information regarding cold/heat stress concerns is provided in Section 4 of the TtNUS Health and Safety Guidance Manual. 8) Preview work locations for unstable/uneven terrain.	Use visual observation, and real-time monitoring instrumentation to ensure equipment has been properly cleaned of contamination and dried. After decon is completed, screen equipment with a PID/FID. If any elevated readings (I.e., above background) are observed, perform decon again and rescreen. Repeat until no elevated PID/FID readings are noted.	For Heavy *Equipment.* Level D Minimum requirements - - Standard field attire (Long sleeve shirt; long pants) - Steel toe safety shoes - Chemical resistant boot covers - Nitrile rubber or natural rubber gloves - Safety glasses If using pressure washer, or steam cleaning wash and rinse procedures, add the following to the above PPE: - PVC Rainsuits or PE or PVC coated Tyvek - Splash shield over safety glasses For sampling equipment the following PPE is required Level D Minimum requirements - - Standard field attire (Long sleeve shirt; long pants) - Steel toe safety shoes - Nitrile rubber or natural rubber gloves - Safety glasses underneath a splash shield In the event of overspray of chemical decontamination fluids employ PVC Rainsuits or PE or PVC coated Tyvek as necessary. **Note:** The Safe Work Permit(s) (See Attachment III) will be issued at the beginning of each day to address the tasks planned for that day. As part of this task additional PPE may be assigned to reflect site-specific conditions or special considerations or conditions associated with any identified task.	**Personnel Decontamination** will consist of a soap/water wash and rinse for reusable and non-reusable outer protective equipment (boots, gloves, PVC splash suits, as applicable). This decontamination function may be subdivided into two locations. Gross contamination of outer boots and outer gloves will be removed at a satellite location near the operation. Final wash and rinse will take place at the centralized decontamination pad. The sequential procedure is as follows: Stage 1: Equipment drop, remove outer protective wrapping; Decon personnel will wipe down the outer shell and pass hand equipment through as necessary. Stage 2: Soap/water wash and rinse of outer boots and gloves Stage 3: Soap/water wash and rinse of the outer splash suit, as applicable Stage 4: Disposable PPE will be removed and bagged. Stage 5: Wash face and hands Stage 6: Depending on ambient conditions, you may be required to report for medical evaluation. This evaluation consists of pulse, breathing rate, oral temperature, and body weight. This medical screening will be performed when ambient conditions dictate and during periods of acclimatization. **Equipment Decontamination** - Heavy equipment decontamination will take place at a centralized decontamination pad utilizing a steam cleaner. Heavy equipment will have the wheels and tires cleaned along with any loose debris removed, prior to transporting to the central decontamination area. Site vehicles will have restricted access to exclusion zones, and have their wheels/tires sprayed off as not to track mud onto the roadways servicing this installation. Roadways shall be cleared of any debris resulting from the onsite activity. **Sampling Equipment Decontamination** Sampling equipment will be decontaminated as per the requirements in the Sampling and Analysis Plan and/or Work Plan. Equipment used in the exclusion zone will require a complete decontamination between locations and prior to removal from the site. The FOL or the SSO will be responsible for evaluating equipment arriving on-site, leaving the site, and between locations. No equipment will be authorized access, exit, or movement to another location without this evaluation.

6.0 HAZARD ASSESSMENT

This section provides information regarding the chemical and physical hazards associated with the Site 57 of the IHDIV-NSWC and the activities that are to be conducted as part of the scope of work. Table 6-1 provides various information related to the chemical hazards that may be present at the site. Specifically, toxicological information, exposure limits, symptoms of exposure, physical properties, and air monitoring and sampling data are also discussed in that table.

6.1 CHEMICAL HAZARDS

The potential health hazards associated with Site 57 include inhalation, ingestion, and dermal contact with various contaminants which may be present at the site in shallow and deep soils as well as in groundwater. Prior sampling in the vicinity of the sump has identified the following low levels of VOCs. The most significant contaminants detected were 1,2-dichloroethylene (1,2-DCE), methylene chloride, and trichloroethylene (TCE). Other contaminants were detected at concentrations too low to present a significant health hazard via inhalation.

Information on the toxicological, chemical, and physical properties of other potential contaminants of concern is addressed in Table 6-1 of this HASP. It is anticipated that the greatest potential for exposure to site contaminants is during activities in which contact with potential contaminated media exists (soil boring, monitoring well installations, sampling activities, etc.).

6.2 PHYSICAL HAZARDS

In addition to the chemical hazards discussed above, the following physical hazards may be present during the performance of site activities.

- Slips, trips, and falls.
- Strain from heavy lifting.
- Pinch / compression points.
- Noise in excess of 85 decibels (dBA).
- Inclement weather.
- Natural hazards (contact with poisonous plants and disease carrying animals and insects).
- Other physical hazards associated with ongoing facility operations (proximity to heavy equipment and machinery, vehicular traffic, etc.).

TABLE 6-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
INDIAN HEAD DIVISION - NAVAL SURFACE WARFARE CENTER, SITE 57

Substance	CAS No.	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
1,2-Dichloroethylene	540-59-0	PID: I.P. 9.65 eV, high response with PID and 10.2 eV lamp. FID: 50% response with FID.	Air sample using charcoal tube; and carbon disulfide desorption; Sampling and analytical protocol in accordance with OSHA Method #07; and NIOSH Method #1003.	OSHA; NIOSH; ACGIH: 200 ppm IDLH: 1000 ppm	Adequate- odor threshold 0.085-17 ppm. Use organic vapor/acid gas cartridges for exceedances above the TWA up to 1,000 ppm. >1,000 ppm should use pressure-demand supplied air respirator above exposure limits. **Recommended glove:** nitrile - 0.12 hrs; viton - 0.95 hrs	**Boiling Pt:** 117°F; 47°C **Melting Pt:** 7°F; -13.8°C **Solubility:** 0.4% **Flash Pt:** 36°F; 2.2°C **LEL/LFL:** 5.6% **UEL/UFL:** 12.8% **Vapor Density:** 2.0 **Vapor Pressure:** 180-260 mmHg **Specific Gravity:** 1.27 @ 90°F; 32°C **Incompatibilities:** Strong oxidizers, alkalis, potassium hydroxide, and copper. When heated to decomposition temperatures will emit toxic fumes of phosgene. **Appearance and Odor:** Colorless liquid with an acrid odor.	Overexposure may result in CNS depression with potential to cause sleepiness, hallucinations, distorted perceptions, and stupor (narcosis). Systemically, symptoms may result in nausea, vomiting, weakness, tremors, and cramps. May also irritate the eyes, skin, and mucous membranes. Chronic exposures may result in dermatitis, liver, kidney, and lung damage.
Trichloroethylene	79-01-6	PID: I.P. 9.45 eV, High response with PID and 10.2 eV lamp. FID: 70% Response with FID.	Air sample using charcoal tube; carbon disulfide desorption; Sampling and analytical protocol shall proceed in accordance with OSHA Method #07, or NIOSH Method #1022 or #1003.	OSHA: 50 ppm; 200 ppm (Ceiling) ACGIH: 50 ppm; 100 ppm STEL NIOSH: 25 ppm IDLH: 1000 ppm	Inadequate - Odor threshold 82 ppm. APRs with organic vapor/acid gas cartridges may be used for escape purposes. Exceedances over the exposure limits require the use of positive pressure-demand supplied air respirator. **Recommended gloves:** PV Alcohol unsupported >16.00 hrs; Silver shield >6.00 hrs; Teflon >24.00 hrs; or Viton >24.00 hrs; Nitrile (Useable time limit 0.5 hr, complete submersion for the nitrile selection)	**Boiling Pt:** 188°F; 86.7°C **Melting Pt:** -99°F; -73°C **Solubility:** 0.1% @ 77°F; 25°C **Flash Pt:** 90°F; 32°C **LEL/LFL:** 8% @ 77°F; 25°C **UEL/UFL:** 10.5 @ 77°F; 25°C **Vapor Density:** 4.53 **Vapor Pressure:** 100 mmHg @ 90°F; 32°C **Specific Gravity:** 1.46 **Incompatibilities:** Strong caustics and alkalis, chemically active metals (barium, lithium, sodium, magnesium, titanium, and beryllium) **Appearance and Odor:** Colorless liquid with a chloroform type odor. Combustible liquid, however, burns with difficulty.	Central nervous system effects including euphoria, analgesia, anesthesia, paresthesia, headaches, tremors, vertigo, and somnolence. Damage to the liver, kidneys, heart, lungs, and skin have also been reported. Contact may result in irritation to the eyes, skin, and mucous membranes. Ingestion may result in GI disturbances including nausea, and vomiting NIOSH lists this substance a potential human carcinogen.

TABLE 6-1
CHEMICAL, PHYSICAL, AND TOXICOLOGICAL DATA
INDIAN HEAD DIVISION - NAVAL SURFACE WARFARE CENTER, SITE 57

Substance	CAS No.	Air Monitoring/Sampling Information		Exposure Limits	Warning Property Rating	Physical Properties	Health Hazard Information
Methylene chloride	75-09-2	PID: I.P. 11.32 eV, High response with PID and 11.7 eV lamp. FID: 100% response with FID.	Air sample using charcoal or Anasorb CMS sorbent tube; carbon disulfide desorption; gas chromatography-flame ionization detector; Sampling and analytical protocol shall proceed in accordance with OSHA Method #59, 80, or NIOSH Method #1005.	OSHA: 50 ppm, 100 ppm (Ceiling) ACGIH: 50 ppm NIOSH: Lowest feasible concentration IDLH: 2300 ppm	Inadequate - Odor threshold 160 ppm. Use a gas mask with a Type N canister for concentrations up to 25 ppm. In excess of 25 ppm, use a supplied air respirator (airline respirator with emergency escape cylinder or a Self-Contained Breathing Apparatus - (SCBA). Recommended gloves: Nitrile rubber latex glove 3.00 hrs (vendor specific); supported Polyvinyl alcohol glove, unsupported 1-8 hrs; Silver shield 1.90 hrs	**Boiling Pt: 104°F; 39.8°C** **Melting Pt: -141°F; -96°C** **Solubility: 2%** **Flash Pt: Not available** **LEL/LFL: 13%** **UEL/UFL: 12%** **Vapor Density: 2.93** **Vapor Pressure: 380 mmHg @ 72°F; 22°C** **Specific Gravity: 1.33** **Incompatibilities: Strong oxidizers, caustics, metals (i.e. aluminum, magnesium, potassium, sodium, lithium), and concentrated acids** **Appearance and Odor:** **Colorless liquid with a chloroform-like odor. (Note: A gas above 104°F; 40°C).**	Effects of overexposure may include CNS effects - cause sleepiness, fatigue, weakness, lightheadedness, numbness of the limbs, altered cardiac rate and incoordination. These signs and symptoms may be accompanied by nausea, gastric and pulmonary irritation leading possibly to pulmonary edema. In addition to the narcosis long term effects may include liver injury. Listed as possessing carcinogenic properties by NTP, IARC, and ACGIH.

These physical hazards and their applicability to each site task are discussed in detail in Table 5-1. Additionally, each of these physical hazards is discussed in detail in the TtNUS Health and Safety Manual.

6.2.1 Slip, Trip and Fall Hazards

Various potential slip, trip, and fall hazards may be encountered during the performance of planned site activities. These hazards are associated with working out doors where uneven or wet terrain may be encountered, or near the edge of bodies of water, as well as on boat decks and docks. To minimize the potential for worker injury from these hazards, the following requirements must be observed:

- Maintain proper housekeeping in work areas.
- Preview and inspect work areas to identify and eliminate slip, trip, or fall hazards. In outdoor locations, pay particular attention to sink holes or other depressions that may be encountered.
- Any work that is to be done on structures that are more than 6-feet above floor or ground level will require fall protection training and the use of 100% fall protection equipment.
- Cover, guard, barricade, and/or place warning postings over/at holes or openings that personnel may fall or step into.
- For traversing steep, slippery, or sloped terrain establish rope ladders to control ascent and descent to sampling areas or use alternative pathways.

6.2.2 Strains/Muscle Pulls

To prevent injuries due to improper lifting and carrying methods observe the following:

- Estimate the weight and configuration of the load (i.e., is it bulky or hard to safely grasp/lift/control). If it appears to be too heavy or bulky to safely handle alone, either use a mechanical lifting device or obtain help from another employee to lift the load. The use of mechanical lifting devises is always preferable over manual lifting.
- Bend at the knees (not at the waist) when attempting a lift.
- Get a firm hold is obtained, and keep the load as close to the body as possible.
- Lift the load using your legs, and not the back.
- Avoid turning or twisting while holding a load.

- Preview the path of travel to identify and eliminate tripping hazards.
- Do not carry loads that obstruct the line of sight.
- When setting a load down use the leg muscles and do not bend at the waist.
- Diuvide heavier loads into smaller amounts.

6.3 NATURAL HAZARDS

Insect/animal bites and stings, poisonous plants, and inclement weather are natural hazards that may be present given the location of activities to be conducted. In general, avoidance of areas of known infestation or growth will be the preferred exposure control for insects/animals and poisonous plants. Specific discussion on principle hazards of concern follows:

6.3.1 Insect Bites and Stings

Insect bites and stings are difficult to control given the climate and environmental setting of IHDIV-NSWC. However, in an effort to minimize this hazard the following control measures will be implemented where possible.

- Commercially available bug sprays and repellents will be used whenever possible – Pesticides analytical screening includes chlordane, endrin, lindane, methoxychlor, toxaphene and heptachlor. Commercially available repellants may be used. Products such as DEET should not be applied directly to the skin due to potential irritation. This product, when permitted for use, should be applied over clothing articles.
- Where possible, loose-fitting and light-colored clothing with long sleeves should be worn. This will also aid in insect control by providing a barrier between the field person and the insects and to provide easy recognition of crawling insects against the lighter background. Pant legs should be secured to the work-boots using duct tape to prevent access by ticks. Mosquito nets are also recommended for use when commercially available repellents are not permitted.
- Clothing/limited body checks for ticks and other crawling insects should be conducted upon exiting heavily vegetated areas. Workers should perform a more detailed check of themselves when showering in the evening. Ticks prefer moist areas of the body (arm-pits, genitals, etc.) and will migrate to those locations.
- The FOL/SSO will preview access routes and work areas in an effort to identify physical hazards including nesting areas in and around the work sites. These areas will be flagged and communicated to site personnel.
- The FOL/SSO must determine if site personnel (through completion of Medical Data Sheets), suffer allergic reactions to bee and other insect stings and bites. Field crew members who are allergic to bites

should have their emergency kit containing antihistamine and a preloaded syringe of epinephrine readily available.

Any allergies (insect bites, bee stings, etc.) must be reported on the Medical Data Sheet and to the SSO.

Tick-Borne Disease

During warm months (spring through early fall), tick-borne lyme disease may pose a potential health hazard in Maryland which is listed as an area for lyme disease. The longer a disease carrying tick remains attached to the body, the greater the potential for contracting the disease. Wearing long sleeved shirts and long pants (tucked into boots). Performing frequent body checks will prevent the tick from attaching for the long term. Site first aid kits should be equipped with medical forceps and rubbing alcohol to assist in tick removal. For information regarding tick removal procedures, and symptoms of exposure consult the health and safety guidance manual.

Mosquito-Borne Illness

The Maryland Department of Health is urging people to take precautions to avoid potentially dangerous mosquitoes. Mosquitoes in Maryland may carry diseases including St. Louis encephalitis, Eastern Equine encephalitis, La Crosse encephalitis and West Nile virus.

The Maryland Department of Health, along with a variety of agencies, routinely conducts testing in mosquitoes and birds to monitor for possible mosquito-borne viruses. Mosquitoes become infected after biting infected birds. The symptoms for mosquito-borne illnesses may include headache, moderate to high fever, stiff neck and confusion. In serious cases coma, seizures or paralysis can result. Symptoms usually appear between 5 to 15 days after exposure to infected mosquitoes. Mosquito-borne illnesses may be mild or serious and can lead to death.

Precautions include:

- Limit outdoor activities during peak mosquito times – at dusk and dawn.
- Avoid standing water
- Wear long-sleeved shirts and long pants whenever you are outdoors.
- Apply insect repellent according to manufacturers instruction to exposed skin. An effective repellent will contain 20% to 30% DEET (N,N-diethyl-meta-toluamide). Avoid products containing more than 30% DEET.
- Spray clothing with repellents containing permethrin or DEET, mosquitoes may bite through thin clothing.

6.3.2 Snakes and Other Wild Animals

Indigenous animals including snakes (only two poisonous and approximately 27 non-poisonous varieties in Maryland), raccoons, and other animals native to the region may be present at the site. These animals may be encountered if work locations encroach on nesting or territories claimed by these animals.

There are two poisonous snakes indigenous to the State of Maryland, the Northern Copperhead and the Timber Rattlesnake. Only the Northern Copperhead is indigenous to this part of the state. It is important to remember that snakes are rarely aggressive towards humans. If you encounter a snake simply maintain a safe distance and move away from it, or allow it to move away.

Northern Copperhead (Agkistrodon contortrix mokasen)

This is one of the two venomous snake species in Maryland. The color is a rich, reddish, brown with a series of darker hourglass markings down its back. Its head is usually a bright copper color and its belly is pinkish. It seldom exceeds three feet in length. It has a single anal plate and keeled scales. This is the only Maryland snake that has dark dorsal markings which are narrow on the back and broad on the sides. Copperheads exist throughout the State in remote rocky, wooded areas where they feed on small rodents and other warm-blooded prey. Occasionally, they will feed on aquatic animals. Females give birth to approximately 12 live young which are 8-10 inches in length.

Prevention

To avoid the obvious hazards conveyed as part of a direct encounter, the following actions will be taken to minimize impact on the field crews and/or operations. The FOL/SSO will preview access routes and work locations for nesting areas or signs of animal activities (tracks, foraging areas, etc.). The identified suspect areas will be communicated to the field crews. Snake chaps will be required as a precaution.

Snake Bites

Initial efforts will be directed to avoid, where possible, nesting and territorial areas. However, should field personnel come in contact with these animals and receive a bite, the following actions are necessary.

- Obtain a detailed description of the snake. This and the bite mark will enable medical personnel administering medical aid to provide prompt and correct antidotes, as necessary.

- Immobilize the bite victim to the extent possible. Physical exertion will mobilize the toxins (if poisonous varieties) from the bite point systemically through the body.

- Apply a pressure wrap (for extremities), just above and over the bite area. With a couple wraps of the pressure wrap in place over the bite area, apply a splint, and continue the application of the pressure wrap. The purpose for the splint is to restrict the movement of the extremity, this along with the pressure wrap will aid in restricting the toxins from leaving the site of the bite.

- Seek medical attention immediately.

6.3.3 Poisonous Plants

Various plants which can cause allergic reactions may be encountered during field work. These include, poison ivy, poison oak, and poison sumac. Contact with these plants may occur when clearing vegetation for access to work areas, or as a result of movement through these plants. An irritating, allergic reaction can occur after direct contact with the plant or indirect contact through some piece of equipment or clothing article. Oils are transferred from the plant to exposed skin, clothing, or piece of equipment. The degree of the irritating, allergic reaction can vary significantly from one person to the next.

Protective measures to control and minimize the effects of this hazard may include, but not be limited to, the following:

- Identify plants for field personnel.
  - Poison Ivy - Characterized by climbing vines, three leaf configuration ovate to elliptical in shape, deep green leaves with a reddish tint, greenish flowers, and white berries.
  - Poison Sumac - Characterized as a tall bush of the sumac family bearing compound leaves (7-13 entire leaflets), branched from a central axis, drooping, with axillary clusters of white fruit: However, these white fruits and berries may exist only during pubescent stages.
  - Poison oak - Characterized as similar to poison ivy consisting of a shrub, stems erect, 0.3 to 2.0 meters tall, leaflets consist of broad thick lobes coarsely serrated configuration, denser at the base, less so than the top.
- Protective measures may include wearing disposable garments such as Tyvek when clearing brush. These may be carefully removed and disposed of along with any oils accumulated from the plants.
- Personal Hygiene - The oils obtained from the plants will only elicit an allergic response when the person's bare skin layer is contacted. This can be aggravated when skin pores are open (perspiring), or through breaks in the skin such as cuts, nicks, scratches, etc. This can also be accomplished when using excessively hot water for cleaning the skin, which also causes pores to open. Prior to

break time, lunchtime, etc. personnel should wash with cool water and soap to remove as much of the oils as possible. In heavily vegetated areas of these plants, additional measures including barrier creams and blocks may be used to prevent the oils from accessing and penetrating the skin.

These plants present an airborne sensitization hazard when burned. This is not to occur as part of this scope of work and therefore will not be addressed.

6.3.4 Inclement Weather

Project tasks under this Scope of Work will be performed outdoors and near water. As a result, inclement weather may be encountered. In the event that adverse weather conditions arise (electrical storms, hurricanes, etc.), the FOL and/or the SSO will be responsible for temporarily suspending or terminating activities until hazardous conditions no longer exist.

7.0 AIR MONITORING

Direct reading instruments will be used at the site to detect and evaluate the presence of site contaminants and other potentially hazardous conditions. As a result, specific air monitoring measures and requirements are established in Table 5-1 pertaining to the hazards and tasks of an identified operation. Additionally Section 1.0, the Health and Safety Guidance Manual contains detailed information regarding direct reading instrumentation, as well as general calibration procedures of various instruments.

7.1 INSTRUMENTS AND USE

Instruments will be used primarily to monitor source points and worker breathing zone areas while observing instrument action levels. Action levels are discussed in Table 5-1 as they may apply to a specific task or location.

7.1.1 Photoionization Detector and Flame Ionization Detector

To accurately monitor for any substances that may present an exposure potential to site personnel, a Photoionization Detector (PID) using a lamp energy of 11.7 electron volts (eV) or higher will be used. This instrument will be used to monitor potential source areas and to screen the breathing zones of employees during site activities. The PID has been selected because it is capable of detecting the organic vapors of concern (Note: A Flame Ionization Detector [FID] may be used as an alternative to the PID). This instrument will only detect the presence of ionizing contaminants. This instrument will not detect the explosive compounds and metals.

Before starting any field activities, the background levels of the site must be determined and noted. Daily background readings will be taken away from any areas of potential contamination. These readings, any influencing conditions (weather, temperature, humidity, etc.), and site location must be documented in the field operations logbook or other site documentation (e.g., sample log sheet).

7.1.2 Hazard Monitoring Frequency

Table 5-1 presents the frequencies in which hazard monitoring will be performed as well as the action levels that will initiate the use of elevated levels of protection. The SSO may decide to increase these frequencies based on instrument responses and site observations. The frequency in which monitoring is performed will not be reduced without the prior consent of the PHSO or HSM.

7.2 INSTRUMENT MAINTENANCE AND CALIBRATION

Hazard monitoring instruments will be maintained and pre-field calibrated by the TtNUS Equipment Manager. Operational checks and field calibration will be performed on the instruments each day before use. Field calibration will be performed on instruments according to manufacturer's recommendations (for example, the PID must be field calibrated daily and an additional field calibration must be performed at the end of each day to determine any significant instrument drift). These operational checks and calibration efforts will be performed in a manner that complies with the employees health and safety training, the manufacturer's recommendations, and with the applicable manufacturer SOP (copies of which can be found in the Health and Safety Guidance Manual that will be maintained onsite for reference). Calibration efforts must be documented. Figure 7-1 is provided for documenting these calibration efforts. This information may instead be recorded in a field operations logbook, provided that the information specified in Figure 7-1 is recorded. This required information includes the following:

- Date calibration was performed
- Individual calibrating the instrument
- Instrument name, model, and serial number
- Any relevant instrument settings and resultant readings (before and after) calibration
- Identification of the calibration standard (lot no., source concentration, supplier)
- Any relevant comments or remarks

FIGURE 7-1

DOCUMENTATION OF FIELD CALIBRATION

SITE NAME: _____ PROJECT NO.:_____

Date of Calibration	Instrument Name and Model	Instrument I.D. Number	Person Performing Calibration	Instrument Settings		Instrument Readings		Calibration Standard (Lot Number)	Remarks/ Comments
				Pre-Calibration	Post-Calibration	Pre-Calibration	Post-Calibration		

8.0 TRAINING/MEDICAL SURVEILLANCE REQUIREMENTS

8.1 INTRODUCTORY/REFRESHER/SUPERVISORY TRAINING

This section is included to specify health and safety training and medical surveillance requirements for both TtNUS and subcontractor personnel participating in site activities.

8.1.1 Requirements for TtNUS Personnel

TtNUS personnel must complete 40 hours of introductory hazardous waste site training prior to performing work at the IND-NSWC facility. Additionally, TtNUS personnel who have had introductory training more than 12 months prior to site work must have completed 8 hours of refresher training in the past 12 months before being cleared for site work. In addition, 8-hour supervisory training in accordance with 29 CFR 1910.120 (e)(4) will be required for site supervisory personnel.

Documentation of TtNUS introductory, supervisory, and refresher training as well as site-specific training will be maintained at the project. Copies of certificates or other official documentation will be used to fulfill this requirement.

8.1.2 Requirements for Subcontractors

TtNUS subcontractor personnel must have completed introductory hazardous waste site training or equivalent work experience as defined in OSHA Standard 29 CFR 1910.120 (e). Additionally, personnel who have had the introductory training more than 12 months ago, are required to have 8 hours of refresher training meeting the requirements of 29 CFR 1910.120 (e)(8) prior to performing field work at the IND-NSWC facility if required. TtNUS subcontractors must certify that each employee has had such training by sending TtNUS a letter, on company letterhead, containing the information in the example letter provided as in Figure 8-1 and by providing copies of certificates for subcontractor personnel participating in site activities.

FIGURE 8-1

OSHA TRAINING CERTIFICATION

The following statements must be typed on company letterhead and signed by an officer of the company and accompanied by copies of personnel training certificates:

LOGO
XYZ CORPORATION
555 E. 5th Street
Nowheresville, Kansas 55555

Month, day, year

Mr. Kim C. Turnbull
Project Manager
Tetra Tech NUS, Inc.
661 Andersen Drive
Pittsburgh, Pennsylvania 15220

Subject: HAZWOPER Training

Dear Mr. Turnbull:

As an officer of XYZ Corporation, I hereby state that I am aware of the potential hazardous nature of the subject project. I also understand that it is our responsibility to comply with the applicable occupational safety and health regulations, including those stipulated in Title 29 of the Code of Federal Regulations (CFR), Parts 1900 through 1910 and Part 1926.

I also understand that Title 29 CFR 1910.120, entitled "Hazardous Waste Operations and Emergency Response," requires appropriate level of training for certain employees engaged in hazardous waste operations. In this regard, I hereby state that the following employees have had 40 hours of introductory hazardous waste site training or equivalent work experience as requested by 29 CFR 1910.120(e) and have had 8 hours of refresher training as applicable and as required by 29 CFR 1910.120(e)(8) and that site supervisory personnel have had training in accordance with 29 CFR 1910.120(e)(4).

LIST FULL NAMES OF EMPLOYEES AND THEIR SOCIAL SECURITY NUMBERS HERE.

Should you have any questions, please contact me at (555) 555-5555

Sincerely,

(Name and Title of Company Officer)

Enclosed: Training Certificates

8.2 SITE-SPECIFIC TRAINING

TtNUS will provide site-specific training to TtNUS employees and subcontractor personnel who will perform work on this project. Site-specific training will also be provided to other personnel (U.S. Department of Defense, EPA, etc.) who may enter the site to perform functions that may or may not be directly related to site operations. Site-Specific training will include:

- Names of designated personnel and alternates responsible for site safety and health
- Safety, health, and other hazards present on site
- Use of personal protective equipment
- Safe use of engineering controls and equipment
- Medical surveillance requirements
- Signs and symptoms of overexposure
- Contents of the Health and Safety Plan
- Emergency response procedures (evacuation and assembly points)
- Incipient response procedures
- Review of the contents of relevant Material Safety Data Sheets
- Review of the use of Safe Work Permits

Site-specific documentation will be established through the use of Figure 8-2. Site personnel and visitors must sign this document upon receiving site-specific training.

8.3 MEDICAL SURVEILLANCE

8.3.1 Medical Surveillance Requirements for TtNUS Personnel

TtNUS personnel participating in project field activities will have had a physical examination meeting the requirements of TtNUS's medical surveillance program and will be medically qualified to perform hazardous waste site work using respiratory protection.

Documentation for medical clearances will be maintained in the TtNUS Pittsburgh office and made available, as necessary.

FIGURE 8-2

SITE-SPECIFIC TRAINING DOCUMENTATION

My signature below indicates that I am aware of the potential hazardous nature of performing remedial investigation activities at Indian Head Division, Naval Surface Warfare Center and that I have received site-specific training which included the elements presented below:

- Names of designated personnel and alternates responsible for site safety and health
- Safety, health, and other hazards present on site
- Use of personal protective equipment
- Safe use of engineering controls and equipment
- Medical surveillance requirements
- Signs and symptoms of overexposure
- Contents of the Health and Safety Plan
- Emergency response procedures (evacuation and assembly points)
- Incipient response procedures
- Review of the contents of relevant Material Safety Data Sheets
- Review of the use of Safe Work Permits

I have been given the opportunity to ask questions and my questions have been answered to my satisfaction. The dates of my training and medical surveillance indicated below are accurate.

Name (Printed and Signature)	Site-Specific Training Date	40-Hour Training (Date)	8-Hour Refresher Training (Date)	8-Hour Supervisory Training (Date)	Medical Exam

8.3.2 Medical Surveillance Requirements for Subcontractors

Subcontractors are required to obtain a certificate of their ability to perform hazardous waste site work and to wear respiratory protection. The "Subcontractor Medical Approval Form" provided in Figure 8-3 shall be used to satisfy this requirement, providing it is properly completed and signed by a licensed physician.

Subcontractors who have a company medical surveillance program meeting the requirements of paragraph (f) of OSHA 29 CFR 1910.120 can substitute "Subcontractor Medical Approval Form" (See Figure 8-3) with a letter, on company letterhead, containing the information in the example letter presented in Figure 8-4 of this HASP.

8.3.3 Requirements for Field Personnel

Each field team member (including subcontractors) and visitors entering the Exclusion Zone(s) shall be required to complete and submit a copy of Medical Data Sheet found in the TtNUS Health and Safety Guidance Manual. This shall be provided to the SSO, prior to participating in site activities. The purpose of this document is to provide site personnel and emergency responders with additional information that may be necessary in order to administer medical attention.

8.4 SUBCONTRACTOR EXCEPTIONS

Subcontractors who will not enter the Exclusion Zone during intrusive operations, and whose activities involve no potential for exposure to site contaminants, will not be required to meet the requirements for training/medical surveillance other than those stated for site-specific training (See Section 8.2).

FIGURE 8-3

SUBCONTRACTOR MEDICAL APPROVAL FORM

For employees of _____
Company Name

Participant Name: _____ Date of Exam: _____

Part A

The above-named individual has:

1. Undergone a physical examination in accordance with OSHA Standard 29 CFR 1910.120, paragraph (f), and was found to be medically -

   ( ) qualified to perform work at the IHDIV-NSWC Site 57 work site
   ( ) not qualified to perform work at the IHDIV-NSWC Site 57 work site

   and,

2. Undergone a physical examination in accordance with OSHA 29 CFR 1910.134(b)(10) and was found to be medically -

   ( ) qualified to wear respiratory protection
   ( ) not qualified to wear respiratory protection

3. My evaluation has been based on the following information, as provided to me by the employer.

   ( ) A copy of OSHA Standard 29 CFR 1910.120 and appendices.
   ( ) A description of the employee's duties as they relate to the employee's exposures.
   ( ) A list of known/suspected contaminants and their concentrations (if known).
   ( ) A description of any personal protective equipment used or to be used.
   ( ) Information from previous medical examinations of the employee that is not readily available to the examining physician.

Part B

I, _____, have examined _____
Physician's Name (print) Participant's Name (print)

and have determined the following information:

FIGURE 8-3
SUBCONTRACTOR MEDICAL APPROVAL FORM
PAGE TWO

1. Results of the medical examination and tests (excluding finding or diagnoses unrelated to occupational exposure):

   _____
   _____
   _____

2. Any detected medical conditions which would place the employee at increased risk of material impairment of the employee's health:

   _____
   _____
   _____

3. Recommended limitations upon the employee's assigned work:

   _____
   _____
   _____

I have informed this participant of the results of this medical examination and any medical conditions which require further examination of treatment.

Based on the information provided to me, and in view of the activities and hazard potentials involved at the IHDIV-NSWC Site 57 work site, this participant

( ) may
( ) may not

perform his/her assigned task.

Physician's Signature _____

Address _____

Phone Number _____

NOTE: Copies of test results are maintained and available at:

_____
Address

FIGURE 8-4

MEDICAL SURVEILLANCE LETTER

The following statements must be typed on company letterhead and signed by an officer of the company:

LOGO
XYZ CORPORATION
555 E. 5th Street
Nowheresville, Kansas 55555

Month, day, year

Mr. Kim C. Turnbull
Project Manager
Tetra Tech NUS, Inc.
Foster Plaza 7, 661 Andersen Drive
Pittsburgh, Pennsylvania 15220

Subject: Medical Surveillance for Indian Head Division - Naval Surface Warfare Center

Dear Mr. Turnbull:

As an officer of XYZ Corporation, I hereby state that the persons listed below participate in a medical surveillance program meeting the requirements contained in paragraph (f) of Title 29 of the Code of Federal Regulations (CFR), Part 1910.120, entitled "Hazardous Waste Operations and Emergency Response: Final Rule." I further state that the persons listed below have had physical examinations under this program within the past 12 months and that they have been cleared, by a licensed physician, to perform hazardous waste site work and to wear positive- and negative- pressure respiratory protection. I also state that, to my knowledge, no person listed below has any medical restriction that would preclude him/her from working at the IHDIV-NSWC Site 57 work site.

LIST FULL NAMES OF EMPLOYEES AND THEIR SOCIAL SECURITY NUMBERS HERE.

Should you have any questions, please contact me at (555) 555-5555.

Sincerely,

(Name and Title of Company Officer)

9.0 SITE CONTROL

This section outlines the means by which TtNUS will delineate work zones and use these work zones in conjunction with decontamination procedures to prevent the spread of contaminants into previously unaffected areas of the site. It is anticipated that a three-zone approach will be used during work at this site, including an Exclusion Zone, a Contamination Reduction Zone, and a Support Zone. It is also anticipated that this control measure will be used to control access to site work areas. Use of such controls will restrict the general public, minimize potentials for the spread of contaminants and to protect individuals who are not cleared to enter the work areas.

9.1 EXCLUSION ZONE

The Exclusion Zone will be considered those areas of the site of known or suspected contamination. It is not anticipated that significant amounts of surface contamination are in the proposed work areas of this site. It is anticipated that this will remain so until/unless contaminants are brought to the surface by intrusive activities. Furthermore, once such activities have been completed and surface contamination has been removed, the potential for exposure is again diminished and the area can then be reclassified as part of the Contamination Reduction Zone. Therefore, the Exclusion Zones for this project will be limited to those areas if the site where active work is being performed plus an established safety zone depending on the task for surface soils and wipe samples maintain a five foot radius surrounding the sample collection point.

9.2 CONTAMINATION REDUCTION ZONE

The Contamination Reduction Zone (CRZ) will be a buffer area between the Exclusion Zone and any area of the site where contamination is not suspected. This area will also serve as a focal point in supporting Exclusion Zone activities. This area will be delineated using barrier tape, cones, and postings to inform and direct facility personnel. Decontamination will be conducted at a central location. Equipment potentially contaminated will be bagged and taken to that location for decontamination.

9.3 SUPPORT ZONE

The Support Zone for this project will include a staging area where site vehicles will be parked, equipment will be unloaded, and where food and drink containers will be maintained. The Support Zones will be established at areas of the site where exposure to site contaminants would not be expected during normal working conditions or foreseeable emergencies.

9.4 SAFE WORK PERMITS

Exclusion Zone work conducted in support of this project will be performed using Safe Work Permits to guide and direct field crews on a task by task basis. An example of the Safe Work Permit to be used is illustrated in Figure 9-1. Partially completed Permits for the work to be performed are included in Attachment III. The daily meetings conducted at the site will further support these work permits. This effort will ensure site-specific considerations and changing conditions are incorporated into the planning effort. Permits will require the signature of the FOL and SSO. Use of these permits will provide the communication line for reviewing protective measures and hazards associated with each operation. This HASP will be used as the primary reference for selecting levels of protection and control measures. The work permit will take precedence over the HASP when more conservative measures are required based on specific site conditions.

FIGURE 9-1

SAFE WORK PERMIT

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope (To be filled in by person performing work)

I. Work limited to the following (description, area, equipment used): _____

II. Names: _____

III. Onsite Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required
Level D ☐ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
SAR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☐

Modifications/Exceptions: _____

V. Chemicals of Concern | Action Level(s) | Response Measures

VI. Additional Safety Equipment/Procedures

Hardhat	☐ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☐ No
Safety Glasses	☐ Yes	☐ No	Safety belt/harness	☐ Yes	☐ No
Chemical/splash goggles	☐ Yes	☐ No	Radio	☐ Yes	☐ No
Splash Shield	☐ Yes	☐ No	Barricades	☐ Yes	☐ No
Splash suits/coveralls	☐ Yes	☐ No	Gloves (Type)	☐ Yes	☐ No
Steel toe/shank Workboots	☐ Yes	☐ No	Work/rest regimen	☐ Yes	☐ No

Modifications/Exceptions: _____

VII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☐	☐
Procedure for safe job completion	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment inspected	☐	☐	Assembly points	☐	☐

VIII. Equipment Preparation

		Yes	NA
Utility Locating and Excavation Clearance completed	☐	☐	☐
Equipment and Foot Traffic Routes Cleared and Established	☐	☐	☐
Physical Hazards Barricaded and Isolated	☐	☐	☐
Emergency Equipment Staged	☐	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.) ☐ Yes ☐ No
If yes, fill out appropriate section(s) on safety work permit addendum

X. Special instructions, precautions: _____

Permit Issued by: _____ Permit Accepted by: _____
Job Completed by: _____ Date: _____

9.5 SITE VISITORS

Site visitors for the purpose of this document are identified as representing the following groups of individuals:

- Personnel invited to observe or participate in operations by TtNUS
- Regulatory personnel (DOD, OSHA, DEP, etc.)
- Northern Division Navy Personnel
- Other authorized visitors

It is not anticipated that this operation will result in a large number of site visitors. However, as some visitors can reasonably be expected, the following requirements will be enforced:

- Site visitors will be routed to the FOL, who will sign them in to the field logbook. Information to be recorded in the logbook will include the individual's name (proper identification required), who they represent, and purpose for the visit.

- Site visitors will be required to produce the necessary information supporting clearance onto the site. This includes information attesting to applicable training (40-hours of HAZWOPER training required for Northern Division Navy personnel) and medical surveillance, as stipulated in Section 8 of this document. In addition, to enter the site's operational zones during planned activities, visitors will be required to first go through site-specific training covering the topics stipulated in Section 8.2 of this document.

NOTE: Site visitors will be escorted while at the site.

Following this, the site visitor will be permitted to enter the site and applicable operational areas. Visitors are required to observe the protective equipment and site restrictions in effect at the area of their visit. Visitors not meeting the requirements as stipulated in this plan for site clearance will not be permitted to enter the site operational zones during planned activities. Any incidence of unauthorized site visitation will cause onsite activities to be terminated until that visitor can be removed. Removal of unauthorized visitors will be accomplished with support from the IHDIV – NSWC contact, if necessary.

9.6 SITE SECURITY

Site security will be accomplished using TtNUS field personnel. TtNUS will retain complete control over active operational areas. Exclusion Zone barriers, and any existing barriers at the site will be used to restrict the general public. The second line of security will take place at the work site referring interested

parties to the FOL or designee. The FOL will serve as a focal point for non-project interested parties, and serve as the final line of security and the primary enforcement contact.

9.7 SITE MAP

Once the areas of contamination, access routes, topography, and dispersion routes are determined, a site map will be generated and adjusted as site conditions change. When possible, these maps will be posted to illustrate up-to-date collection of contaminants and adjustment of zones and access points.

9.8 BUDDY SYSTEM

Personnel engaged in on-site activities will practice the "buddy system" to ensure the safety of personnel involved in this operation.

9.9 MATERIAL SAFETY DATA SHEET (MSDS) REQUIREMENTS

TtNUS and subcontractor personnel will provide MSDSs for the chemicals brought on site. The contents of these documents will be reviewed by the SSO with the user(s) of the chemical substances prior to any actual use or application of the substances on site. A chemical inventory of the chemicals used on site will be developed using the Health and Safety Guidance Manual. The MSDSs will then be maintained in a central location (i.e., temporary office) and will be available for anyone to review upon request.

9.10 COMMUNICATION

As personnel will be working in proximity to one another during field activities, a supported means of communication between field crews members will not be necessary. External communication will be accomplished by using the telephones at predetermined and approved locations. External communication will primarily be used for the purpose of resource and emergency resource communications. Prior to the commencement of activities, the FOL will determine and arrange for telephone communications.

10.0 SPILL CONTAINMENT PROGRAM

10.1 SCOPE AND APPLICATION

It is not anticipated that bulk hazardous materials (over 55-gallons) will be handled at any given time, or that any cylinders or containers will be unearthed, as part of this scope of work. It is also not anticipated that such spillage of Investigative Derived Wastes (IDW) would constitute a danger to human health or the environment. However, as the job progresses, the potential may exist for accumulating (IDW) such as decontamination fluids, soil cuttings, and purge and well development waters, in a central staging area. Once these fluids and other materials have been characterized, they can be removed from this area and properly disposed.

10.2 POTENTIAL SPILL AREAS

Potential spill areas will be periodically monitored in an ongoing attempt to prevent and control further potential contamination of the environment. Currently, limited areas are vulnerable to this hazard including:

- Resource deployment
- Waste transfer
- Central staging
- Concrete Coring Operations

It is anticipated that the IDW generated as a result of this scope of work will be containerized, labeled, and staged to await further analyses. The results of these analyses will determine the method of disposal.

10.3 LEAK AND SPILL DETECTION

During coring operations absorbent socks will be placed around coring location to contain water run-off.

To establish an early detection of potential spills or leaks, a periodic walk-around by the personnel staging or disposing of drums or in the resource deployment area will be conducted during working hours to visually determine that storage vessels are not leaking. If a leak is detected, the contents will be transferred, using a hand pump, into a new vessel. The leak will be collected and contained using absorbents such as Oil-Dry, vermiculite, or sand, which are stored at the vulnerable areas in a

conspicuously marked drum. This used material, too, will be containerized for disposal pending analysis. Inspections will be documented in the project logbook.

It is not anticipated that any cylinders or containers will be unearthed during site activities. Should a cylinder or container be uncovered, however, work will immediately be stopped and personnel will retreat to a safe area until directed by the FOL or SSO.

10.4 PERSONNEL TRAINING AND SPILL PREVENTION

Personnel will be instructed in the procedures for incipient spill prevention, containment, and collection of hazardous materials in the site-specific training. The FOL and the SSO will serve as the Spill Response Coordinators for this operation, should the need arise.

10.5 SPILL PREVENTION AND CONTAINMENT EQUIPMENT

The following represents the minimum equipment that may be maintained (depending on anticipated need) at the staging areas for the purpose of supporting this Spill Prevention/Containment Program.

- Sand; clean fill, vermiculite, or other non-combustible absorbent (Oil-dry)
- Drums (55-gallon U.S. DOT 17-E or 17-H)
- Shovels, rakes, and brooms
- Absorbent Socks (for water containment during coring operations

10.5.1 PPE for Spill Control

Minimal PPE for spill control will be employed as needed. These materials may include:

- Nitrile work and inner gloves
- Tyvek coveralls
- Hard Hat
- Steel toed shoes with neoprene boot covers

10.6 SPILL CONTROL PLAN

This section describes the procedures the TtNUS field crewmembers will use upon the detection of a spill or leak.

1. Notify the SSO or FOL immediately upon detection of a leak or spill. Activate emergency alerting procedures for that area to remove non-essential personnel.

2. Employ the personal protective equipment stored at the staging area. Take immediate actions to stop the leak or spill by plugging or patching the container or raising the leak to the highest point in the vessel. Spread the absorbent material in the area of the spill, covering it completely.

3. Transfer the material to a new vessel; collect and containerize the absorbent material. Label the new container appropriately. Await analyses for treatment and disposal options.

4. Re-containerize spills, including top cover impacted by the spill. Await test results for treatment or disposal options.

It is not anticipated that a spill will occur that the field crew cannot handle. Should this occur, notification of the appropriate Emergency Response agencies will be carried out by the FOL or SSO in accordance with the procedures discussed in Section 2.0 of this HASP.

11.0 CONFINED-SPACE ENTRY

Personnel under the provisions of this HASP are not allowed, under any circumstances, to enter confined spaces. A confined space is defined as an area that has one or more of the following characteristics:

- Is large enough and so configured that an employee can bodily enter and perform assigned work.
- Has limited or restricted means for entry or exit (for example, tanks, manholes, sewers, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry).
- Is not designed for continuous employee occupancy.

Additionally, a Permit-Required Confined Space may also have one or more of the following characteristics:

- Contains or has a potential to contain a hazardous atmosphere.
- Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly caving walls or by a floor that slopes downward and tapers to a smaller cross-section.
- Contains any other recognized, serious, safety or health hazard.

For further information on confined space operations, consult the Health and Safety Guidance Manual or call the HSM. Any activity that may be considered a confined-space entry shall require modifications of this HASP and shall result in the immediate notification of the Project Health and Safety Officer. This determination shall be made by the FOL and SSO.

12.0 MATERIALS AND DOCUMENTATION

The TtNUS FOL shall ensure the following materials/documents are taken to the project site and used when required.

- A complete copy of this HASP
- Health and Safety Guidance Manual
- Incident Reports
- Medical Data Sheets (multiple copies)
- Material Safety Data Sheets for the chemicals brought on site, including decon solutions, fuels, lime, sample preservatives, calibration gases, etc.
- A full-size OSHA Job Safety and Health Poster (See Attachment VI)
- Training/Medical Surveillance Documentation Form (Blank) (multiple copies)
- Emergency Reference Information (Section 2.0, extra copy for posting)

12.1 MATERIALS TO BE POSTED OR MAINTAINED AT THE SITE

The following documentation is to be posted or maintained at the site for quick reference purposes. In situations where posting of these documents is not feasible (such as no office trailer), these documents should be filed in a transportable file container and immediately accessible. The file should remain in the FOL's possession.

Chemical Inventory Listing (posted) - This list represents the chemicals brought on site, including decontamination solutions, sample preservatives, fuel, calibration gases, etc.. This list should be posted in a central area.

Material Safety Data Sheets (MSDSs) (maintained) - The MSDSs should also be in a central area accessible to site personnel. These documents should match the listings on the chemical inventory list for

substances employed on site. It is acceptable to have these documents within a central folder and the chemical inventory as the table of contents.

The OSHA Job Safety & Health Protection Poster (posted) - This poster, as directed by 29 CFR 1903.2 (a)(1), should be conspicuously posted in places where notices to employees are normally posted. Each FOL shall ensure that this poster is not defaced, altered, or covered by other material. See Attachment VII of this HASP.

Site Clearance (maintained) - This is found within the training section of the HASP (See Figure 8-1). This list identifies site personnel, dates of training (including site-specific training), and medical surveillance and indicates not only clearance but also status. If personnel do not meet these requirements, they do not enter the site while site personnel are engaged in activities.

Emergency Phone Numbers and Directions to the Hospital(s) (maintained) - This list of emergency numbers and hospital directions will be maintained at phone communications points and in each site vehicle.

Medical Data Sheets/Cards (maintained) - Medical Data Sheets will be filled out by onsite personnel and filed in a central location. The Medical Data Sheet will accompany any injury or illness requiring medical attention to the medical facility. A copy of this sheet or a wallet card will be given to personnel to be carried on their person.

Investigative Derived Waste Inventory Log (maintained) – The FOL and/or the SSO shall log collected containers of IDW. An updated inventory will be submitted to the Base POC at the termination of each shift.

13.0 GLOSSARY

ACGIH	American Conference of Governmental Industrial Hygienists
CFR	Code of Federal Regulations
CIH	Certified Industrial Hygienist
CNS	Central Nervous System
CRZ	Contamination Reduction Zone
CSE	Confined Space Entry
CSP	Certified Safety Professional
CTO	Contract Task Order
dBA	Decibels average
DOD	Department of Defense
DOT	Department of Transportation
EPA	Environmental Protection Agency
eV	electron Volts
FID	Flame Ionization Detector
FOL	Field Operations Leader
HASP	Health and Safety Plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HEPA	High Efficiency Particulate Air
HRC	Hydrogen Release Compound
HSM	Health and Safety Manager
IHDIV – NSWC	Indian Head Division – Naval Surface Warfare Center
IDW	Investigative Derived Waste
LEL	Lower Explosive Limit
MSDS	Material Safety Data Sheet
N/A	Not Available
NIOSH	National Institute Occupational Safety and Health
OSHA	Occupational Safety and Health Administration (U.S. Department of Labor)
PAH	Polynuclear Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PE	Professional Engineer
PEL	Permissible Exposure Limit
PHSO	Project Health and Safety Officer
PID	Photo Ionization Detector
PM	Project Manager
PPE	Personal Protective Equipment

PVC	Poly Vinyl Chloride
RAC	Remedial Action Contractor
SOP	Standard Operating Procedure
SSO	Site Safety Officer
STEL	Short Term Exposure Limit
TBD	To Be Determined
TCE	Trichloroethylene
TPH	Total Petroleum Hydrocarbons
TtNUS	Tetra Tech NUS, Inc.
TWA	Time Weighted Average
UEL	Upper Explosive Limit
UST	Underground Storage Tank
UV	Ultraviolet

ATTACHMENT I

INJURY/ILLNESS PROCEDURE AND REPORT FORM

TETRA TECH, INC.

ACCIDENT AND ILLNESS INVESTIGATION REPORT

To: _____
Subsidiary Health and Safety Representative

cc: _____
Workers Compensation Administrator

Project name: _____

Project number: _____

Prepared by: _____

Position: _____

Office: _____

Telephone number: _____

Fax number: _____

Information Regarding Injured or Ill Employee

Name: _____ Office: _____

Home address: _____ Gender: M ☐ F ☐ No. of dependents: _____

_____ Marital status: _____

Home telephone number: _____ Date of birth: _____

Occupation (regular job title): _____ Social security number: _____

Department: _____

Date of Accident: _____ **Time of Accident:** _____ a.m. ☐ p.m. ☐

Time Employee Began Work: _____ ☐ Check if time cannot be determined

Location of Incident

Street address: _____

City, state, and zip code: _____

County: _____

Was place of accident or exposure on employer's premises? Yes ☐ No ☐

Information About the Incident

What was the employee doing just before the incident occurred? Describe the activity as well as the tools, equipment, or material the employee was using. Be specific. Examples: "Climbing a ladder while carrying roofing materials"; "Spraying chlorine from hand sprayer"; "Daily computer key-entry"

What Happened? Describe how the injury occurred. Examples: "When ladder slipped on wet floor, worker fell 20 feet"; "Worker was sprayed with chlorine when gasket broke during replacement"; "Worker developed soreness in wrist over time"

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

TETRA TECH, INC.

ACCIDENT AND ILLNESS INVESTIGATION REPORT (Continued)

Information About the Incident (Continued)

What was the injury or illness? Describe the part(s) of the body affected and how it was affected. Be more specific than "hurt," "pain," or "sore." Examples "Strained back"; "Chemical burn, right hand"; "Carpal tunnel syndrome, left wrist"

Describe the Object or Substance that Directly Harmed the Employee: Examples: "Concrete floor"; "Chlorine"; "Radial arm saw." If this question does not apply to the incident, write "Not applicable."

Did the employee die? Yes ☐ No ☐ Date of death: _____

Was employee performing regular job duties? Yes ☐ No ☐

Was safety equipment provided? Yes ☐ No ☐ Was safety equipment used? Yes ☐ No ☐

Note: Attach any police reports or related diagrams to this report.

Witness (Attach additional sheets for other witnesses.)

Name: _____

Company: _____

Street address: _____

City: _____ State: _____ Zip code: _____

Telephone number: _____

Medical Treatment Required? ☐ Yes ☐ No ☐ First aid only

Name of physician or health care professional: _____

If treatment was provided away from the work site, provide the information below.

Facility name: _____

Street address: _____

City: _____ State: _____ Zip code: _____

Telephone number: _____

Was the employee treated in an emergency room? ☐ Yes ☐ No

Was the employee hospitalized over night as an in-patient? ☐ Yes ☐ No

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

TETRA TECH, INC.

ACCIDENT AND ILLNESS INVESTIGATION REPORT (Continued)

Corrective Action(s) Taken by Unit Reporting the Accident:

Corrective Action Still to be Taken (by whom and when):

Name of Tetra Tech employee the injury or illness was first reported to: _____

Date of Report: _____ **Time of Report:** _____

I have reviewed this investigation report and agree, to the best of my recollection, with its contents.

_____ _____

Printed Name of Injured Employee | Telephone Number

_____ _____

Signature of Injured Employee | Date

The signatures provided below indicate that appropriate personnel have been notified of the incident.

Title	Printed Name	Signature	Telephone Number	Date
Office Manager				
Project Manager				
Site Safety Coordinator or Office Health and Safety Representative				

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

TETRA TECH, INC.

ACCIDENT AND ILLNESS INVESTIGATION REPORT (Continued)

To Be Completed by the Subsidiary Health and Safety Representative

Classification of Incident:

☐ Injury ☐ Illness

Result of Incident:

☐ First aid only

☐ Days away from work

☐ Remained at work but incident resulted in job transfer or work restriction

☐ Incident involved days away and job transfer or work restriction

☐ Medical treatment only

No. of days away from work _____

Date employee left work _____

Date employee returned to work _____

No. of days placed on restriction or job transfer: _____

OSHA Recordable Case Number _____

To Be Completed by Human Resources

Social security number: _____

Date of hire: _____ Hire date for current job: _____

Wage information: $ _____ per ☐ Hour ☐ Day ☐ Week ☐ Month

Position at time of hire: _____

Current position: _____ Shift hours: _____

State in which employee was hired: _____

Status: ☐ Full-time ☐ Part-time Hours per week: _____ Days per week: _____

Temporary job end date: _____

To Be Completed during Report to Workers Compensation Carrier

Date reported: _____ Reported by: _____

Confirmation number: _____

Name of contact: _____

Field office of claims adjuster: _____

This form contains information relating to employee health and must be used in a manner that protects the confidentiality of the employee to the extent possible while the information is being used for occupational safety and health purposes.

ATTACHMENT II

MEDICAL DATA SHEET

MEDICAL DATA SHEET

This Medical Data Sheet must be completed by all on-site personnel and kept in the command post during the conduct of site operations. This data sheet will accompany any personnel when medical assistance is needed or if transport to hospital facilities is required.

Project _____

Name _____ Home Telephone _____

Address _____

Age _____ Height _____ Weight _____

Name of Next Kin _____

Drug or other Allergies _____

Particular Sensitivities _____

Do You Wear Contacts? _____

Provide a Checklist of Previous Illnesses or Exposure to Hazardous Chemicals _____

_____

_____

What medications are you presently using? _____

_____

_____

Do you have any medical restrictions? _____

_____

_____

_____

Name, Address, and Phone Number of personal physician: _____

_____

_____

I am the individual described above. I have read and understand this HASP.

_____ _____

Signature Date

ATTACHMENT III

SAFE WORK PERMITS

SAFE WORK PERMIT FOR
MOBILIZATION AND DEMOBILIZATION
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Mobilization and Demobilization of equipment and supplies.

II. Required Monitoring Instrument(s): None anticipated

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
PAPR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants and safety shoes. Hard hats and safety glasses when working around machinery or other conditions which present eye or overhead hazards. Hearing protection will be worn when working near operating equipment, reflective vest When working near vehicular traffic or when required by the SSO.

VI.

Chemicals of Concern	Action Level(s)	Response Measures
None anticipated	Refer to Manufacturer's	
Refer to MSDS for any	MSDS	
Chemicals brought on-site		

VII. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☐ No
Safety Glasses	☐ Yes	☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes	☒ No	Radio	☐ Yes	☒ No
Splash Shield	☐ Yes	☒ No	Barricades	☐ Yes	☒ No
Splash suits/coveralls	☐ Yes	☐ No	Gloves (Type - Nitrile)	☐ Yes	☒ No
Steel toe Work shoes or boots	☒ Yes	☐ No	Work/rest regimen	☐ Yes	☒ No

Modifications/Exceptions: Reflective vests for high traffic areas.

VIII.

Procedure review with permit acceptors	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☐	☐
Procedure for safe job completion	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment/PPE inspected	☐	☐	Assembly points	☐	☐

IX.

Site Preparation	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☒
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐	☒
Physical Hazards Barricaded and Isolated	☐	☐	☒
Emergency Equipment Staged	☐	☐	☒

X. Additional Permits required (Hot work, confined space entry, excavation etc.). ☐ Yes ☐ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

XI. Special instructions, precautions: _____

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT FOR
MULTI-MEDIA SAMPLING
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Multi-media sampling including groundwater, soils and IDW. Well abandonment and field measurements including water-level measurements, PID/FID screening.

II. Required Monitoring Instrument(s): PID with 11.7 eV lamp or a FID

III. Field Crew: _____

IV. On-site Inspection conducted ☒ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
PAPR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants, safety shoes, surgical style gloves, and safety glasses. Nitrile gloves when saturated soils are handled. Hard hats and hearing protection will be worn when working near operating equipment or when required by the SSO

VI.

Chemicals of Concern	Action Level(s)	Response Measures
TCE, 1,2-DCE and	if > 25 ppm in worker BZ	Retreat to an unaffected area.
Methylene chloride		Return when levels return to
		<25 ppm in worker BZ

VII. Additional Safety Equipment/Procedures

Hard-hat	☒ Yes ☐ No		Hearing Protection (Plugs/Muffs)	☐ Yes	☐ No
Safety Glasses	☒ Yes ☐ No		Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes ☒ No		Radio	☐ Yes	☒ No
Splash Shield	☐ Yes ☒ No		Barricades	☐ Yes	☒ No
Splash suits/coveralls	☐ Yes ☐ No		Gloves (Type - Nitrile)	☒ Yes	☐ No
Steel toe Work shoes or boots	☒ Yes ☐ No		Work/rest regimen	☐ Yes	☒ No

Modifications/Exceptions: Reflective vests for high traffic areas. Tyvek coverall if there is a potential for soiling work cloths. SSO may dictate double-layering gloves.

VIII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☐	☐
Procedure for safe job completion	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment/PPE inspected	☐	☐	Assembly points	☐	☐

IX. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☒	☐	☐
Vehicle and Foot Traffic Routes Cleared and Established	☒	☐	☐
Physical Hazards Barricaded and Isolated	☒	☐	☐
Emergency Equipment Staged	☒	☐	☐

X. Additional Permits required (Hot work, confined space entry, excavation etc.) ☐ Yes ☐ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

XI. Special instructions, precautions: Minimize contact with saturated soils.

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT FOR
SOIL BORING AND DPT WELL INSTALLATION AND ABANDONMENT
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Installation and abandonment of temporary DPT monitoring wells and associated activities.

II. Required Monitoring Instrument(s): PID or FID

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
PAPR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants, safety shoes, surgical style gloves, and safety glasses. Nitrile gloves when saturated soils are handled. Hard hats and hearing protection will be worn when working near operating equipment or when required by the SSO.

VI. Chemicals of Concern	Action Level(s)	Response Measures
TCE, 1,2-DCE and	if > 25 ppm in worker BZ	retreat to an unaffected area.
Methlyene chloride		return when levels fall to
		< 25 ppm in breathing zone

VII. Additional Safety Equipment/Procedures

Hard-hat	☒ Yes ☐ No		Hearing Protection (Plugs/Muffs)	☒ Yes ☐ No	
Safety Glasses	☒ Yes ☐ No		Safety belt/harness	☐ Yes ☒ No	
Chemical/splash goggles	☐ Yes ☒ No		Radio	☐ Yes ☒ No	
Splash Shield	☐ Yes ☒ No		Barricades	☐ Yes ☒ No	
Splash suits/coveralls	☐ Yes ☐ No		Gloves (Type - Nitrile)	☒ Yes ☐ No	
Steel toe Work shoes or boots	☒ Yes ☐ No		Work/rest regimen	☐ Yes ☒ No	

Modifications/Exceptions: Reflective vests for high traffic areas. Tyvek coverall if there is a potential for soiling work cloths. Leather work gloves when handling probes or other equipment presenting a pinch point. SSO may require double-layering gloves.

VIII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☐	☐
Procedure for safe job completion	☐	☐	Evacuation routes	☐	☐
Contractor tools/equipment/PPE inspected	☐	☐	Assembly points	☐	☐

IX. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☒	☐	☐
Vehicle and Foot Traffic Routes Cleared and Established	☒	☐	☐
Physical Hazards Barricaded and Isolated	☒	☐	☐
Emergency Equipment Staged	☒	☐	☐

X. Additional Permits required (Hot work, confined space entry, excavation etc.) ☐ Yes ☐ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

XI. Special instructions, precautions: _____

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT FOR
HYDROGEN RELEASE COMPOUND (HRC) HANDLING
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): HRC handling and injection

II. Required Monitoring Instrument(s): PID with 11.7 eV lamp or FID

III. Field Crew: _____

IV. On-site Inspection conducted ☒ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. Protective equipment required
Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
PAPR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants, safety shoes, inner and outer gloves, and safety glasses. Hard hats and hearing protection when required near DPT rig.

VI.

Chemicals of Concern	Action Level(s)	Response Measures
TCE, 1,2-DCE and Methylene chloride	if > 25 ppm in worker BZ	Retreat to an unaffected area, return when levels return to < 25ppm in worker BZ.
HRC	if spilled	Avoid incompatibles and clean area.

VII. Additional Safety Equipment/Procedures

Hard-hat	☒ Yes ☐ No		Hearing Protection (Plugs/Muffs)	☐ Yes	☒ No
Safety Glasses	☐ Yes ☒ No		Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☒ Yes ☐ No		Radio	☐ Yes	☒ No
Splash Shield	☒ Yes ☐ No		Barricades	☐ Yes	☒ No
Splash suits/coveralls	☐ Yes ☐ No		Gloves (Type – Nitrile&Vinyl)	☒ Yes	☐ No
Steel toe Work shoes or boots	☒Yes ☐ No		Work/rest regimen	☐ Yes	☒ No

Modifications/Exceptions: Avoid skin contact wear tyvek coverall if there is a potential for soiling work cloths. Wear nitrile inner gloves and vinyl or rubber outer gloves when handling HRC.

VIII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☒	☐	Emergency alarms	☒	☐
Procedure for safe job completion	☒	☐	Evacuation routes	☐	☒
Contractor tools/equipment/PPE inspected	☒	☐	Assembly points	☐	☒

IX. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☒	☐	☐
Vehicle and Foot Traffic Routes Cleared and Established	☒	☐	☐
Physical Hazards Barricaded and Isolated	☒	☐	☐
Emergency Equipment Staged	☒	☐	☐

X. Additional Permits required (Hot work, confined space entry, excavation etc.) ☐ Yes ☐ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

XI. Special instructions, precautions: Carefully read manufacturers instructions and plan out work activities prior to beginning work.

Permit Issued by:_____ Permit Accepted by:_____

SAFE WORK PERMIT FOR
DECONTAMINATION ACTIVITIES
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Decontamination of sampling equipment and machinery (i.e., drill rigs, augers). Brushes and spray bottles will be used to decon small sampling equipment. Pressure washers or steam cleaning units will be used to decon the drilling equipment.

II. Required Monitoring Instrument(s): PID with 11.7 eV lamp source or FID (used to screen equipment)

III. Field Crew: _____

IV. On-site Inspection conducted ☐ Yes ☐ No Initials of Inspector _____ _____
TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

IV. Protective equipment required

Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
SAR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: Minimum requirement include sleeved shirt and long pants, safety glasses, safety footwear, and nitrile gloves. When using pressure washers, field crews will also wear hearing protection, and face shields. Coveralls and boot covers are at the SSO's discretion.

V.

Chemicals of Concern	Action Level(s)	Response Measures
TCE, 1,2-DCE and	if > 25 ppm in worker BZ	Retreat to an unaffected area.
Methylene chloride		Return when levels return to
		< 25ppm in worker BZ

VI. Additional Safety Equipment/Procedures

Hard-hat	☒ Yes	☐ No	Hearing Protection (Plugs/Muffs)	☒ Yes	☐ No
Safety Glasses	☒ Yes	☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes	☒ No	Radio	☐ Yes	☒ No
Splash Shield	☒ Yes	☐ No	Barricades	☐ Yes	☒ No
Splash suits/coveralls	☐ Yes	☐ No	Gloves (Type - Nitrile)	☒ Yes	☐ No
Steel toe Work shoes or boots	☒ Yes	☐ No	Work/rest regimen	☐ Yes	☐ No

Modifications/Exceptions: PVC rain suits or PE or PVC coated Tyvek may be required (at the SSO's discretion) for protection against splashes and overspray. Chemical resistant boot covers if excessive liquids are generated or to protected footwear.

VII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☐	Emergency alarms	☐	☐
Procedure for safe job completion	☐	☒	Evacuation routes	☐	☐
Contractor tools/equipment/PPE inspected	☐	☐	Assembly points	☐	☐

VIII. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☒
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐	☒
Physical Hazards Barricaded and Isolated	☐	☐	☒
Emergency Equipment Staged	☒	☐	☐

IX. Additional Permits required (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

X. Special instructions, precautions: If decontamination solvents are used (such as isopropyl alcohol, methanol, etc.), consult appropriate MSDS and container labels. Avoid or control visible dust clouds. To minimize the potential for exposure, site personnel will use PPE and prevent contact with potentially contaminated equipment..

Permit Issued by: _____ Permit Accepted by: _____

SAFE WORK PERMIT FOR
SURVEYING ACTIVITIES
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Permit No. _____ Date: _____ Time: From _____ to _____

SECTION I: General Job Scope

I. Work limited to the following (description, area, equipment used): Geographical surveys

II. Required Monitoring Instruments: None

III. Field Crew: _____

IV. On-site Inspection conducted ☒ Yes ☐ No Initials of Inspector _____ TtNUS

SECTION II: General Safety Requirements (To be filled in by permit issuer)

V. Protective equipment required

Level D ☒ Level B ☐
Level C ☐ Level A ☐
Detailed on Reverse

Respiratory equipment required

Full face APR	☐	Escape Pack	☐
Half face APR	☐	SCBA	☐
SAR	☐	Bottle Trailer	☐
Skid Rig	☐	None	☒

Modifications/Exceptions: Minimum requirements include sleeved shirt and long pants and safety footwear. Safety glasses, hard hats, and hearing protection will be worn when working near operating equipment.

VI.

Chemicals of Concern	Action Level(s)	Response Measures
None anticipated given the nature of surveying activities and limited contact w/ media.	None	

VII. Additional Safety Equipment/Procedures

Hard-hat	☐ Yes ☐ No	Hearing Protection (Plugs/Muffs)	☐ Yes	☒ No
Safety Glasses	☐ Yes ☐ No	Safety belt/harness	☐ Yes	☒ No
Chemical/splash goggles	☐ Yes ☒ No	Radio	☐ Yes	☒ No
Splash Shield	☐ Yes ☒ No	Barricades	☐ Yes	☒ No
Splash suits/coveralls	☐ Yes ☒ No	Gloves (Type - Work)	☐ Yes	☐ No
Steel toe Work shoes or boots	☐ Yes ☐ No	Work/rest regimen	☐ Yes	☒ No

Modifications/Exceptions: Tyvek coverall to protect against natural hazards (e.g., ticks). In high traffic areas wear high visibility vests.

VIII. Procedure review with permit acceptors

	Yes	NA		Yes	NA
Safety shower/eyewash (Location & Use)	☐	☒	Emergency alarms	☒	☐
Procedure for safe job completion	☐	☒	Evacuation routes	☒	☐
Contractor tools/equipment/PPE inspected	☐	☒	Assembly points	☒	☐

IX. Site Preparation

	Yes	No	NA
Utility Locating and Excavation Clearance completed	☐	☐	☒
Vehicle and Foot Traffic Routes Cleared and Established	☐	☐	☒
Physical Hazards Barricaded and Isolated	☐	☐	☒
Emergency Equipment Staged	☐	☐	☒

X. Additional Permits required (Hot work, confined space entry, excavation etc.). ☐ Yes ☒ No
If yes, complete permit required or contact Health Sciences, Pittsburgh Office

XI. Special instructions, precautions: Preview work locations to identify potential hazards (slips, trips, and falls, natural hazards, etc.) Avoid potential nesting areas. Wear light colored clothing so that ticks and other biting insects can be easily visible and can be removed. Inspect clothing and body for ticks. Minimize contact with potentially contaminated media. Suspend site activities in the event of inclement weather.

Permit Issued by: _____ Permit Accepted by: _____

ATTACHMENT IV

SOP FOR UTILITY LOCATING AND EXCAVATION CLEARANCE

TETRA TECH NUS, INC.	STANDARD OPERATING PROCEDURES	Number HS-1.0	Page 1 of 11
		Effective Date 03/00	Revision 1
		Applicability Tetra Tech NUS, Inc.	
		Prepared Health & Safety	
Subject UTILITY LOCATING AND EXCAVATION CLEARANCE		Approved D. Senovich	

TABLE OF CONTENTS

SECTION **PAGE**

1.0 PURPOSE 2

2.0 SCOPE 2

3.0 GLOSSARY 2

4.0 RESPONSIBILITIES 2

5.0 PROCEDURES 3

5.1 BURIED UTILITIES 3
5.2 OVERHEAD POWER LINES 4

6.0 UNDERGROUND LOCATING TECHNIQUES 5

6.1 GEOPHYSICAL METHODS 5
6.2 PASSIVE DETECTION SURVEYS 6
6.3 INTRUSIVE DETECTION SURVEYS 6

7.0 INTRUSIVE ACTIVITIES SUMMARY 7

8.0 REFERENCES 7

ATTACHMENTS

1 Listing of Underground Utility Clearance Resources 8
2 Frost Line Penetration Depths by Geographic Location 10
3 Utility Clearance Form 11

1.0 PURPOSE

Utilities such as electric service lines, natural or propane gas lines, water and sewage lines, telecommunications, and steam lines are very often in the immediate vicinity of work locations. Contact with underground or overhead utilities can have serious consequences including employee injury/fatality, property and equipment damage, substantial financial impacts, and loss of utility service to users.

The purpose of this procedure is to provide minimum requirements and technical guidelines regarding the appropriate procedures to be followed when performing subsurface and overhead utility locating services. It is the policy of Tetra Tech NUS, Inc. (TtNUS) to provide a safe and healthful work environment for the protection of our employees. The purpose of this Standard Operating Procedure (SOP) is to aid in achieving the objectives of the TtNUS Utility Locating and Clearance Policy. The TtNUS Utility Locating and Clearance Policy must be reviewed by anyone potentially involved with underground or overhead utility services.

2.0 SCOPE

This procedure applies to all TtNUS field activities where there may be potential contact with underground or overhead utilities. This procedure provides a description of the principles of operation, instrumentation, applicability, and implementability of typical methods used to determine the presence or absence of utility services. This procedure is intended to assist with work planning and scheduling, resource planning, field implementation, and subcontractor procurement. Utility locating and excavation clearance requires site-specific information prior to the development of detailed operating procedures. This guidance is not intended to provide a detailed description of methodology and instrument operation. Specialized expertise during both planning and execution of several of the geophysical methods may also be required.

3.0 GLOSSARY

Electromagnetic Induction (EMI) Survey - A geophysical exploration method whereby electromagnetic fields are induced in the ground and the resultant secondary electromagnetic fields are detected as a measure of ground conductivity.

Magnetometer – A device used for precise and sensitive measurements of magnetic fields.

Magnetic Survey – A geophysical survey method that depends on detection of magnetic anomalies caused by the presence of buried ferromagnetic objects.

Metal Detection – A geophysical survey method that is based on electromagnetic coupling caused by underground conductive objects.

Vertical Gradiometer – A magnetometer equipped with two sensors that are vertically separated by a fixed distance. It is best suited to map near surface features and is less susceptible to deep geologic features.

Ground Penetrating Radar – Ground Penetrating Radar (GPR) involves specialized radar equipment whereby a signal is sent into the ground via a transmitter. Some portion of the signal will be reflected from the subsurface material, which is then recorded with a receiver and electronically converted into a graphic picture.

4.0 RESPONSIBILITIES

Project Manager (PM)/Task Order Manager (TOM) - Responsible for ensuring that all field activities are conducted in accordance with this procedure and the TtNUS Utility Locating and Clearance Policy.

Site Manager (SM)/Field Operations Leader (FOL) - Responsible for the onsite verification that all field activities are performed in compliance with approved SOPs or as otherwise directed by the approved project plan(s).

Site Health & Safety Officer (SHSO) – Responsible to provide technical assistance and verify full compliance with this SOP and the TtNUS Utility Locating and Clearance Policy. The SHSO is also responsible for reporting any deficiencies to the Corporate Health and Safety Manager (HSM) and to the PM/TOM.

Health & Safety Manager (HSM) – Responsible for preparing, implementing, and modifying corporate health and safety policy.

Site Personnel – Responsible for understanding and implementing this SOP and the TtNUS Utility Locating and Clearance Policy.

5.0 PROCEDURES

This procedure addresses the requirements and technical procedures that must be performed to minimize the potential for contact with underground and overhead utility services. These procedures are addressed individually from a buried and overhead standpoint.

5.1 Buried Utilities

Buried utilities present a heightened concern because their location is not typically obvious by visual observation, and it is common that their presence and/or location is unknown or incorrectly known on client properties. The following procedure must be followed prior to beginning any excavation that might potentially be in the vicinity of underground utility services. In addition, the Utility Clearance Form (Attachment 3) must be completed for every location or cluster of locations where intrusive activities will occur.

Where the positive identification and de-energizing of underground utilities cannot be obtained and confirmed using the following steps, the PM/TOM is responsible for arranging for the procurement of a qualified, experienced, utility locating subcontractor who will accomplish the utility location and demarcation duties specified herein.

1. A comprehensive review must be made of any available property maps, blue lines, or as-builts prior to site activities. Interviews with local personnel familiar with the area should be performed to provide additional information concerning the location of potential underground utilities. Information regarding utility locations shall be added to project maps upon completion of this exercise.

2., A visual site inspection must be performed to compare the site plan information to actual field conditions. Any findings must be documented and the site plan/maps revised. The area(s) of proposed excavation or other subsurface activities must be marked at the site in white paint or pin flags to identify those locations of the proposed intrusive activities. The site inspection should focus on locating surface indications of potential underground utilities. Items of interest include the presence of nearby area lights, telephone service, drainage grates, fire hydrants, electrical service vaults/panels, asphalt/concrete scares and patches, and topographical depressions. Note the location of any emergency shut off switches. Any additional information regarding utility locations shall be added to project maps upon completion of this exercise and returned to the PM/TOM.

3. If the planned work is to be conducted on private property (e.g., military installations, manufacturing facilities, etc.) the FOL must identify and contact appropriate facility personnel (e.g., public works or facility engineering) before any intrusive work begins to inquire about (and comply with) property owner requirements. It is important to note that private property owners may require several days to several weeks advance notice prior to locating utilities.

4. If the work location is on public property, the state agency that performs utility clearances must be notified (see Attachment 1). State "one-call" services must be notified prior to commencing fieldwork per their requirements. Most one-call services require, by law, 48- to 72-hour advance notice prior to beginning any excavation. Such services typically assign a "ticket" number to the particular site. This ticket number must be recorded for future reference and is valid for a specific period of time, but may be extended by contacting the service again. The utility service will notify utility representatives who then mark their respective lines within the specified time frame. It should be noted that most military installations own their own utilities but may lease service and maintenance from area providers. Given this situation, "one call" systems may still be required to provide location services on military installations.

5. Utilities must be identified and their locations plainly marked using pin flags, spray paint, or other accepted means. The location of all utilities must be noted on a field sketch for future inclusion on project maps. Utility locations are to be identified using the following industry-standard color code scheme, unless the property owner or utility locator service uses a different color code:

white	excavation/subsurface investigation location
red	electrical
yellow	gas, oil, steam
orange	telephone, communications
blue	water, irrigation, slurry
green	sewer, drain

6. Where utility locations are not confirmed with a high degree of confidence through drawings, schematics, location services, etc., the work area must be thoroughly investigated prior to beginning the excavation. In these situations, utilities must be identified using such methods as passive and intrusive surveys, physical probing, or hand augering. Each method has advantages and disadvantages including complexity, applicability, and price. It also should be noted that in many states, initial excavation is required by hand to a specified depth.

7. At each location where trenching or excavating will occur using a backhoe or other heavy equipment, and where utility identifications and locations cannot be confirmed prior to groundbreaking, the soil must be probed with a hand auger or pole (tile probe) made of non-conductive material. If these efforts are not successful in clearing the excavation area of suspect utilities, hand shoveling must be performed for the perimeter of the intended excavation.

8. All utilities uncovered or undermined during excavation must be structurally supported to prevent potential damage. Unless necessary as an emergency corrective measure, TtNUS shall not make any repairs or modifications to existing utility lines without prior permission of the utility owner, property owner, and Corporate HSM. All repairs require that the line be locked-out/tagged-out prior to work.

5.2 Overhead Power Lines

If it is necessary to work within the minimum clearance distance of an overhead power line, the overhead line must be de-energized and grounded, or re-routed by the utility company or a registered electrician. If protective measures such as guarding, isolating, or insulating are provided, these precautions must be

adequate to prevent employees from contacting such lines directly with any part of their body or indirectly though conductive materials, tools, or equipment.

The following table provides the required minimum clearances for working in proximity to overhead power lines.

Nominal Voltage	Minimum Clearance
0 -50 kV	10 feet, or one mast length; whichever is greater
50+ kV	10 feet plus 4 inches for every 10 kV over 50 kV or 1.5 mast lengths; whichever is greater

6.0 UNDERGROUND LOCATING TECHNIQUES

6.1 Geophysical Methods

Geophysical methods include electromagnetic induction, magnetics, and ground penetrating radar. Additional details concerning the design and implementation of electromagnetic induction, magnetics, and ground penetrating radar surveys can be found in one or more of the TtNUS SOPs included in the References (Section 8.0).

Electromagnetic Induction

Electromagnetic Induction (EMI) line locators operate either by locating a background signal or by locating a signal introduced into the utility line using a transmitter. A utility line acts like a radio antenna, producing electrons, which can be picked up with a radiofrequency receiver. Electrical current carrying conductors have a 60HZ signal associated with them. This signal occurs in all power lines regardless of voltage. Utilities in close proximity to power lines or used as grounds may also have a 60HZ signal, which can be picked up with an EM receiver. A typical example of this type of geophysical equipment is an EM-61.

EMI locators specifically designed for utility locating use a special signal that is either indirectly induced onto a utility line by placing the transmitter above the line or directly induced using an induction clamp. The clamp induces a signal on the specific utility and is the preferred method of tracing since there is little chance of the resulting signals being interfered with. A good example of this type of equipment is the Schonstedt® MAC-51B locator. The MAC-51B performs inductively traced surveys, simple magnetic locating, and traced nonmetallic surveys.

When access can be gained inside a conduit to be traced, a flexible insulated trace wire can be used. This is very useful for non-metallic conduits but is limited by the availability of gaining access inside the pipe.

Magnetics

Magnetic locators operate by detecting the relative amounts of buried ferrous metal. They are incapable of locating or identifying nonferrous utility lines but can be very useful for locating underground storage tanks (UST's), steel utility lines, and buried electrical lines. A typical example of this type of equipment is the Schonstedt® GA-52Cx locator. The GA-52Cx is capable of locating 4-inch steel pipe up to 8 feet deep.

Non-ferrous lines are often located by using a typical plumbing tool (snake) fed through the line. A signal is then introduced to the snake that is then traced.

Ground Penetrating Radar

Ground Penetrating Radar (GPR) involves specialized radar equipment whereby a signal is sent into the ground via a transmitter. Some portion of the signal will be reflected from the subsurface material, which is then recorded with a receiver and electronically converted into a graphic picture. In general, an object which is harder than the surrounding soil will reflect a stronger signal. Utilities, tunnels, UST's, and footings will reflect a stronger signal than the surrounding soil. Although this surface detection method may determine the location of a utility, this method does not specifically identify utilities (i.e., water vs. gas, electrical vs. telephone); hence, verification may be necessary using other methods. This method is somewhat limited when used in areas with clay soil types or with a high water table.

6.2 Passive Detection Surveys

Acoustic Surveys

Acoustic location methods are generally most applicable to waterlines or gas lines. A highly sensitive Acoustic Receiver listens for background sounds of water flowing (at joints, leaks, etc.) or to sounds introduced into the water main using a transducer. Acoustics may also be applicable to determine the location of plastic gas lines.

Thermal Imaging

Thermal (i.e., infrared) imaging is a passive method for detecting the heat emitted by an object. Electronics in the infrared camera convert subtle heat differentials into a visual image on the viewfinder or a monitor. The operator does not look for an exact temperature; rather they look for heat anomalies (either elevated or suppressed temperatures) characteristic of a potential utility line.

The thermal fingerprint of underground utilities results from differences in temperature between the atmosphere and the fluid present in a pipe or the heat generated by electrical resistance. In addition, infrared scanners may be capable of detecting differences in the compaction, temperature and moisture content of underground utility trenches. High-performance thermal imagery can detect temperature differences to hundredths of a degree.

6.3 Intrusive Detection Surveys

Vacuum Excavation

Vacuum excavation is used to physically expose utility services. The process involves removing the surface material over approximately a 1' x 1' area at the site location. The air-vacuum process proceeds with the simultaneous action of compressed air-jets to loosen soil and vacuum extraction of the resulting debris. This process ensures the integrity of the utility line during the excavation process, as no hammers, blades, or heavy mechanical equipment comes into contact with the utility line, eliminating the risk of damage to utilities. The process continues until the utility is uncovered. Vacuum excavation can be used at the proposed site location to excavate below the "utility window" which is usually 8 feet.

Hand-auger Surveys

When the identification and location of underground utilities cannot be positively confirmed through document reviews and/or other methods, borings must be hand-augered for all locations where there is a potential to impact buried utilities. The minimum hand-auger depth that must be reached is to be determined considering the geographical location of the work site. This approach recognizes that the

placement of buried utilities is influenced by frost line depths that vary by geographical region. Attachment 2 presents frost line depths for the regions of the contiguous United States. At a minimum, hand-auger depths must be at least to the frost line depth plus two (2) feet, but never less than 4 feet below ground surface (bgs). For augering, the hole must be reamed by hand to at least the diameter of the drill rig auger or bit prior to drilling. For soil gas surveys, the survey probe shall be placed as close as possible to the cleared hand-auger. It is important to note that a post-hole digger must not be used in place of a hand-auger.

Tile Probe Surveys

For some soil types, site conditions, and excavation requirements, tile probes may be used instead of or in addition to hand-augers. Tile probes must be performed to the same depth requirements as hand-augers. Depending upon the site conditions and intended probe usage, tile probes should be made of non-conductive material such as fiberglass.

7.0 INTRUSIVE ACTIVITIES SUMMARY

The following list summarizes the activities that must be performed prior to beginning subsurface activities:

1. Map and mark all subsurface locations and excavation boundaries using white paint or markers specified by the client or property owner.

2. Notify the property owner and/or client that the locations are marked. At this point, drawings of locations or excavation boundaries shall be provided to the property owner and/or client so they may initiate (if applicable) utility clearance.

   Note: Drawings with confirmed locations should be provided to the property owner and/or client as soon as possible to reduce potential time delays.

3. Notify "One Call" service. If possible, arrange for an appointment to show the One Call representative the subsurface locations or excavation boundaries in person. This will provide a better location designation to the utilities they represent. You should have additional drawings should you need to provide plot plans to the One Call service.

4. Complete Attachment 3, Utility Clearance Form. This form should be completed for each excavation location. In situations where multiple subsurface locations exist within the close proximity of one another, one form may be used for multiple locations provided those locations are noted on the Utility Clearance Form. Upon completion, the Utility Clearance Form and revised/annotated utility location map becomes part of the project file.

8.0 REFERENCES

TtNUS Utility Locating and Clearance Policy
TtNUS SOP GH-3.1; Resistivity and Electromagnetic Induction
TtNUS SOP GH-3.2; Magnetic and Metal Detection Surveys
TtNUS SOP GH-3.4; Ground-penetrating Radar Surveys

ATTACHMENT 1
LISTING OF UNDERGROUND UTILITY CLEARANCE RESOURCES

ALABAMA Alabama Line Location (800) 292-8525 Tucson Blue Stake Center (800) 782-5348
Alaska Locate Call Center of Alaska Inc. (800) 478-3121
Arizona Arizona Blue Stake Inc. (800) 782-5348
Arkansas Arkansas One Call System Inc. (800) 482-8998
California Underground Service Alert North (800) 227-2600 Underground Service Alert South (800) 227-2600
Colorado Utility Notification Center of Colorado (800) 922-1987
Connecticut Call Before You Dig (800) 922-4455
Delaware Miss Utility of Delmarva (800) 282-8555
District of Columbia Miss Utility (800) 257-7777
Florida Call Sunshine (800) 432-4770
Georgia Utilities Protection Center Inc. (800) 282-7411
Idaho Palouse Empire Underground Coordinating Council (800) 882-1974 Utilities Underground Location Center (800) 424-5555 Kootenai Country Utility Coordinating Council (800) 428-4950 Shoshone County One Call (800) 398-3285 Dig Line (800) 342-1585 One Call Concepts (800) 626-4950
Illinois Julie Inc. (800) 892-0123 Digger (Chicago Utility Alert Network) (312) 744-7000
Indiana Indiana Underground Plant Protection Services (800) 382-5544
Iowa Underground Plant Location Service Inc. (800) 292-8989
Kansas Kansas One-Call Center (800) 344-7233
Kentucky Kentucky Underground Protection Inc. (800) 752-6007
Louisiana Louisiana One Call (800) 272-3020

Maine Dig Safe – Maine (800) 225-4977
Maryland Miss Utility (800) 257-777 Miss Utility of Delmarva (800) 282-8555
Massachusetts Dig Safe – Massachusetts (800) 322-4844
Michigan Miss Dig System (800) 482-7171
Minnesota Gopher State One Call (800) 252-1166
Mississippi Mississippi One-Call System Inc. (800) 227-6477
Missouri Missouri One Call System Inc. (800) 344-7483
Montana Utilities Underground Location Center (800) 424-5555 Montana One Call Center (800) 551-8344
Nebraska Diggers Hotline of Nebraska (800) 331-5666
Nevada Underground Service Alert North (800) 227-2600
New Hampshire Dig Safe – New Hampshire (800) 225-4977
New Jersey New Jersey One Call (800) 272-1000
New Mexico New Mexico One Call System Inc. (800) 321-ALERT Las Cruces-Dona Utility Council (505) 526-0400
New York Underground Facilities Protection Organization (800) 962-7962 New York City: Long Island One Call Center (800) 272-4480
North Carolina The North Carolina One-Call Center Inc. (800) 632-4949
North Dakota Utilities Underground Location Center (800) 795-0555
Ohio Ohio Utilities Protection Service (800) 362-2764 Oil & Gas Producers Underground Protection Service (800) 925-0988
Oklahoma Call Okie (800) 522-6543

Oregon
Utilities Underground Location Center
(800) 424-5555

Douglas Utilities Coordinating Council
(503) 673-6676

Josephine Utilities Coordinating Council
(503) 476-6676

Rogue Basin Utility Coordinating Council
(503) 779-6676

Utilities Notification Center
(800) 332-2344

Pennsylvania
Pennsylvania One Call System Inc.
(800) 242-1776

Rhode Island
Dig Safe – Rhode Island (800) 225-4977

South Carolina
Palmetto Utility Protection Service Inc.
(800) 922-0983

South Dakota
South Dakota One Call (800) 781-7474

Tennessee
Tennessee One-Call System (800) 351-1111

Texas
Texas One Call System (800) 245-4545

Texas Excavation Safety System (800) 344-8377

Lone Star Notification Center (800) 669-8344

Utah
Blue Stakes Location Center (800) 662-4111

Vermont
Dig Safe – Vermont (800) 225-4977

Virginia
Miss Utility of Virginia (800) 552-7001

Miss Utility (800) 257-7777

Miss Utility of Delmarva (800) 441-8355

Washington
Utilities Underground Location Center
(800) 424-5555

Grays Harbor & Pacific County
Utility Coordinating Council
(206) 535-3550

Utilities County of Cowlitz County
(360) 425-2506

Chelan-Douglas Utilities Coordinating Council
(509) 663-6111

Upper Yakima County
Underground Utilities Council
(800) 553-4344

Inland Empire Utility Coordinating Council
(509) 456-8000

Palouse Empire Utilities Coordinating Council
(800) 822-1974

Utilities Notification Center (800) 332-2344

West Virginia
Miss Utility of West Virginia Inc. (800) 245-4848

Wisconsin
Diggers Hotline Inc. (800) 242-8511

Wyoming
West Park Utility Coordinating Council
(307) 587-4800

Call-In Dig-In Safety Council (800) 300-9811

Fremont County Utility Coordinating Council
(800) 489-8023

Central Wyoming Utilities Coordinating Council
(800) 759-8035

Southwest Wyoming One Call (307) 362-8888

Carbon County Utility
Utility Coordinating Council (307) 324-6666

Albany County Utility Coordinating Council
(307) 742-3615

Southeast Wyoming Utilities Coordinating Council
(307) 638-6666

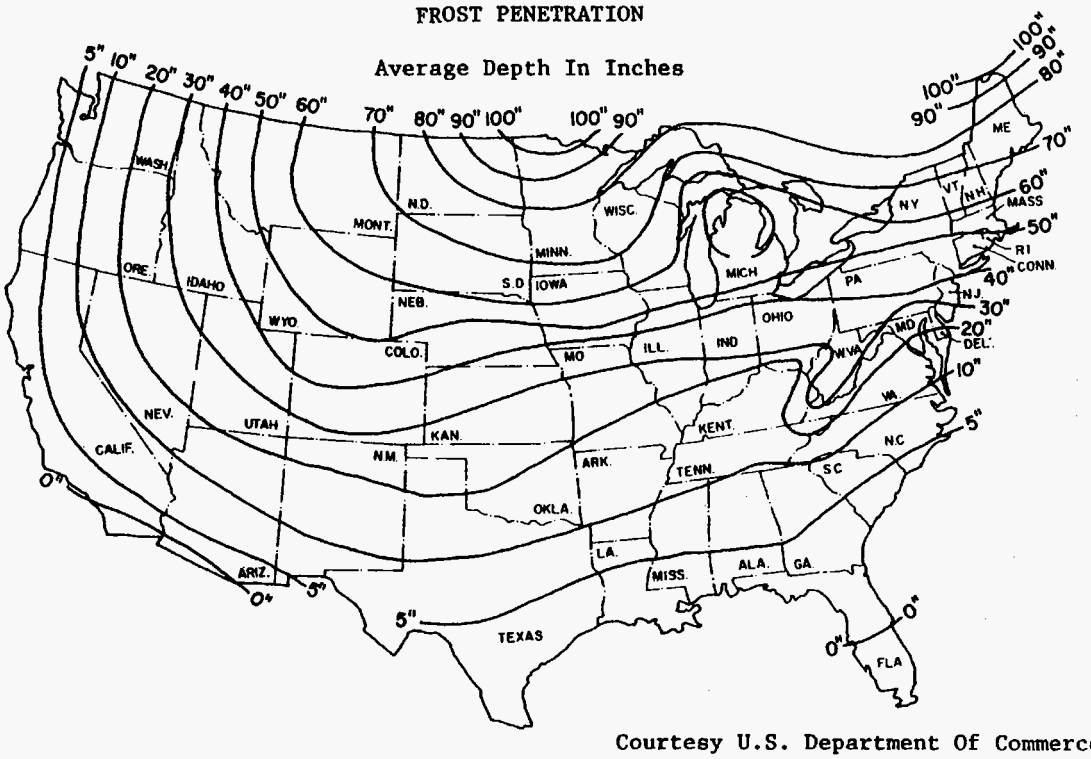
Wyoming One-Call
(800) 348-1030

Utilities Underground Location Center
(800) 454-5555

Converse County Utility Coordination Council
(800) 562-5561

ATTACHMENT 2

FROST LINE PENETRATION DEPTHS BY GEOGRAPHIC LOCATION



Courtesy U.S. Department Of Commerce

ATTACHMENT 3
UTILITY CLEARANCE FORM

Client: _____ Project Name: _____

Project No.: _____ Completed By: _____

Location Name: _____ Work Date: _____

Excavation Method/Overhead Equipment: _____

			Circle One
1.	Underground Utilities		
	a)	Review of existing maps?	yes no N/A
	b)	Interview local personnel?	yes no N/A
	c)	Site visit and inspection?	yes no N/A
	d)	Excavation areas marked in the field?	yes no N/A
	e)	Utilities located in the field?	yes no N/A
	f)	Located utilities marked/added to site maps?	yes no N/A
	g)	Client contact notified Name _____ Telephone: _____ Date: _____	yes no N/A
	g)	State One-Call agency called? Caller: _____ Ticket Number: _____ Date: _____	yes no N/A
	h)	Geophysical survey performed? Survey performed by: _____ Method: _____ Date: _____	yes no N/A
	i)	Hand augering performed? Augering completed by: _____ Total depth: _____ feet Date: _____	yes no N/A
	j)	Trench/excavation probed? Probing completed by: _____ Depth/frequency: _____ Date: _____	yes no N/A

			Present Absent
2.	Overhead Utilities		
	a)	Determination of nominal voltage	yes no N/A
	b)	Marked on site maps	yes no N/A
	c)	Necessary to lockout/insulate/re-route	yes no N/A
	d)	Document procedures used to lockout/insulate/re-route	yes no N/A
	e)	Minimum acceptable clearance (SOP Section 5.2): _____	

3. Notes:

_____

_____

_____

Approval:

_____ _____

Site Manager/Field Operations Leader Date

c: PM/Project File
Program File

ATTACHMENT V

EQUIPMENT INSPECTION CHECKLIST

EQUIPMENT INSPECTION

COMPANY:_____ **UNIT NO.**_____

FREQUENCY: Inspect daily, document prior to use and as repairs are needed.

Inspection Date: ____/____/____ Time: _____ Equipment Type:_____
(e.g., bulldozer)

	Good	Need Repair	N/A
Tires or tracks	❒	❒	❒
Hoses and belts	❒	❒	❒
Cab, mirrors, safety glass	❒	❒	❒
- Turn signals, lights, brake lights, etc. (front/rear) for equipment approved for highway use?	❒	❒	❒
- Is the equipment equipped with audible back-up alarms and back-up lights?	❒	❒	❒
Horn and gauges	❒	❒	❒
Brake condition (dynamic, park, etc.)	❒	❒	❒
Fire extinguisher (Type/Rating -_____)	❒	❒	❒
Fluid Levels:			
- Engine oil	❒	❒	❒
- Transmission fluid	❒	❒	❒
- Brake fluid	❒	❒	❒
- Cooling system fluid	❒	❒	❒
- Windshield wipers	❒	❒	❒
- Hydraulic oil	❒	❒	❒
Oil leak/lube	❒	❒	❒
Coupling devices and connectors	❒	❒	❒
Exhaust system	❒	❒	❒
Blade/boom/ripper condition	❒	❒	❒
Accessways: Frame, hand holds, ladders, walkways (non-slip surfaces), guardrails?	❒	❒	❒
Power cable and/or hoist cable	❒	❒	❒
Steering (standard and emergency)	❒	❒	❒

Safety Guards:

	Yes	No
– Around rotating apparatus (belts, pulleys, sprockets, spindles, drums, flywheels, chains) all points of operations protected from accidental contact?_____	❒	❒
– Hot pipes and surfaces exposed to accidental contact?_____	❒	❒
– All emergency shut offs have been identified and communicated to the field crew?_____	❒	❒
– Have emergency shutoffs been field tested? _____	❒	❒
– Results?_____	❒	❒
– Are any structural members bent, rusted, or otherwise show signs of damage?_____	❒	❒

- Are fueling cans used with this equipment approved type safety cans?_____ ❒ ❒
- Have the attachments designed for use (as per manufacturer's recommendation) with this equipment been inspected and are considered suitable for use?_____ ❒ ❒

Portable Power Tools:

- Tools and Equipment in Safe Condition?_____ ❒ ❒
- Saw blades, grinding wheels free from recognizable defects (grinding wheels have been sounded)? ❒ ❒
- Portable electric tools properly grounded?_____ ❒ ❒
- Damage to electrical power cords?_____ ❒ ❒
- Blade guards in place?_____ ❒ ❒
- Components adjusted as per manufacturers recommendation?_____ ❒ ❒

Cleanliness:

- Overall condition (is the decontamination performed prior to arrival on-site considered acceptable)?_____
- Where was this equipment used prior to its arrival on site?_____
- Site Contaminants of concern at the previous site?_____
- Inside debris (coffee cups, soda cans, tools and equipment) blocking free access to foot controls?_____

Operator Qualifications (as applicable for all heavy equipment):

- Does the operator have proper licensing where applicable, (e.g., CDL)?_____
- Does the operator, understand the equipments operating instructions?_____
- Is the operator experienced with this equipment? _____
- Does the operator have emotional and/or physical limitations which would prevent him/her from performing this task in a safe manner?_____
- Is the operator 21 years of age or more?_____

Identification:

- Is a tagging system available, for positive identification, for tools removed from service?___

Additional Inspection Required Prior to Use On-Site

	Yes	No
- Does equipment emit noise levels above 90 decibels?	❒	❒
- If so, has an 8-hour noise dosimetry test been performed?	❒	❒

- Results of noise dosimetry:_____
- Defects and repairs needed:_____
- General Safety Condition: _____
- Operator or mechanic signature:_____

Approved for Use: ❒ Yes ❒ No

_____
Site Safety Officer Signature

ATTACHMENT VI

HRC
SAFE WORK PRACTICES
AND
MATERIAL SAFETY DATA SHEET

BIOREMEDIATION PROCESS

HYDROGEN RELEASE COMPOUND (HRC®)

Hydrogen Release Compound (HRC®) is a product that is used to stimulate rapid degradation of chlorinated solvent contaminants often found in groundwater and soil. It has been applied to treat compounds such as perchloroethene and trichloroethene on sites across the US and has demonstrated breakthrough results. HRC has been shown to achieve rapid in situ degradation of target contamination without the costs and disruption associated with complex engineered remediation systems, and without the ongoing cost and liability of natural attenuation approaches. HRC is a proven, technically sound and very cost effective technology.

HRC is an environmentally safe, food quality, polylactate ester specially formulated for slow release of lactic acid upon hydration. The HRC is simply applied to the subsurface via push-point injection or within dedicated wells. The HRC is then left in place where it passively works to stimulate rapid contaminant degradation.

The process by which HRC operates is a rather complex series of chemical and biologically mediated reactions. Initially, when in contact with subsurface moisture, the HRC slowly releases lactic acid. Indigenous anaerobic microbes (such as acetogens) metabolize the lactic acid producing consistent low concentrations of dissolved hydrogen. The resulting hydrogen is then used by other subsurface microbes (reductive dehalogenators) to strip the solvent molecules of their chlorine atoms and allow for further biological degradation. When in the subsurface, HRC continues to operate in this fashion for a period of a year's time, cost effectively degrading a wide range of chlorinated aliphatic hydrocarbons (CAHs) including common groundwater pollutants such as PCE, TCE, TCA as well as their daughter products.

General Guidelines

The best method to deliver HRC into the subsurface is to inject the material using direct push hydraulic equipment. This approach increases the spreading and mixing of HRC into the aquifer. This set of instructions is specific to direct push equipment.

Regenesis has found that very few pumps can adequately deliver HRC to the subsurface. Although other pumps may inject HRC, we have developed the following instructions specifically for use with an R.E. RUPE Company Model ORC/HRC 9-1500 mixing and pumping machine.

The installation of HRC should span the entire vertical contaminated saturated thickness. If the vertical extent of HRC application is confined to a limited interval, then the HRC material should be placed across

a vertical zone extending a minimum of 2 feet above and below the screened interval of monitoring wells to be used to evaluate the performance of the bioremediation project.

Material Overview, Handling, And Safety

HRC is shipped in 3-gallon buckets, and each bucket has a gross weight of approximately 32 pounds (net weight of HRC is 30 pounds). HRC material is a sticky gel with a viscosity of approximately 20,000 centipoise (roughly equivalent to cold honey). HRC material has a nominal density of 1.3 grams/cubic centimeter or approximately 11 pounds per gallon. HRC viscosity is sensitive to temperature. The viscosity changes significantly with changes in product temperature.

For ease of installation, HRC should be stored in a warm, dry place that is protected from direct sunlight. It is common for stored HRC to settle somewhat in a container. Care should be taken to mix the HRC into a relatively uniform fluid prior to installation. This can be done by pouring and scraping HRC into the pump hopper and then mixing and recirculating this mixture within the hopper until it is of uniform consistency.

Although HRC is manufactured as a food-grade material that is safe to ingest, field personnel should take precautions while handling and applying HRC. Field personnel should use appropriate safety equipment, including eye protection. The low pH when dissolved in water and stickiness of HRC make eye protection mandatory. Gloves should be used appropriate to exposure duration and field conditions. A Material Safety Data Sheet is provided with each shipment. Personnel who operate field equipment during the installation process should have appropriate training, supervision, and experience.

Specific Installation Procedures

1. Identify the location of all underground structures, including utilities, tanks, distribution piping, sewers, drains, and landscape irrigation systems. Identify surface and overhead impediments.
2. Adjust planned installation locations for all impediments and obstacles.
3. Premark the installation grid point locations, noting any points that may have different vertical application requirements or total depth.
4. Set up the direct push unit over each specific point and follow the manufacturer's standard operating procedures (SOP) for the direct push equipment. Care should be taken to assure that probe holes remain in the vertical.
5. Advance through the surface pavement, as necessary, following SOP.
6. Drive the 1.25-inch drive rod assembly with an expendable tip to the desired maximum depth (use of a 1.5-inch pre-probe attachment is optional). It is critical to use 1.25-inch Geoprobe rods. HRC delivery sub-assemblies are designed for use with 1.25-inch Geoprobe rods. (Suggestion: Pre-

counted drive rods should be positioned prior to the installation driving procedure to assure the desired depth is reached.)

7. Drop the expendable tip from the drive rods, following SOP.
8. To displace air in the rods and prevent injection of air into the aquifer during HRC application, fill the drive rods with water. If water does not remain in the rods due to seepage, glycerol may be substituted.
9. Pour the HRC into the pump hopper (up to a capacity of 40 gallons). Use the pump recirculation feature to obtain a uniform consistency. This typically requires recirculation of approximately one hopper volume. NOTE: Do not mix HRC with water or other liquids to thin or decrease the viscosity of the material.
10. Prior to pumping into the aquifer, confirm the strokes per gallon measurements by counting the number of pump strokes required to deliver 3 gallons of HRC. This should be confirmed against the HRC level decrease in the pump hopper.
11. Connect the provided 1.25-inch outer diameter, 1-inch inner diameter delivery hose to the pump outlet and the provided HRC delivery subassembly. Circulate the HRC through the hose and the delivery subassembly to remove air in the hose.
12. Connect the HRC subassembly to the drive rods. Upon confirmation of all connections, pump the HRC through the delivery system to displace the water in the rods. NOTE: Prior to pumping HRC into the aquifer, close the pump recirculation valve; failure to close this valve will introduce variability in the volume of HRC delivered per pump stroke. In addition, the pump motor RPM and hydraulic settings should remain at a single setting throughout the day.
13. Use the pump's stroke counter and the provided volume/weight conversions to apply the appropriate HRC volume per injection location (and per vertical foot of contaminated saturated zone). Below is some typical HRC delivery information and an example calculation.

TABLE 1. PUMP VOLUME CALCULATION

Pump Stroke Volume (gallons)	Number of Pump Strokes	HRC Per Stroke (pounds/stroke)
3	14	2.4
0.22	1	2.4

Example: For each injection location, install 60 pounds of HRC across 10 vertical feet of aquifer (6 pounds per vertical foot HRC dosing rate). Solution:

- 60 pounds/11 pounds per gallon » 5.5 gallons for the injection location

- 5.5 gallons/0.22 gallons per stroke » 25 pump strokes for the injection location
- 25 pump strokes/10 vertical feet = 2.5 strokes per vertical foot
- 2.5 strokes per vertical foot = 7.5 strokes per 3 foot drive rod
- 2.5 strokes per vertical foot = 10 strokes per 4 foot drive rod

14. While slowly withdrawing a single length of drive rod (3 or 4 feet), pump the predetermined volume of HRC into the aquifer (Step 13). Use the stroke counter and pump on/off switch to control volume of injection. See Helpful Hints at the end of this section.
15. Pump the predetermined quantity of HRC material across the desired treatment interval. Observe any indications of aquifer refusal. This is typically indicated by a high-pitched squeal in the pump's hydraulic system or (in the case of shallow applications) HRC "surfacing" around the injection rods or previously installed injection points. If aquifer acceptance is low, allow 0.5 to 1 minute for backpressure to equilibrate prior to removal of the rod.
16. Remove one section of the drive rod. The drive rod may contain some residual HRC. Place the HRC-filled rod in a clean, empty bucket and allow the HRC to drain. The HRC should be returned to the HRC pump hopper for reuse.
17. Repeat steps 11 through 16 until treatment of the entire contaminated vertical zone has been achieved.
18. Install an appropriate seal, such as bentonite, above the HRC material through the entire vadose zone. This assures that the HRC remains properly placed and prevents contaminant migration from the surface. Depending on soil conditions and local regulations, a bentonite seal can be pumped through the slurry pump or added via chips or pellets after the probe rods have been removed.
19. Remove and clean the drive rods as necessary.
20. Finish the probe hole at the surface as appropriate (concrete or asphalt cap, if necessary).
21. Periodically check for pump stroke volume variability by counting pump strokes per gallon throughout the day. Counting the number of strokes needed to fill up a 3-gallon bucket can do this.
22. Periodically compare the pre- and post-injection volumes of HRC in the pump hopper using the premarked volume levels. Volume markings are not on all pump hoppers. In this case, volume markings can be temporarily added using known amounts of water and a carpenter's grease pencil prior to starting the HRC injection.

23. Move to the next probe point, repeating steps 4 through 20.

Helpful Hints

1) Application in Cold Weather Settings: The viscosity of HRC is directly related to the ambient temperature. As discussed in the Material Overview, Handling, and Safety section, cold weather tends to increase HRC viscosity and decrease ease of pumping. To maintain HRC at a temperature/viscosity that is easily applied

- Keep the product at the optimal temperature for injection of 80 to 100°F (27 to 38°C). This may require placing the plastic HRC buckets within a hot water bath. This can be accomplished quite easily by simply filling a large tub with hot water from a heated pressure washer and submersing multiple buckets therein.
- Periodically check the HRC temperature in the hopper and in the hoses
- Circulate HRC through the pump to maintain a minimum temperature and viscosity
- Limit the volume circulated to a single HRC volume contained in the hopper
- Do not constantly recirculate HRC through the pump and hoses, this may adversely affect product longevity.

2) HRC Pump Information: Regenesis has evaluated a number of pumps that are capable of delivering 20,000 centipoise HRC to the subsurface at a sufficient pressure and volume rate. Although a number of pumps may be capable of delivering the HRC to the subsurface at adequate pressures and volume, each pump has a set of practical issues that make it difficult to manage in a field setting. As a result of this evaluation, Regenesis has determined that the R.E. RUPE Company Model ORC/HRC 9-1500 meets the pressure/volume requirements, as well as the field application requirements.

When applying measured volumes of HRC via probe holes, it is useful to know the volume of a single pump stroke (Table 1 above) and the associated delivery system lines. The following additional information is provided for reference:

TABLE 2. HRC PHYSICAL CHARACTERISTICS

Density	1.3 g/cc or 11 lbs./gal.
Viscosity	Approx. 20,000 centipoise

TABLE 3. EQUIPMENT VOLUME AND HRC WEIGHT PER LENGTH

Equipment	VOLUME	HRC WEIGHT
1 inch OD; 5/8 ID hose (10 feet long)	0.16 gallon	1.76 lbs.
1.25 inch OD; 5/8 inch ID drive rod (3 feet length):	0.05 gallon	0.53 lbs.
1.25 inch OD; 5/8 inch ID drive rod (4 feet length):	0.06 gallon	0.70 lbs.

1) **Pump Cleaning:** For best results use hot water (150°F or 66°C) combined with pressure washing to clean equipment and rods periodically throughout the day. Internal pump mechanisms and hoses can be easily cleaned by circulating hot water and a biodegradable cleaner such as Simple Green through the pump and delivery hose. Further cleaning and decontamination (if necessary due to subsurface conditions) should be performed according to the equipment supplier's standard procedures and local regulatory requirements.

2) **Pump maintenance check list:**

   - Check the fuel level periodically (it's best to start with a full tank)
   - Check the remote control/pump stroke counter LCD display; if no display is present, the electronic counter will require replacement (Granger Stock No. 2A540)
   - Monitor pump strokes by observing proximity switches on the top of the piston.

HRC Bedrock Applications

When contaminants are present in bedrock aquifers, the use of direct push technology as a delivery method is not possible. Regenesis is in the process of developing methods for applying HRC via boreholes drilled using conventional rotary techniques. To develop the best installation strategy for a particular bedrock site, it is critical that our customers call the technical support department at Regenesis early in the design process.

HRC can be applied into a bedrock aquifer in cased and uncased boreholes. HRC can be delivered by simply filling the borehole without pressure or by using a single or straddle packer system to inject HRC under pressure at discrete locations. Selection of the backfill or straddle packer delivery method is directly related to site-specific conditions. The following issues should be considered in developing an HRC delivery strategy:

- Backfilling may be the better delivery method in fractured or unfractured bedrock, in an aquifer setting with high permeability and little fracturing such as found in sandstones.
- In fractured bedrock aquifers, the fracture type, trends, and interconnections should be evaluated and identified to the extent possible.
- It should be determined whether it is likely that the HRC injection zone is connected to the proposed monitoring points.
- If pressure injection via straddle packers is desired, consideration should be given to the well construction. Specific issues to be considered are:
    1. Diameter of the uncased borehole (will casing diameter allow a packer system to be used?)
    2. Diameter of the casing (same as above)
    3. Strength of the casing (can it withstand the delivery pressures?)
    4. Length of screened interval (screened intervals greater than 10 feet will require a straddle packer system).

MATERIAL SAFETY DATA SHEET

Last Revised: March 1, 2001

****
Section 1 - Material Identification
****

Supplier: Regenesis Bioremediation Products
1011 Calle Sombra
San Clemente, CA 92673
Telephone: (949) 366-8000
Facsimile: (949) 366-8090

Chemical Name: Propanoic acid, 2-[2-[2-(2-hydroxy-1-oxopropoxy)-1-oxopropoxy]
-1-oxopropoxy]-1,2,3-propanetriyl ester
Chemical Family: Organic Chemical
Trade Name: Glycerol tripolylactate
Product Name: Hydrogen Release Compound® (HRC®)

****
Section 2 - Hazardous Ingredients
****

CAS #: 201167-72-8
One should anticipate the potential for eye irritation and skin irritation with large scale exposure or in sensitive individuals.

****
Section 3 - Physical Data
****

Melting Point: NA
Boiling Point: ND
Flash Point: ND
Density: 1.347
Solubility: Acetone and DMSO
Appearance: Amber semi-solid
Odor: Not detectable
Vapor Pressure: None

****
Section 4 - Fire and Explosion Hazard Data
****

Extinguishing Media: Carbon Dioxide, Dry Chemical Powder or Appropriate Foam.
Water may be used to keep exposed containers cool.
For large quantities involved in a fire, one should wear full protective clothing and a NIOSH approved self contained breathing apparatus with full face piece operated in the pressure demand or positive pressure mode as for a situation where lack of oxygen and excess heat are present.

Section 5 - Toxicological Information

Acute Effects: May be harmful by inhalation, ingestion, or skin absorption.
May cause irritation. To the best of our knowledge, the chemical, physical, and toxicological properties of the glycerol tripolylactate have not been investigated. Listed below are the toxicological information for glycerol and lactic acid.
RTECS#: MA8050000
Glycerol
Irritation data: SKN-RBT 500 MG/24H MLD 85JCAE-,207,1986
EYE-RBT 126 MG MLD BIOFX* 9-4/1970
EYE-RBT 500 MG/24H MLD 85JCAE-,207,1986
Toxicity data: ORL-MUS LD50:4090 MG/KG FRZKAP (6),56,1977
SCU-RBT LD50:100 MG/KG NIIRDN 6,215,1982
ORL-RAT LD50:12600 MG/KG FEPRA7 4,142,1945
IHL-RAT LC50: >570 MG/M3/1H BIOFX* 9-4/1970
IPR-RAT LD50: 4420 MG/KG RCOCB8 56,125,1987
IVN-RAT LD50:5566 MG/KG ARZNAD 26,1581,1976
IPR-MUS LD50: 8700 MG/KG ARZNAD 26,1579,1978
SCU-MUS LD50:91 MG/KG NIIRDN 6,215,1982
IVN-MUS LD50: 4250 MG/KG JAPMA8 39,583,1950
ORL-RBT LD50: 27 GM/KG DMDJAP 31,276,1959
SKN-RBT LD50:>10GM/KG BIOFX* 9-4/1970
IVN-RBT LD50: 53 GM/KG NIIRDN 6,215,1982
ORL-GPG LD50: 7750 MG/KG JIHTAB 23,259,1941
Target Organ data: Behavioral (headache), gastrointestinal (nausea or vomiting), Paternal effects (spermatogenesis, testes, epididymis, sperm duct), effects of fertility (male fertility index, post-implantation mortality).
RTECS#: OD2800000
Lactic acid
Irritation data: SKN-RBT 5MG/24H SEV 85JCAE -,656,86
EYE-RBT 750 UG SEV AJOPAA 29,1363,46
Toxicity data: ORL-RAT LD50:3543 MG/KG FMCHA2-,C252,91
SKN-RBT LD50:>2 GM/KG FMCHA2-,C252,91
ORL-MUS LD50: 4875 MG/KG FAONAU 40,144,67
ORL-GPG LD50: 1810 MG/KG JIHTAB 23,259,41
ORL-QAL LD50: >2250 MG/KG FMCHA2-,C252,91
Only selected registry of toxic effects of chemical substances (RTECS) data is presented here. See actual entry in RTECS for complete information on lactic acid and glycerol.

Section 6 - Health Hazard Data

Handling: Avoid continued contact with skin.
Avoid contact with eyes.
In any case of any exposure which elicits a response, a physician should be consulted immediately.
First Aid Procedures:
Inhalation: Remove to fresh air. If not breathing give artificial respiration. In case of labored breathing give oxygen. Call a physician.
Ingestion: No effects expected. Do not give anything to an unconscious person. Call a physician immediately.
Skin Contact: Flush with plenty of water. Contaminated clothing may be washed or dry cleaned normally.

Eye contact: Wash eyes with plenty of water for at least 15 minutes lifting both upper and lower lids. Call a physician.

****
Section 7 - Reactivity Data
****

Conditions to Avoid: Strong oxidizing agents, bases and acids
Hazardous Polymerization: None known
Further Information: Hydrolyses in water to form Lactic Acid and Glycerol.

****
Section 8 - Spill, Leak or Accident Procedures
****

After Spillage or Leakage: Neutralization is not required. This combustible material may be burned in a chemical incinerator equipped with an afterburner and scrubber.
Disposal: Laws and regulations for disposal vary widely by locality. Observe all applicable regulations and laws. This material, may be disposed of in solid waste. Material is readily degradable and hydrolyses in several hours. No requirement for a reportable quantity (CERCLA) of a spill is known.

****
Section 9 - Special Protection or Handling
****

Should be stored in plastic lined steel, plastic, glass, aluminum, stainless steel, or reinforced fiberglass containers.
Protective Gloves: Vinyl or Rubber
Eyes: Splash Goggles or Full Face Shield
Area should have approved means of washing
eyes.
Ventilation: General exhaust.
Storage: Store in cool, dry, ventilated area.
Protect from incompatible materials.

****
Section 10 - Other Information
****

This material will degrade in the environment by hydrolysis to lactic acid and glycerol.
Only personnel with appropriate chemical training should use materials containing reactive chemicals.

The information contained in this document is the best available to the supplier as of the time of writing. Some possible hazards have been determined by analogy to similar classes of material. No separate tests have been performed on the toxicity of this material. The items in this document are subject to change and clarification as more information becomes available.

ATTACHMENT VII

OSHA JOB SAFETY POSTER

You Have a Right to a Safe and Healthful Workplace.

IT'S THE LAW!

- You have the right to notify your employer or OSHA about workplace hazards. You may ask OSHA to keep your name confidential.
- You have the right to request an OSHA inspection if you believe that there are unsafe and unhealthful conditions in your workplace. You or your representative may participate in the inspection.
- You can file a complaint with OSHA within 30 days of discrimination by your employer for making safety and health complaints or for exercising your rights under the *OSH Act*.
- You have a right to see OSHA citations issued to your employer. Your employer must post the citations at or near the place of the alleged violation.
- Your employer must correct workplace hazards by the date indicated on the citation and must certify that these hazards have been reduced or eliminated.
- You have the right to copies of your medical records or records of your exposure to toxic and harmful substances or conditions.
- Your employer must post this notice in your workplace.

The *Occupational Safety and Health Act of 1970 (OSH Act)*, P.L. 91-596, assures safe and healthful working conditions for working men and women throughout the Nation. The Occupational Safety and Health Administration, in the U.S. Department of Labor, has the primary responsibility for administering the *OSH Act*. The rights listed here may vary depending on the particular circumstances. To file a complaint, report an emergency, or seek OSHA advice, assistance, or products, call 1-800-321-OSHA or your nearest OSHA office: • Atlanta (404) 562-2300 • Boston (617) 565-9860 • Chicago (312) 353-2220 • Dallas (214) 767-4731 • Denver (303) 844-1600 • Kansas City (816) 426-5861 • New York (212) 337-2378 • Philadelphia (215) 861-4900 • San Francisco (415) 975-4310 • Seattle (206) 553-5930. Teletypewriter (TTY) number is 1-877-889-5627. To file a complaint online or obtain more information on OSHA federal and state programs, visit OSHA's website at **www.osha.gov**. If your workplace is in a state operating under an OSHA-approved plan, your employer must post the required state equivalent of this poster.

1-800-321-OSHA

www.osha.gov

U.S. Department of Labor • **Occupational Safety and Health Administration** • **OSHA 3165**

APPENDIX B

PROJECT-SPECIFIC
QUALITY ASSURANCE PROJECT PLAN

**(To be used in conjunction with the
Master Quality Assurance Project Plan)**

Quality Assurance Project Plan
for
In Situ Bioremediation Pilot Study
at
Site 57 – Former Drum Loading Area
Building 292

Indian Head Division
Naval Surface Warfare Center
Indian Head, Maryland

Engineering Field Activity Chesapeake
Naval Facilities Engineering Command
Contract Number N62467-94-D-0888
Contract Task Order 0805

May 2003

030302/P

QUALITY ASSURANCE PROJECT PLAN
FOR
IN SITU BIOREMEDIATION PILOT STUDY

AT
SITE 57 – FORMER DRUM LOADING AREA
BUILDING 292

INDIAN HEAD DIVISION
NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Engineering Field Activity Chesapeake
1314 Harwood Street, SE
Washington Navy Yard, D.C. 20374-5018

Submitted by:
Tetra Tech NUS, Inc.
600 Clark Avenue, Suite 3
King of Prussia, Pennsylvania 19406-1433

CONTRACT NUMBER N62467-94-D-0888
CONTRACT TASK ORDER 0805

MAY 2003

PREPARED UNDER DIRECTION OF:

for _____
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PITTSBURGH, PENNSYLVANIA

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TABLE OF CONTENTS

SECTION		PAGE
LIST OF ACRONYMS AND ABBREVIATIONS		**v**
1.0	**PROJECT DESCRIPTION**	**1-1**
1.1	INTRODUCTION	1-1
1.1.1	Overall Project Objectives	1-1
1.1.2	QAPP Preparation Guidelines	1-1
1.2	FACILITY DESCRIPTION	1-1
1.3	PROJECT TARGET PARAMETERS AND INTENDED DATA USES	1-2
1.3.1	Field Parameters	1-2
1.3.2	Laboratory Parameters	1-2
1.4	DATA QUALITY OBJECTIVES	1-2
1.5	SAMPLE NETWORK DESIGN AND RATIONALE	1-2
1.6	PROJECT SCHEDULE	1-3
2.0	**PROJECT ORGANIZATION**	**2-1**
3.0	**QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA**	**3-1**
3.1	PRECISION	3-1
3.1.1	Definition	3-1
3.1.2	Field Precision Objectives	3-1
3.1.3	Laboratory Precision Objectives	3-1
3.2	ACCURACY	3-2
3.2.1	Definition	3-2
3.2.2	Field Accuracy Objectives	3-2
3.2.3	Laboratory Accuracy Objectives	3-3
3.3	COMPLETENESS	3-4
3.3.1	Definition	3-4
3.3.2	Field Completeness Objectives	3-4
3.3.3	Laboratory Completeness Objectives	3-4
3.4	REPRESENTATIVENESS	3-5
3.4.1	Definition	3-5
3.4.2	Measures to Ensure Representativeness of Field Data	3-5
3.4.3	Measures to Ensure Representativeness of Laboratory Data	3-5
3.5	COMPARABILITY	3-5
3.5.1	Definition	3-5
3.5.2	Measures to Ensure Comparability of Field Data	3-5
3.5.3	Measures to Ensure Comparability of Laboratory Data	3-6
3.6	LEVEL OF QUALITY CONTROL EFFORT	3-6
4.0	**SAMPLING PROCEDURES**	**4-1**
5.0	**CUSTODY PROCEDURES**	**5-1**
6.0	**CALIBRATION PROCEDURES AND FREQUENCY**	**6-1**
7.0	**ANALYTICAL AND MEASUREMENT PROCEDURES**	**7-1**
7.2	LABORATORY ANALYTICAL AND MEASUREMENT PROCEDURES	7-1
7.2.1	List of Project Target Compounds and Detection Limits	7-1
7.2.2	List of Associated Quality Control Samples	7-1

TABLE OF CONTENTS (Continued)

SECTION		PAGE
8.0	**INTERNAL QUALITY CONTROL CHECKS**	**8-1**
8.1	FIELD QUALITY CONTROL CHECKS	8-1
8.2	LABORATORY QUALITY CONTROL CHECKS	8-1
9.0	**DATA REDUCTION, VALIDATION, AND REPORTING**	**9-1**
10.0	**PERFORMANCE AND SYSTEM AUDITS**	**10-1**
11.0	**PREVENTATIVE MAINTENANCE PROCEDURES**	**11-1**
12.0	**SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS**	**12-1**
13.0	**CORRECTIVE ACTION**	**13-1**
14.0	**QUALITY ASSURANCE REPORTS TO MANAGEMENT**	**14-1**
REFERENCES		**R-1**

TABLES

NUMBER		PAGE
1-1	Analytical Detection Limits - Organics	1-5
1-2	Analytical Detection Limits - Inorganics	1-6
1-3	Analytical Detection Limits – Miscellaneous Parameters	1-7
1-4	Analytical Detection Limits – Metabolic Acids	1-8
7-1	Summary of Organic and Inorganic Analytical Procedures	7-3
11-1	Preventative Maintenance for Analytical Instruments	11-3

LIST OF ACRONYMS AND ABBREVIATIONS

B&R Environmental	Brown & Root Environmental
CLEAN	Comprehensive Long-Term Environmental Action Navy
CLP	Contract Laboratory Program
CTO	Contract Task Order
DQO	data quality objectives
FOL	field operations leader
FS	feasibility study
GC/MS	gas chromatograph/mass spectrometer
IHDIV-NSWC	Indian Head Division, Naval Surface Warfare Center
LCS	laboratory control sample
MS/MSD	matrix spike / matrix spike duplicate
mV	milivolts
mg/L	milligrams per liter
NTU	nephelometric turbidity units
PARCC	precision, accuracy, representativeness, comparability, and completeness
QA	quality assurance
QC	quality control
QAPP	Quality Assurance Project Plan
RDL	required detection limit
RI	remedial investigation
RPD	relative percent difference
RPM	remedial project manager
RSK	Robert S. Kerr Labs
%R	percent recovery
SOP	standard operating procedure
SRM	standard reference material
TCL	Target Compound List (EPA's)
TOC	total organic carbon
TtNUS	Tetra Tech NUS, Inc.
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
U. S. EPA	United States Environmental Protection Agency
VOC	volatile organic compound

1.0 PROJECT DESCRIPTION

1.1 INTRODUCTION

This project-specific Quality Assurance Project Plan (QAPP) for an investigation at the Indian Head Division, Naval Surface Warfare Center (IHDIV-NSWC), Indian Head, Maryland, was prepared by Tetra Tech NUS, Inc. (TtNUS) in response to Contract Task Order (CTO) 0805 under the Comprehensive Long-Term Environmental Action Navy (CLEAN), Contract Number N62467-94-D-0888.

This document is intended to be used in conjunction with the accompanying Pilot Study Work Plan (TtNUS, March 2003) and Master QAPP dated April 1997 and is limited to the sections and information specific to Site 57, Former Drum Loading Area. This document is not intended to be used by itself.

1.1.1 Overall Project Objectives

The Master QAPP provides general quality assurance (QA) guidelines common to multiple site investigations to be conducted at the Facility. It outlines QA issues for what are expected to be the most common types of field efforts and analyses during remedial investigations (RIs). Specific project objectives are identified in the Project-Specific Work Plans. Additional QA issues are addressed in addenda to the Master QAPP as necessary and are to be provided as appendices to the project-specific work plans.

Important companion documents to the Master QAPP and the project-specific workplan include the Master Plans for RIs (Master Work Plan), dated April 1997 and the Indian Head NSWC Station Standard Operating Procedures (SOPs) that were attached to the Master Work Plan.

1.1.2 QAPP Preparation Guidelines

The project-specific QAPP and accompanying Pilot Study Work Plan has been prepared to be used in conjunction with the Master QAPP to fulfill the general requirements outlined in EPA Requirements for Quality Assurance Project Plans, EPA QA/R-5 (March 2001) and Guidance for Quality Assurance Project Plans, EPA QA/G-5 (December 2002).

1.2 FACILITY DESCRIPTION

A facility description, including the location and general description, station history, land use, water sources and usage, population, physiography and topography, geology, soils, hydrogeology, hydrology, ecology, and meteorology, is provided in the Master Work Plan.

1.3 PROJECT TARGET PARAMETERS AND INTENDED DATA USES

This section discusses typical field and laboratory analytical information to be generated during the course of the pilot study for in situ groundwater remediation at Site 57. Field parameters and intended data uses are discussed in Section 1.3.1. Laboratory parameters and intended data uses are discussed in Section 1.3.2.

1.3.1 Field Parameters

Field parameters will include those associated with groundwater sampling and analysis. Field measurements will include only those completed using simple field instrumentation.

Field parameters, including pH, specific conductance, dissolved oxygen, and temperature, will be completed for all aqueous-phase samples. These measurements will typically be used to support monitoring well development and monitoring well sampling. Specific conductance and pH will also be used as general indicators of water quality. Oxidation/reduction potential, ferrous iron, and hydrogen sulfide will also be tested in the field.

1.3.2 Laboratory Parameters

Laboratory parameters will include Chlorinated volatile organic compounds (VOCs), arsenic, iron, manganese, alkalinity, dissolved gases, anions, Total Organic Carbon (TOC), and metabolic acids. Tables 1-1, 1-2, 1-3, and 1-4 provide a summary of all target laboratory analytes and associated required detection limits (RDLs).

Although not included in the list of chlorinated VOCs, for the purpose of this investigation, ethyl ether will be added to the VOC list.

1.4 DATA QUALITY OBJECTIVES

Data quality objectives are discussed in the Pilot Study Work Plan.

1.5 SAMPLE NETWORK DESIGN AND RATIONALE

Sample network design and rationale are provided in the Pilot Study Work Plan.

1.6 PROJECT SCHEDULE

The project schedule has not been determined to date and will be provided as an addendum to the Pilot Study Work Plan.

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TABLE 1-1

REQUIRED DETECTION LIMITS - ORGANICS
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Parameter	RDL[1] Soil (µg/kg)	RDL[1] Aqueous (µg/L)
Volatile Organic Compounds (SW-846 8260B)		
Carbon tetrachloride	10	5
Chlorobenzene	10	5
Chloroethane	10	5
Chloroform	10	5
Chloromethane	10	5
cis-1,2-Dichloroethene	10	5
cis-1,3-Dichloropropene	10	5
1,1-Dichloroethane	10	5
1,2-Dichloroethane	10	5
1,1-Dichloroethene	10	5
1,2-Dichloropropane	10	5
Trans-1,3-Dichloropropene	10	5
Ethyl ether	10	5
Methylene chloride	10	5
1,1,2,2-Tetrachloroethane	10	5
1,1,1-Trichloroethane	10	5
1,1,2-Trichloroethane	10	5
Trichloroethene	10	5
Tetrachloroethene	10	5
Vinyl chloride	10	2
Trans-1,2-dichloroethene	10	5

1 Required detection limit.

TABLE 1-2

REQUIRED DETECTION LIMITS - INORGANICS
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Parameter	RDL[1]	
	Aqueous (µg/L)	Solid (µg/kg)
Target Analyte List Metals (SW-846 6010B)		
Arsenic	NA	100
Iron	100	NA
Manganese	15	NA

1 RDL: Required Detection Limit.
NA – parameter not being analyzed for this matrix.

TABLE 1-3

REQUIRED DETECTION LIMITS - MISCELLANEOUS PARAMETERS
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Parameter	RDL[1]
Miscellaneous Parameters	
Alkalinity (CaCO3) (mg/L) (EPA 310.1)	20
Methane (µg/L) (RSK SOP 147/175)	10
Ethane (µg/L) (RSK SOP 147/175)	10
Ethene (µg/L) (RSK SOP 147/175)	10
Carbon Dioxide (µg/L)(RSK SOP 147/175)	1000
Sulfate (mg/L) (EPA 300.0)	1
Sulfide (mg/L) (EPA 376.1)	1
Nitrate (mg/L) (EPA 300.0)	0.05
Nitrite (mg/L) (EPA 300.0)	0.05
Chloride (mg/L) (EPA 300.0)	2
Phosphate (mg/L) (EPA 300.0)	0.05
TOC (mg/L) (EPA 415.1)	1

Reporting Limit provided by Katahdin Analytical Services.

TABLE 1-4

REQUIRED DETECTION LIMITS - METABOLIC ACIDS
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Parameter	RDL[(1)] (mg/L)
Metabolic Acids	
Acetic Acid	0.58
Butyric Acid	0.2
Lactic Acid	17.1
Propionic Acid	0.21
Pyruvic Acid	4.43

1 Reporting Limits Provided by Microseeps.

2.0 PROJECT ORGANIZATION

The project organization for the investigation activities is project specific and is provided in the project-specific Work Plan in Section 1.3. Personnel expected to be involved with the RI/ Feasibility Study (FS) activities at a programmatic level for the foreseeable future include the Navy remedial project manager (RPM), the Facility point of contact, and the current contractor's program manager and quality manager, as follows:

Jeffrey W. Morris (Code C21EC)
Department of the Navy
Engineering Field Activity Chesapeake
1314 Harwood Street NE
Washington Navy Yard, DC 20374-5018
(202) 685-3279
(202) 433-6193 (FAX)

Mr. Shawn Jorgensen, Code 044SJ
Indian Head Division
Naval Surface Warfare Center
Building D-327, 101 Strauss Avenue
Indian Head, MD 20640-5035
(301) 744-2263
(301) 744-4180 (FAX)

Mr. John Trepanowski
Program Manager
Tetra Tech NUS, Inc.
600 Clark Avenue, Suite 3
King of Prussia, PA 19406-1433
(610) 491-9688
(610) 971-0924 (FAX)

Ms. Kelly Carper
Quality Assurance Manager
Tetra Tech NUS, Inc.
661 Andersen Drive
Pittsburgh, PA 15220
(412) 921-7273
(412) 921-4040 (FAX)

3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall QA objective for this project is to develop and implement procedures for field sampling, chain-of-custody, laboratory analysis, and reporting that will provide results which will indicate that enhanced bioremediation is, or is not, a viable remedial technology for Site 57. Specific procedures for sampling, chain of custody, laboratory instrument calibration, laboratory analysis, reporting of data, internal quality control, audits, preventive maintenance of field equipment, and corrective action are described in other sections of the Master QAPP.

The PARCC parameters (precision, accuracy, representativeness, comparability, and completeness) are qualitative and/or quantitative statements regarding the quality characteristics of the data used to support project objectives and ultimately, environmental decisions. These parameters are discussed in the remainder of this section. Specific routine procedures used to assess the quantitative parameters (precision, accuracy, and completeness) are provided in Section 12.0 of the Master QAPP.

3.1 PRECISION

3.1.1 Definition

Precision is a measure of the amount of variability and bias inherent in a data set. Precision describes the reproducibility of measurements of the same parameter for samples under similar conditions. The equation for determining precision is provided in Section 12.2 of the Master QAPP.

3.1.2 Field Precision Objectives

Field duplicate precision monitors the consistency with which environmental samples were obtained and analyzed. Field duplicate results for solid matrix samples are considered to be precise if the relative percent difference (RPD) is less than or equal to 50 percent. Field duplicate results for aqueous matrix samples are considered to be precise if the RPD is less than or equal to 30 percent. Field precision is assessed through the collection and measurement of field duplicates at a rate of 1 duplicate per 10 environmental samples or one duplicate per sampling day per matrix, whichever is greater.

3.1.3 Laboratory Precision Objectives

Laboratory precision Quality Control samples are analyzed at a frequency of 5 percent (i.e., one quality control sample per 20 environmental samples). Laboratory precision is measured via comparison of calculated Relative Percent Difference (RPD) values and Precision Control Limits specified in the analytical method or by the laboratory's QA/Quality Control (QC) Program.

The following analyses will be completed for environmental samples collected during the Site 57 Pilot Study at NSWC Indian Head:

- Chlorinated volatile organic compounds and ethyl ether analyses via SW-846 8260B
- Arsenic, iron (total and dissolved), and manganese (total and dissolved) analysis via SW-846 6010B
- Alkalinity via EPA Method 310.1
- Dissolved gases via RSK SOP-147/175
- Anions via EPA Method 300.0
- Sulfide via EPA Method 376.1
- Metabolic acids via the Laboratory SOP
- TOC via EPA Method 415.1

Precision for chlorinated VOCs organic analysis will be measured via the RPDs for matrix spike/matrix spike duplicate (MS/MSD) samples. Precision for arsenic, iron, and manganese inorganic analysis will be measured via RPDs for laboratory duplicates. RPDs should be statistically derived at the analytical laboratory. These limits will be provided in each analytical data package. Precision for anions, metabolic acids, TOC, alkalinity, and dissolved gases will be measured via the RPDs for MS/MSD or laboratory control/laboratory control duplicate samples. RPDs should be statistically derived at the analytical laboratory. These limits will be provided in each analytical data package.

3.2 ACCURACY

3.2.1 Definition

Accuracy is the degree of agreement between two results which are observed value and an accepted reference value. The equation for determining accuracy is provided in Section 12.1 of the Master QAPP.

3.2.2 Field Accuracy Objectives

Accuracy in the field is assessed through the use of field, equipment, and trip blanks and is ensured through the adherence to all sample handling, preservation and holding times. Accuracy and precision requirements for field measurements (e.g., pH) are ensured through use of the manufacturers standard operating instructions.

3.2.3 Laboratory Accuracy Objectives

Accuracy in the laboratory is measured through the comparison of a spiked sample result against a known or calculated value expressed as a percent recovery (%R). Percent recoveries are derived from the analysis of known amounts of compounds spiked into deionized water (i.e., laboratory control sample analysis), or into actual samples (i.e., surrogate or matrix spike analysis). These analyses measure the accuracy of laboratory operations as affected by matrix. Laboratory control sample and/or matrix spike analyses are performed with a frequency of one per twenty associated samples of like matrix. Surrogate spike analysis is performed for all organic analyses. Laboratory accuracy is assessed via comparison of calculated %R values with Accuracy Control Limits specified in the analytical method or by the contracted laboratory's QA/QC Program.

The following analyses will be completed for environmental samples collected during the Site 57 Pilot Study at NSWC Indian Head:

- Chlorinated volatile organic compounds and ethyl ether analyses via SW-846 8260B
- Arsenic, iron (total and dissolved), and manganese (total and dissolved) analysis via SW-846 6010B
- Alkalinity via EPA Method 310.1
- Dissolved gases via RSK SOP-147/175
- Anions via EPA Method 300.0
- Sulfide via EPA method 376.1
- Metabolic acids via the Laboratory SOP
- TOC via EPA Method 415.1

Accuracy for chlorinated VOCs analyses will be measured via the percent recoveries for surrogate spikes and matrix spike/matrix spike duplicates. Accuracy for arsenic, manganese, and iron analysis will be measured via percent recoveries for matrix spikes and laboratory control samples. Quality control limits for matrix and surrogate spike recoveries are statistically derived by the analytical laboratory and will be provided in each analytical data package. Accuracy for anions, metabolic acids, TOC, alkalinity, and dissolved gases will be measured via percent recoveries for MS or laboratory control samples. RPDs should be statistically derived at the analytical laboratory. These limits will be provided in each analytical data package. Quality control limits for matrix and surrogate spike recoveries are statistically derived by the analytical laboratory and will be provided in each analytical data package.

3.3 COMPLETENESS

3.3.1 Definition

Completeness is a measure of the amount of usable, valid, analytical data obtained, compared to the amount expected to be obtained. Completeness is typically expressed as a percentage.

The ideal objective for completeness is 100 percent (i.e., every sample planned to be collected is collected; every sample submitted for analysis yields valid data). However, samples can be rendered unusable during shipping or preparation (e.g., bottles broken or extracts accidentally destroyed); errors can be introduced during analysis (e.g., loss of instrument sensitivity, introduction of ambient laboratory contamination), or strong matrix effects can become apparent (e.g., extremely low matrix spike recovery). These instances result in data that do not meet QC criteria. Based on these considerations, 95 percent is considered an acceptable target for the data completeness objective. If critical data points are lost, resampling and/or reanalysis may be required.

One hundred percent of the data for the Pilot Study activities shall be validated in a limited fashion. The validation will be formulated to address only gross non-compliances resulting in the rejection of data and the elimination of false positives in accordance with the U.S. EPA National Functional Guidelines for Organic and Inorganic Data Review unless dictated otherwise by Project-Specific Data Quality Objectives (DQOs). Data rejected as a result of the validation process will be treated as incomplete data.

3.3.2 Field Completeness Objectives

Field completeness is a measure of the amount of valid field measurements obtained from all the field measurements taken in the project. The equation for completeness is presented in Section 12.3 of the Master QAPP. Field data completeness for the NSWC Indian Head Site 57 Pilot Study activities is expected to be 100 percent.

3.3.3 Laboratory Completeness Objectives

Laboratory completeness is a measure of the amount of valid laboratory measurements obtained from all the laboratory measurements made in support of a given project. The equation for completeness is presented in Section 12.3 of the Master QAPP. Laboratory completeness for the NSWC Indian Head Site 57 Pilot Study activities is expected to be at least 95 percent.

3.4 REPRESENTATIVENESS

3.4.1 Definition

Representativeness is an expression of the degree to which the data accurately and precisely depict the actual characteristics of a population or environmental condition existing at an individual sampling point. Use of standardized sampling, handling, analytical, and reporting procedures ensures that the final data accurately represent actual site conditions.

3.4.2 Measures to Ensure Representativeness of Field Data

Representativeness is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the Pilot Study Work Plan is followed and that the sampling techniques detailed are used.

3.4.3 Measures to Ensure Representativeness of Laboratory Data

Representativeness in the laboratory is ensured by using the proper analytical procedures, meeting sample holding times, and analysis of field duplicate samples.

3.5 COMPARABILITY

3.5.1 Definition

Comparability is defined as the confidence with which one data set can be compared to another (e.g., between sampling points; between sampling events). Comparability is achieved by using standardized sampling and analysis methods, and data reporting formats (including use of consistent units of measure and reporting of solid matrix sample results on a dry-weight basis). Additionally, consideration is given to seasonal conditions and other environmental variations that could exist to influence data results.

3.5.2 Measures to Ensure Comparability of Field Data

Comparability is dependent upon the proper design of the sampling program and will be satisfied by ensuring that the Pilot Study Work Plan is followed and that proper sampling techniques are used. It is also dependent on recording field measurements using the correct units.. The units used for the Pilot Study field measurements are as follows:

- pH is measured to the nearest 0.1 standard pH unit.
- Specific conductance is measured in µmhos (the inverse of the ohm).
- Temperature is measured in degrees Celsius.

- Turbidity is measured in nephelometric turbidity units (NTU).
- Dissolved oxygen is measured in mg/L.
- Oxidation Reduction Potential is measured in millivolts (mV).
- Ferrous Iron is measured in mg/L.
- Hydrogen Sulfide is measured in mg/L.

3.5.3 Measures to Ensure Comparability of Laboratory Data

Analytical data will be comparable when similar sampling and analytical methods are used and documented. Results will be reported in units that ensure comparability with previous data and with current state and federal standards and guidelines. Chlorinated VOCs will be reported in µg/L for aqueous samples and µg/kg for solid samples. Arsenic, iron, and manganese will be reported as µg/L for aqueous samples and mg/kg for solid samples. Dissolved gases and metabolic acids will be reported as µg/L for aqueous samples. TOC, alkalinity, and anions will be reported as mg/L for aqueous samples. Detection/reporting limits are discussed in Section 1 of this project-specific QAPP.

3.6 LEVEL OF QUALITY CONTROL EFFORT

Trip blank, equipment blank, field blank, method blank, duplicate, standard reference materials (SRM), and matrix spike samples will be analyzed to assess the quality of the data resulting from the field sampling and analytical programs. In addition, duplicate field measurements will be completed for oxidation reduction potential, ferrous iron, hydrogen sulfide, temperature, dissolved oxygen, pH, specific conductance, and turbidity, as applicable.

External QC samples (i.e., field quality control samples) consist of field duplicates, field blanks, trip blanks, and equipment (rinsate) blanks. Each of these types of field quality control samples undergo the same preservation, analysis, and reporting procedures as the related environmental samples. Each type of field quality control sample is discussed below.

Field duplicates are either two samples collected independently at a sampling location (e.g., surface water), or a single sample homogenized and split into two portions. Where VOCs are to be analyzed, the VOC sample aliquots are containerized first to avoid loss of constituents, then the remaining sample matrix is homogenized. Field duplicates are collected and analyzed for chemical constituents to measure the precision of the sampling and analysis methods employed. The general level of the QC effort will be one field duplicate for every 10 or fewer investigative samples or one duplicate per matrix per sampling day, whichever is greater.

Trip blanks and field blanks (ambient condition blanks), consisting of distilled water, will be submitted to the laboratories to provide the means to assess the quality of the data resulting from the field sampling program. Field blank samples are analyzed to check for background contamination at the facility (e.g., vapors or exhaust fumes) which may cause sample contamination. Field blanks will be collected based on conditions at the time of sampling at the discretion of the Field Operations Leader (FOL), with a minimum of one field blank being collected per individual contiguous area of potential concern. Trip blanks pertain to VOCs only. Trip blanks are used to assess the potential for contamination of VOCs resulting from contaminant migration into sample bottles/jars during sample shipment and storage. Trip blanks are prepared by the laboratory prior to the sampling event, shipped to the site with the sample containers, and kept with the investigative samples throughout the sampling event. They are then packaged for shipment with other VOC samples and sent for analysis. There should be one trip blank included in each sample shipping container that contains VOCs. At no time after trip blank preparation are the trip blank sample containers opened before they reach the laboratory.

Equipment (rinsate) blanks are obtained under representative field conditions by collecting the rinse water generated by running analyte-free water through sample collection equipment after decontamination and prior to use. One rinsate blank will be collected per each type of sampling equipment used (i.e., bailer, split-spoon sampler, hand tools, etc.) per day that sampling is conducted at a minimum frequency of 10 percent. A sampling event is matrix specific, therefore an equipment blank must be collected for each matrix sampled. If pre-cleaned, dedicated, or disposable sampling equipment is used, one rinsate blank must be collected as a "batch blank." Rinsate blanks are analyzed for the same chemical constituents as the associated environmental samples.

Method blank samples are generated within the laboratory and used to assess contamination resulting from laboratory procedures. Laboratory duplicate samples are analyzed for inorganic parameters to check for sampling and analytical reproducibility. Matrix spikes provide information about the effect of the sample matrix on the digestion and measurement methodology. All matrix spikes for organic analyses are performed in duplicate and are hereinafter referred to as MS/MSD samples. One matrix spike/matrix spike duplicate will be analyzed for every 20 or fewer investigative samples.

MS/MSD samples are investigative samples. Soil MS/MSD samples require no extra volume for VOCs or extractable organics. However, aqueous MS/MSD samples must be collected at triple the volume for VOCs and double the volume for extractable organics. One MS/MSD sample will be collected/designated for every 20 or fewer investigative samples per sample matrix (i.e. groundwater, soil).

The level of QC effort for testing of chlorinated volatile organics plus ethyl ether will conform to the SW-846 Method 8260B. The level of QC effort for testing of arsenic, iron, and manganese will conform to the SW-846 Method 6010B. The level of QC effort for testing dissolved gases will conform to the RSK

SOP-147/175. The level of QC effort for testing anions will conform to the EPA Method 300.0. The level of QC effort for testing TOC will conform to the EPA Method 415.1. The level of QC effort for testing alkalinity will conform to the EPA Method 310.1. The level of QC effort for testing metabolic acids will conform to the laboratory SOP.

4.0 SAMPLING PROCEDURES

Field sampling procedures for NSWC Indian Head Remedial Investigation activities are discussed in detail in the Station SOPs deliverable. Specific sampling information contained in the Master SOP Deliverable and to be provided in Project-Specific Work Plans is as follows:

- Field sampling by matrix
- Field quality control sample collection/preparation procedures
- Sample containers, preservatives, and volume requirements
- Decontamination procedures
- Sample packaging and shipping procedures
- Mobilization/demobilization
- Monitoring well installation
- Monitoring well development
- Groundwater sampling
- Water level measurements
- Soil sampling procedures
- Surveying
- Aquifer testing
- Waste handling
- Quality control sample procedures
- Field measurements/screening
- Preventive maintenance procedures/schedule
- Sample disposal

5.0 CUSTODY PROCEDURES

Refer to Section 5.0 of the Master QAPP (B&R Environmental, 1997).

6.0 CALIBRATION PROCEDURES AND FREQUENCY

Calibrations for the laboratory analyses detailed in the accompanying Pilot Study Work Plan will be performed in accordance with laboratory standard operating procedures. Calibration for the field parameters will be performed according to manufacturers instructions.

7.0 ANALYTICAL AND MEASUREMENT PROCEDURES

Refer to Section 7.0 and 7.1 of the Master QAPP (B&R Environmental, 1997).

7.2 LABORATORY ANALYTICAL AND MEASUREMENT PROCEDURES

Chlorinated volatile organics and arsenic, iron, and manganese will be analyzed in accordance with the SW-846 analytical procedures set forth in the U.S. EPA SW-846 Methods 8260B and 6010B, respectively. Anions, TOC, and alkalinity will be analyzed in accordance with the analytical procedures set forth in the U.S. EPA Methods 300.0, 415.1, and 310.1, respectively. Dissolved gases will be analyzed in accordance with the analytical procedures set forth in the RSK SOP-147/175. Metabolic acids will be analyzed in accordance with the laboratory's SOP.

7.2.1 List of Project Target Compounds and Detection Limits

Table 7-1 provides a summary of the analytical methods for the anticipated activities. A complete list of the target compounds/analytes and Required Quantitation and Detection Limits is provided in Section 1 of the Project-specific QAPP. Data generated through use of SW-846 protocols will be reported to the RDL for organics and inorganics analysis. All solid sample results will be reported on a dry-weight basis. Quantitation and detection limits will also be adjusted, as necessary, based on dilutions and sample volume.

7.2.2 List of Associated Quality Control Samples

In addition to the field quality control samples (duplicates, trip blanks, rinsate blanks, etc.) discussed in Section 3.0 of the Master Quality Assurance Project Plan, laboratory quality control samples including matrix spike/matrix spike duplicate samples, method blanks, preparation blanks, etc. will be analyzed as required by the SW-846 methods. Laboratory Quality Control samples are discussed in additional detail in Section 8.0 of the Master QAPP.

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TABLE 7-1

SUMMARY OF ORGANIC AND INORGANIC ANALYTICAL PROCEDURES
SOLID AND AQUEOUS MATRICES
INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER
INDIAN HEAD, MARYLAND

Analytical Parameter	Analytical Method
Chlorinated Volatile Organics	SW-846 8260B[1]
Arsenic, iron, and manganese	SW-846 6010B[1]
Alkalinity	EPA 310.1[2]
TOC	EPA 415.1[2]
Anions	EPA 300.0[3]
Sulfide	EPA 376.1[2]
Dissolved gases	RSK SOP 147/175[4]
Metabolic acids	Laboratory SOP

1 U.S. EPA (U.S. Environmental Protection Agency), 1994. Test Methods for Evaluating Solid Waste Physical/Chemical Methods (SW-846). Third Edition, Final Update IIA.
2 U.S. EPA (600/4-79-020) Methods for Chemical Analysis of Water and Wastes. Revised March 1983.
3 U.S. EPA (600/R-93-100) Methods for the Determination of Inorganic Substances in Environmental Samples. August 1993.
4 RSK SOP-147/175, (U.S.) Robert S. Kerr Environmental Research Lab, Ada, OK.

8.0 INTERNAL QUALITY CONTROL CHECKS

Field-related Quality Control checks were discussed in Section 3.0 of the Master Quality Assurance Project Plan and in the Master Work Plan. This section provides additional information regarding internal quality control checks for the field and the laboratory.

8.1 FIELD QUALITY CONTROL CHECKS

Quality Control procedures for pH, specific conductance, temperature, ferrous iron, hydrogen sulfide, and turbidity will include calibrating the instruments as described in Section 6.0 of the Master QAPP and in the Indian Head Master Standard Operating Procedures. Assessment of field sampling precision and bias will be made by collection of field duplicates and equipment blanks for laboratory analysis. Collection of the Field Quality Control samples will be in accordance with the procedures provided in the Master Work Plan at the frequency discussed in Section 3.0 of this QAPP.

8.2 LABORATORY QUALITY CONTROL CHECKS

Subcontract laboratories will have a Quality Control program that ensures the reliability and validity of the analyses performed at the laboratory. All analytical procedures are typically documented in writing as SOPs. Laboratory SOPs for any and all analyses will be provided in either Addenda to the QAPP or under separate cover contingent upon the logistics of the laboratory procurement process.

Internal quality control procedures for SW-846 analyses (volatile, arsenic, iron, and manganese) are discussed in SW-846 Methods 8000, 8260, 6000, and 6010B. Internal quality control procedures for EPA analyses (anions, alkalinity, and TOC) are discussed in EPA Methods 300.0, 310.1, and 415.1. Internal quality control procedures for dissolved gases are discussed in RSK SOP-147-175. Internal quality control procedures for metabolic acids are discussed in the laboratory SOP. Several internal laboratory Quality Control checks are briefly discussed in the remainder of this section.

Laboratory method blanks are prepared and analyzed in accordance with the analytical method employed to determine whether contaminants originating from laboratory sources have been introduced and have affected environmental sample analyses. A method blank generally consists of an aliquot of analyte-free water (or purified sodium sulfate for soil/sediment samples) that is subjected to the same preparation and analysis procedures as the environmental samples undergoing analysis. If method blank contamination is found to exist, corrective actions indicated in the SW-846 Methods or laboratory SOPs must be followed. Under no circumstances are laboratory method blank contaminant values subtracted from environmental sample analysis results.

Matrix spike analysis for organic fraction analyses is performed in duplicate as a measure of laboratory precision. For inorganic analyses, one **laboratory duplicate** analysis is likewise performed for every 20 environmental sample analyses of like matrix. With the exception of VOC MSD analyses, laboratory duplicates are prepared by thoroughly mixing and splitting a sample aliquot into two portions and analyzing each portion following the same analytical procedures that are used for the environmental sample analyses. For VOC MSD analyses, a second sample aliquot is used for analysis in order to avoid VOC constituent loss through the homogenization process. The field crew provides extra volumes of sample matrices designated for laboratory quality control analyses, as required. Control limits for laboratory duplicate analyses are established statistically by the laboratory in accordance with method-specific procedures and general protocols outlined in the laboratory SOPs for non-CLP analyses. The laboratory SOPs and SW-846 Methods define under what circumstances corrective actions are warranted and how they must be performed when required.

Surrogates are organic compounds (typically brominated, fluorinated, or isotopically labeled), which are similar in nature to the compounds of concern, and which are not likely to be present in environmental media. Surrogates are spiked into each sample, standard, and method blank prior to analysis, and are used only in organic chromatographic analysis procedures as a check of method effectiveness. Surrogate recoveries are evaluated against laboratory-derived statistical control limits.

Laboratory control samples (LCS) serve to monitor the overall performance of each step during the analysis, including the sample preparation. Laboratory control sample analysis will be performed for arsenic and VOC analyses. Aqueous LCS results must fall within the control limits statistically established by the laboratory. Solid LCS results must fall within the control limits established by EPA-EMSL/LV, where applicable, or the supplier of the LCS standard. Aqueous and solid Laboratory Control Samples shall be analyzed utilizing the same sample preparations, analytical methods and QA/QC procedures as employed for the samples.

Internal standard performance criteria ensure that gas chromatograph/mass spectrometer (GC/MS) analysis sensitivity and response are stable during every analytical run. Internal standard area counts for samples and blanks must not vary by more than a factor of two (-50% to +100%) from the associated 12-hour calibration standard. The retention time of the internal standards in samples and blanks must not vary by more than $\pm$30 seconds from the retention time of the associated 12-hour calibration standard.

Additional internal laboratory Quality Control checks include mass tuning for GC/MS analysis.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

Refer to Section 9 of the Master QAPP (B&R Environmental, 1997).

10.0 PERFORMANCE AND SYSTEM AUDITS

Refer to Section 10 of the Master QAPP (B&R Environmental, 1997).

11.0 PREVENTIVE MAINTENANCE PROCEDURES

Refer to Section 11 of the Master QAPP (B&R Environmental, 1997) with the exception of Table 11-1.

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TABLE 11-1

PREVENTIVE MAINTENANCE FOR ANALYTICAL INSTRUMENTS INDIAN HEAD DIVISION, NAVAL SURFACE WARFARE CENTER INDIAN HEAD, MARYLAND

Instrument	Preventive Maintenance	Maintenance Frequency
Ion Chromatograph	Replace pump seals.	Annually.
	Lubricate analytical pump motor.	Semi-annually.
	Check chromatography module and all gas lines for leaks.	Every run.
	Clean conductivity detector cell electrodes, check cell calibration.	Monthly.
	Replace bed supports, clean columns, clean membrane suppressor, replace autosampler pipette tip.	As needed.
TOC Analyzer	Replace pump tubing.	Each run.
	Change other tubing, change furnace tubes, change LiOH tube, change tin trap, adjust optical balance, change septum, change permeation dryer tubing.	As needed.
	Change IR filter screen, change gas tubing.	Check monthly.
Alkalinity	N/A (titrimetric analysis)	

12.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY, AND COMPLETENESS

Refer to Section 12 of the Master QAPP (B&R Environmental, 1997).

13.0 CORRECTIVE ACTION

Refer to Section 13 of the Master QAPP (B&R Environmental, 1997).

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

Refer to Section 14 of the Master QAPP (B&R Environmental, 1997).

REFERENCES

B&R Environmental, 1997. Master Plans for Remedial Investigations, Indian Head Division, Naval Surface Warfare Center, Indian Head, Maryland. Pittsburgh, Pennsylvania. April 1997.

SW-846 Methods 6010B and 8260B. Test Methods for Evaluating Solid Wastes, Volumes 1A through 1C: Laboratory Manuals Physical/Chemical Methods. SW 846, third edition with updates up to and including Update III. Office of Solid Waste and Emergency Response, Washington, D.C., November.

EPA Methods 310.1 and 415.1. U.S. EPA (600/4-79-020) Methods for Chemical Analysis of Water and Wastes. Revised March 1983.

EPA Method 300.0. U.S. EPA (600/R-93-100) Methods for the Determination of Inorganic Substances in Environmental Samples. August 1993.

RSK SOP-147/175, (U.S.) Robert S. Kerr Environmental Research Lab, Ada, OK.

EPA QA/G-5. Guidance for Quality Assurance Project Plans. December 2000.

EPA QA/R-5. EPA Requirements for Quality Assurance Project Plans. March 2001.

U.S. Navy Closed, Transferred, and Transferring Range and Other Sites Questionnaire

I. Installation Information

A. Installation Name: **IHDIVNAVSURFWARCEN**
FFID Number: **MD3170024109**
UIC Number: **N00174**

B. Nearest Installation City: **Indian Head** County: **Charles** State: **MD**

C. Regional Command:

D. Major Claimant: **Commander, Naval Sea Systems Command**

E. Point of contact (POC) for completing the questionnaire:

Name: **Elaine Magdinec**
Organization: **Environmental Office**
Address: **IHDIVNAVSURFWARCEN**
Address: **101 STRAUSS AVE. CODE 044EM**
City: **INDIAN HEAD**
State: **MD**
Phone: **(301) 744-2264**
E-mail: **magdinecea@ih.navy.mil**

II. Known CTT Range Areas and Other Sites

A. Does or did the installation ever have a **CTT military range** or **other site (not located on an operational range)** where MEC or munitions constituents are known or suspected to be present?

- (•) Yes
- ( ) No

B. If yes, identify each range/site by the name and status below (refer to range definitions).

Table II-1 - Range/Site Status[1]

No.	Range/Site Name[2]	Range/Site Status (select one)				Navy ID[3]
		Closed	Transferred	Transferring	Other	
1	Caffee Road Thermal Treatment Point	( )	( )	( )	(•)	N0017402
2	Safety Thermal Treatment Point	( )	( )	( )	(•)	N0017403
3	Small Arms Range (Pistol Range)	(•)	( )	( )	( )	N0017406
4	Area 8	(•)	( )	( )	( )	N0017408
5	Improvised Explosive Device (IED) Practical Training Area	(•)	( )	( )	( )	N0017409
6	Inert Ordnance Devices (IOD) Site	(•)	( )	( )	( )	N0017410
7	Air Blast Pond	(•)	( )	( )	( )	N0017411

8	Old Demolition Range	◉	○	○	○	N0017412
9	Marine Rifle Range	◉	○	○	○	
10	Test Area 1	◉	○	○	○	
11	Test Area 2	○	○	○	◉	
12	Stump Neck Impact Area	◉	○	○	○	
13	The Valley	◉	○	○	○	
14	Water Impact Areas	◉	○	○	○	
15	Igniter Area	○	○	○	◉	
16	Battle Range Firing	◉	○	○	○	
17	Former Pinkwater Treatment Facility	○	○	○	◉	
18	Torpedo Burial Site	○	○	○	◉	
19	Single Base Propellant Grains Spill Area	○	○	○	◉	
20	Causeway	○	○	○	◉	
21	NG Slums Burning Ground	○	○	○	◉	
22	Original Burning Ground	○	○	○	◉	
23	Torpedo Casing Disposal Area	○	○	○	◉	
24	Old Skeet and Trap Range	◉	○	○	○	
25	Rum Point Skeet Range	◉	○	○	○	
26	FDR Skeet Range	◉	○	○	○	

[1]Range status/classification should be determined by existing property records and/or, in the case of closed ranges, by the range operations community.

[2]The purpose of this questionnaire is to identify individual ranges and sites.

[3]CNO will populate the Navy ID column to correlate the questionnaire data with previously submitted information.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Caffee Road Thermal Treatment Point**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **OTHER**
3. Range/Site Point of Contact:

a. Name: **Elaine Magdinec**
b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
c. Phone: **(301) 744-2264**
d. E-mail: **MagdinecEA@ih.navy.mil**

4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   - ○ Yes
   - ◉ No

   a. NORM Site Number:
   b. NORM Site Name:

5. Range/Site Classification (check all that apply):
   - ☐ Disposal
   - ☐ Emergency Destruction
   - ☑ Open Burn/Open Detonation (OB/OD)
   - ☑ Other: **Decontamination of minutely explosive contaminated metal and**

6. Range/Site Type (check all that apply):
   - ☑ Land
   - ☐ Water

7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☐ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200

8. Please indicate the:
   a. Total range/site acreage: **2.0**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **2.0**
      ○ Known ◉ Estimated ○ Unknown

9. Is a range/site map available?
   - ◉ Yes
   - ○ No

   a. If yes, is the map available in electronic format?
      - ◉ Yes - what format?
        - ☑ .pdf ☐ .shp
        - ☐ .bmp ☐ .dwg
        - ☐ .tif ☐ .dgn
        - ☐ .gif ☐ .dxf
        - ☐ .jpg
      - ○ No

   b. What information does the map (or maps) depict? (select all that apply)

- ☑ Range location
- ☑ Range boundaries
- ☐ Target locations
- ☑ Natural/cultural resources
- ☑ Other: **Many other GIS layers**

10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☐ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☑ Bulk Propellant (solid or liquid)	◉	○	○	○

☑ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	◉	○	○	○
☑ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	◉	○	○	○
☐ Demolition Charges	○	○	○	○
☑ CADs/PADs	◉	○	○	○
☑ Primers, Detonators, Fuzes, Squibs	◉	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☑ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	◉	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☑ Other: **Metal and combustibles minutely contaminated with explosives**	○	○	○	◉

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous

- ○ Rolling w/gorges or gullies
- ○ Water Range

14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Barren or low grass
    - ○ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ○ Heavily Wooded
    - ○ Water Range
15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ○ Actual (known)
    - ○ Potential
    - ○ No Potential
    - ◉ Unknown
16. Are there any wetland areas associated with this range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, what is the estimated acreage? **0.25**
17. Are threatened or endangered species present on this range/site?
    - ○ Yes, please list:
    - ◉ No
    - ○ Unknown
18. Does the range/site contain archeological or cultural sites?
    - ○ Yes
    - ◉ No
    - ○ Unknown
19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ○ Yes
    - ◉ No

20. Have munitions response activities been initiated/conducted on the range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
    - ☐ Munitions and Explosives of Concern (includes UXO)
    - ☐ Munitions Constituents
    - ☐ Other chemical contamination
    - ☐ Unknown

    b. What is the status of the munitions response activities? (select all that apply)
    - ☐ Data collection
    - ☐ Investigation
    - ☐ Response/remedial action
    - ☐ Operation and maintenance
    - ☐ Monitoring
    - ☐ Close out

    c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?
    - ○ Yes
    - ○ No
    - ○ Unknown

    d. Under what authority were/are response actions conducted?
    - ○ CERCLA
    - ○ RCRA
    - ○ Both CERCLA and RCRA
    - ○ Unknown
    - ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - ☐ Emergency response actions
    - ☐ Time-critical removal actions
    - ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - ☐ Non-munitions response actions

      Explain:
    - ☑ None
    - ☐ Unknown
    - ☐ Other:

22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)

23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
    Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

    What is the RAC Hazard Severity? ◉ I ○ II ○ III ○ IV ○ V

    What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

What is the RAC? ◉ I ○ II ○ III ○ IV ○ V

24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
☐	☐	Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
☐	☐	Other:

25. How is access currently controlled? (select all that apply)
- ☐ No controls
- ☐ Not controlled, used for another purpose
- ☑ Signs
- ☐ Fencing around entire range/site
- ☑ Partial fencing
- ☑ Locked/secured gates
- ☑ Log-in book/Office check-in
- ☑ Security patrol
  - ☐ Vessel ☐ Aircraft ☑ Other **Vehicle**
- ☑ Other: **barricade, siren, The guard at gate and patrols by security officer are controls for the entire restricted area.**

26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

Lease to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Ownership transfer to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity

☐ Unknown

Reason for transfer:

☐ Termination of lease
☐ Revocation of withdrawn land
☐ Base Realignment and Closure action
☐ Other:

a. List the entity(ies) receiving the property:

☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)

☐ Unknown

27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

☑ Federal Agency
☐ State Government
☐ Local Government
☐ Private Sector
☐ Tribal Government
☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Caffee Road Thermal Treatment Point

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 4: The site is not in the IR program but the landfill underneath is an IR site and will be capped.

Part II-C Question 19: Caffee Road Thermal Treatment Point was included in the original RCRA Subpart X permit application in 1988 for open burning explosive hazardous waste.

Part II-C Question 3: Caffee Road Thermal Treatment Point was used to thermally decontaminate items that were minutely contaminated with any propellant, explosives or pyrotechnics. This site was added to this inventory because the operations have ceased and have been relocated to another location. Operations will not be able to reopen in the future because a landfill exists underneath the site. The landfill is an IR site and will be capped.

Part II-C Question 10: Contamination from military munitions should be in minute amounts. No full up rounds were treated here.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Caffee Road Thermal Treatment Point
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	**6**
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**6**

What evidence do you have regarding conventional unexploded ordnance?
Operating procedures document the use of initiating devices.

B. Pyrotechnics (for munitions not described above):	VALUE
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	**4**
Pyrotechnics (largest single value)	**4**

What evidence do you have regarding pyrotechnics?

MTV contaminated items were sent to CRTTP

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	VALUE
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	**10**
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	**8**
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**10**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	VALUE
Solid or liquid propellants	**6**
Propellants	**6**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	VALUE
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **26**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1

HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	**I**	**21 and/or greater**
CRITICAL	II	10 to 20
MARGINAL	III	5 to 9
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	**2**
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1

0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:
residential, industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F **24**

(maximum of 30)
Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	**1**	2	3	4
CRITICAL II	1	2	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	**High Risk - Highest priority for further action.**
RAC 2	Serious Risk - Priority for further action.
RAC 3	Moderate Risk - Recommend further action.
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Safety Thermal Treatment Point**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **OTHER**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   ○ Yes
   ◉ No
   a. NORM Site Number:
   b. NORM Site Name:
5. Range/Site Classification (check all that apply):
   ☐ Disposal
   ☐ Emergency Destruction
   ☑ Open Burn/Open Detonation (OB/OD)
   ☑ Other: **Testing**
6. Range/Site Type (check all that apply):
   ☑ Land
   ☐ Water
7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   ☐ Less than 3
   ☐ Between 3 and 12
   ☐ Between 12 and 200
   ☐ Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **1.3**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **1.3**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?

- (●) Yes
- ( ) No

a. If yes, is the map available in electronic format?

- (●) Yes - what format?
  - [x] .pdf [ ] .shp
  - [ ] .bmp [ ] .dwg
  - [ ] .tif [ ] .dgn
  - [ ] .gif [ ] .dxf
  - [ ] .jpg
- ( ) No

b. What information does the map (or maps) depict? (select all that apply)

- [x] Range location
- [x] Range boundaries
- [ ] Target locations
- [x] Natural/cultural resources
- [x] Other: **Many other GIS layers**

10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
[ ] Small Arms (.50 cal and under)	( )	( )	( )	( )
[ ] Hand Grenades, explosive	( )	( )	( )	( )
[ ] Hand Grenades, practice (w/spotting charges)	( )	( )	( )	( )
[ ] Rifle Grenades, explosive	( )	( )	( )	( )
[ ] Rifle Grenades, practice (w/spotting charges)	( )	( )	( )	( )
[ ] Projected Grenades, explosive	( )	( )	( )	( )
[ ] Projected Grenades, practice (w/spotting charges)	( )	( )	( )	( )
[ ] Mortars, explosive	( )	( )	( )	( )
[ ] Mortars, practice (w/spotting charges)	( )	( )	( )	( )
[x] Projectiles	( )	( )	( )	(●)
[ ] Bombs, Explosive	( )	( )	( )	( )
[ ] Bombs, practice (w/spotting charges)	( )	( )	( )	( )
[ ] Rockets, explosive	( )	( )	( )	( )
[ ] Rockets, practice (w/spotting charges)	( )	( )	( )	( )
[ ] Large Rocket Motors (>1,000 lbs)	( )	( )	( )	( )
[ ] Warheads	( )	( )	( )	( )

☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☑ Bulk Propellant (solid or liquid)	○	○	○	◉
☑ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	◉
☑ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	◉
☑ Demolition Charges	○	○	○	○
☑ CADs/PADs	○	○	○	◉
☑ Primers, Detonators, Fuzes, Squibs	○	○	○	◉
☐ Military Dynamite	○	○	○	○
☑ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	◉
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☑ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	◉
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft

- ☐ 30-80 ft
- ☐ Greater than 80 ft
- ☐ Unknown

13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Barren or low grass
    - ○ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ○ Heavily Wooded
    - ○ Water Range
15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ○ Actual (known)
    - ○ Potential
    - ○ No Potential
    - ◉ Unknown
16. Are there any wetland areas associated with this range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, what is the estimated acreage? **0.25**
17. Are threatened or endangered species present on this range/site?
    - ○ Yes, please list:
    - ◉ No
    - ○ Unknown
18. Does the range/site contain archeological or cultural sites?
    - ○ Yes

- (•) No
- ( ) Unknown

19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - (•) Yes
    - ( ) No
    - ( ) Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
        - ( ) Yes
        - (•) No

20. Have munitions response activities been initiated/conducted on the range/site?
    - (•) Yes
    - ( ) No
    - ( ) Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
        - [x] Munitions and Explosives of Concern (includes UXO)
        - [x] Munitions Constituents
        - [x] Other chemical contamination
        - [ ] Unknown

    b. What is the status of the munitions response activities? (select all that apply)
        - [x] Data collection
        - [x] Investigation
        - [ ] Response/remedial action
        - [ ] Operation and maintenance
        - [ ] Monitoring
        - [ ] Close out

    c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?
        - ( ) Yes
        - ( ) No
        - (•) Unknown

    d. Under what authority were/are response actions conducted?
        - ( ) CERCLA
        - ( ) RCRA
        - (•) Both CERCLA and RCRA
        - ( ) Unknown
        - ( ) Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - [ ] Emergency response actions
    - [ ] Time-critical removal actions
    - [ ] Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - [ ] Non-munitions response actions

    Explain:

    - [ ] None
    - [ ] Unknown

☑ Other: **See comments**

22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)

23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

What is the RAC Hazard Severity? ◉ I ○ II ○ III ○ IV ○ V

What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

What is the RAC? ◉ I ○ II ○ III ○ IV ○ V

24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
☐	☐	Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
☐	☐	Other:

25. How is access currently controlled? (select all that apply)
- ☐ No controls
- ☐ Not controlled, used for another purpose
- ☑ Signs
- ☐ Fencing around entire range/site
- ☑ Partial fencing
- ☑ Locked/secured gates
- ☑ Log-in book/Office check-in
- ☑ Security patrol
  - ☐ Vessel ☐ Aircraft ☑ Other **vehicle**
- ☑ Other: **The signs, guard at gate, fence and security patrols are for the facility's restricted area.**

26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)
Lease to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency

- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Ownership transfer to:

- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Reason for transfer:

- ☐ Termination of lease
- ☐ Revocation of withdrawn land
- ☐ Base Realignment and Closure action
- ☐ Other:

a. List the entity(ies) receiving the property:

- ☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)

- ☐ Unknown

27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- ☑ Federal Agency
- ☐ State Government
- ☐ Local Government
- ☐ Private Sector
- ☐ Tribal Government
- ☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Safety Thermal Treatment Point

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 19: The site was on the original RCRA Subpart X permit application sent to EPA in 1988. The permit was never issued.

Part II-C Question 21: STTP became inactive in 1988. Since it was included in our Subpart X permit application, it was being closed under RCRA. A characterization study was done in 1995. A Closure/Post Closure Plan was drafted but not submitted to EPA because we suspected that some contamination may have resulted from nearby testing operations as shown in the characterization study. The STTP was included in the IR program as SWMU 20 and is an area of concern.

Part II-C Question 3: The Safety Thermal Treatment Point (STTP) was used to thermally treat explosives and propellants generated from research and testing operations. Explosive safety testing

was also conducted. The STTP was included in the RCRA Subpart X Permit application submitted in 1988 but the STTP was shut down soon thereafter and the permit was never issued. Closure of the STTP was initiated but during the characterization and investigation, we discovered that the high lead levels near the site was caused by testing operations not covered in the Subpart X permit. To ensure adequate clean up of the entire area, the site was included in the IR program and the cleanup handled under CERCLA not RCRA. The STTP is sometimes referred to as the Safety Burn Point.

Part II-C Question 10: This area should only have residues from military munitions. No full up rounds should be on the site.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Safety Thermal Treatment Point
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition: **VALUE**

Medium/large caliber (20mm and larger)	**10**
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	**6**
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**10**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	**4**
Pyrotechnics (largest single value)	**4**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	**10**
Demolition charges	**10**
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	**8**
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	**3**
High explosives (largest single value)	**10**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	**6**
Propellants	**6**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **30**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	**I**	**21 and/or greater**
CRITICAL	II	10 to 20
MARGINAL	III	5 to 9
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	**2**
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4

0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:
residential, industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **24**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	**1**	2	3	4
CRITICAL II	1	2	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE

	RAC
RAC 1	**High Risk - Highest priority for further action.**
RAC 2	Serious Risk - Priority for further action.
RAC 3	Moderate Risk - Recommend further action.
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Small Arms Range (Pistol Range)**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **CLOSED**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   ○ Yes
   ◉ No
   a. NORM Site Number:
   b. NORM Site Name:
5. Range/Site Classification (check all that apply):
   ☐ Testing
   ☐ Training
   ☑ Small Arms Only (.50 cal and under)
   ☐ Emergency Destruction
   ☐ Open Burn/Open Detonation (OB/OD)
   ☐ Other:
6. Range/Site Type (check all that apply):
   ☐ Air-to-Air
   ☐ Air-to-Water

- ☐ Air-to-Land
- ☐ Land-to-Air
- ☑ Land-to-Land
- ☐ Land-to-Water
- ☐ Water-to-Air
- ☐ Water-to-Land
- ☐ Water-to-Water
- ☐ Unknown

7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☐ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **1.0**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **1.0**
      ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?
   ◉ Yes
   ○ No
   a. If yes, is the map available in electronic format?
      ◉ Yes - what format?
      - ☑ .pdf ☐ .shp
      - ☐ .bmp ☐ .dwg
      - ☐ .tif ☐ .dgn
      - ☐ .gif ☐ .dxf
      - ☐ .jpg

      ○ No
   b. What information does the map (or maps) depict? (select all that apply)
      - ☑ Range location
      - ☑ Range boundaries
      - ☐ Target locations
      - ☑ Natural/cultural resources
      - ☑ Other: **Many other layers of information**
10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC

Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☑ Small Arms (.50 cal and under)	○	○	◉	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☐ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○

☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ○ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ◉ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Barren or low grass
    - ○ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ○ Heavily Wooded
    - ○ Water Range

15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ○ Actual (known)
    - ○ Potential
    - ○ No Potential
    - ◉ Unknown

16. Are there any wetland areas associated with this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, what is the estimated acreage? **0.0**

17. Are threatened or endangered species present on this range/site?
    - ○ Yes, please list:
    - ◉ No
    - ○ Unknown

18. Does the range/site contain archeological or cultural sites?
    - ○ Yes
    - ◉ No
    - ○ Unknown

19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ○ Yes
    - ○ No

20. Have munitions response activities been initiated/conducted on the range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
    - ☐ Munitions and Explosives of Concern (includes UXO)
    - ☑ Munitions Constituents
    - ☐ Other chemical contamination
    - ☐ Unknown

    b. What is the status of the munitions response activities? (select all that apply)
    - ☑ Data collection

- [x] Investigation
- [ ] Response/remedial action
- [ ] Operation and maintenance
- [ ] Monitoring
- [ ] Close out

c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?

- ○ Yes
- ○ No
- ◉ Unknown

d. Under what authority were/are response actions conducted?

- ◉ CERCLA
- ○ RCRA
- ○ Both CERCLA and RCRA
- ○ Unknown
- ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - [ ] Emergency response actions
    - [ ] Time-critical removal actions
    - [ ] Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - [ ] Non-munitions response actions

      Explain:
    - [ ] None
    - [ ] Unknown
    - [x] Other:
22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)
23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
    Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

    What is the RAC Hazard Severity? ○ I ○ II ○ III ◉ IV ○ V

    What is the RAC Hazard Probability? ◉ A ○ B ○ C ○ D ○ E

    What is the RAC? ○ I ○ II ◉ III ○ IV ○ V
24. What are the land use restrictions? (select all that apply)

Current	Future	
[x]	[ ]	No public access authorized
[ ]	[ ]	Limited public access (wildlife refuge)
[ ]	[ ]	Limited public access (livestock grazing)
[ ]	[ ]	Public access (agriculture/forestry)
[ ]	[ ]	Public access (surface recreation)
[ ]	[ ]	Public access (vehicle parking)

- ☐ ☐ Public access (surface supply storage)
- ☐ ☐ Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
- ☐ ☐ Other:

25. How is access currently controlled? (select all that apply)
    - ☐ No controls
    - ☐ Not controlled, used for another purpose
    - ☐ Signs
    - ☐ Fencing around entire range/site
    - ☑ Partial fencing
    - ☑ Locked/secured gates
    - ☐ Log-in book/Office check-in
    - ☑ Security patrol
        - ☐ Vessel ☐ Aircraft ☑ Other **By Vehicle**
    - ☐ Other:
26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

    Lease to:
    - ☐ Other DoD Component
    - ☐ Federal agency
    - ☐ Tribal government
    - ☐ State agency
    - ☐ Local agency
    - ☐ Private entity
    - ☐ Unknown

    Ownership transfer to:
    - ☐ Other DoD Component
    - ☐ Federal agency
    - ☐ Tribal government
    - ☐ State agency
    - ☐ Local agency
    - ☐ Private entity
    - ☐ Unknown

    Reason for transfer:
    - ☐ Termination of lease
    - ☐ Revocation of withdrawn land
    - ☐ Base Realignment and Closure action
    - ☐ Other:

    a. List the entity(ies) receiving the property:

    - ☐ Unknown

    b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)
    - ☐ Unknown
27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- [x] Federal Agency
- [ ] State Government
- [ ] Local Government
- [ ] Private Sector
- [ ] Tribal Government
- [ ] None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Small Arms Range (Pistol Range)

Part II-C Question 15:

The average depth to the Patapsco Aquifer (our drinking water source) is 300 ft. The average depth to shallow groundwater is 15 ft. This is not used as a drinking water source.

Part II-C Question 17:

There are no species protection areas located on this range but there are threatened/endangered species on the facility. For more information, contact Jeff Bossart, Natural Resources, on (301) 744-4705.

Part II-C Question 20:

The Pistol Range is a SWMU #29 Area of Concern (AOC) per the Federal Facilities Agreement between EPA Region III and the Dept. of the Navy. There will be a desk-top evaluation. Discrete samples may be taken. There may be sufficient information to close out the AOC. If not, the AOC may proceed to the site screening process, which is a more detailed investigation to determine potential threat to human health and the environment.

Part II-C Question 21:

Under the Federal Facilities Agreement between EPA Region III and the Dept. of the Navy, the range has been declared an area of concern and will undergo a desk-top evaluation.

Part II-C Question 3: The Small Arms (Pistol) Range was used for qualification and practice for various Federal, State and local law enforcement agencies. It was also used by active duty Navy and Marine Corps personnel. The pistol range was closed due its proximity to Small Wood State Park which borders the range on the target side and its potential for stray ammunition to enter the park.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Small Arms Range (Pistol Range)
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name ELAINE MAGDINEC
Phone Number (301) 744-2264
Organization ENVIRONMENTAL ENGINEER/CODE 044EM
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	6
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	**1**
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**1**

What evidence do you have regarding conventional unexploded ordnance?

Interviews of past users of the range.

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6

Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**0**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **1**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	**CATEGORY**	**HAZARD SEVERITY VALUE**
CATASTROPHIC	I	21 and/or greater
CRITICAL	II	10 to 20
MARGINAL	III	5 to 9
NEGLIGIBLE	**IV**	**1 to 4**

**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	**2**
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

Visual Observations

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

Smallwood State Park is about 800 ft behind the range.

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	VALUE
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	**3**
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:

State park, residential, industrial, commercial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	VALUE
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	0
Accessibility (largest single value)	**4**

Describe the site accessibility:

There is a fence with a locked gate to the control access to the road. There is no fence that completely surrounds the range. The back of the range has a large cliff. Access to the range is restricted 24 hours/day. Security patrols the road.

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	VALUE
Expected	**5**
None anticipated	0
Site Dynamics (largest single value)	**5**

Describe the site dynamics:

The range butts against a state park. Park development may change near the range. It's currently heavily wooded.

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **29**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	**A**	**27 or greater**
PROBABLE	B	21 to 26
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	2	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	**3**	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	Serious Risk - Priority for further action.
RAC 3	**Moderate Risk - Recommend further action.**
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Area 8**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **CLOSED**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   - (•) Yes
   - ( ) No

   a. NORM Site Number: **4684**
   b. NORM Site Name: **SWMU 00025**
5. Range/Site Classification (check all that apply):
   - [x] Testing
   - [x] Training
   - [ ] Small Arms Only (.50 cal and under)
   - [ ] Emergency Destruction
   - [ ] Open Burn/Open Detonation (OB/OD)
   - [ ] Other:
6. Range/Site Type (check all that apply):
   - [x] Air-to-Air
   - [ ] Air-to-Water
   - [ ] Air-to-Land
   - [ ] Land-to-Air
   - [ ] Land-to-Land
   - [ ] Land-to-Water
   - [ ] Water-to-Air
   - [ ] Water-to-Land
   - [x] Water-to-Water
   - [x] Unknown
7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - [x] Less than 3
   - [ ] Between 3 and 12
   - [ ] Between 12 and 200
   - [ ] Greater than 200

8. Please indicate the:
   a. Total range/site acreage: **20.0**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **20.0**
      ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?
   ◉ Yes
   ○ No
   a. If yes, is the map available in electronic format?
      ◉ Yes - what format?
      ☑ .pdf ☐ .shp
      ☐ .bmp ☐ .dwg
      ☐ .tif ☐ .dgn
      ☐ .gif ☐ .dxf
      ☐ .jpg
      ○ No
   b. What information does the map (or maps) depict? (select all that apply)
      ☑ Range location
      ☑ Range boundaries
      ☐ Target locations
      ☑ Natural/cultural resources
      ☑ Other: **Many other GIS layers**
10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☐ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○

☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☑ Demolition Charges	○	○	○	◉
☐ CADs/PADs	○	○	○	○
☑ Primers, Detonators, Fuzes, Squibs	○	○	○	◉
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11.

Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):

- ○ Sand/Gravel-Sand
- ○ Sand-Silt/Sand-Clay

- ○ Silt/Silty-Clay
- ○ Clay-Sand/Clay-Silt
- ○ Gravel/Gravel-Sand
- ○ Clay/Sand with Stone
- ○ Rock
- ◉ Water Range

12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☑ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Barren or low grass
    - ○ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ◉ Heavily Wooded
    - ○ Water Range
15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ○ Actual (known)
    - ○ Potential
    - ○ No Potential
    - ◉ Unknown

16. Are there any wetland areas associated with this range/site?
    - ◉ Yes

- ○ No
- ○ Unknown

If yes, what is the estimated acreage? **4.0**

17. Are threatened or endangered species present on this range/site?
    - ◉ Yes, please list: **The range is within an eagle protection area and a wildlife protection area**
    - ○ No
    - ○ Unknown
18. Does the range/site contain archeological or cultural sites?
    - ○ Yes
    - ◉ No
    - ○ Unknown
19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
        - ○ Yes
        - ○ No
20. Have munitions response activities been initiated/conducted on the range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
        - ☑ Munitions and Explosives of Concern (includes UXO)
        - ☐ Munitions Constituents
        - ☐ Other chemical contamination
        - ☐ Unknown

    b. What is the status of the munitions response activities? (select all that apply)
        - ☑ Data collection
        - ☑ Investigation
        - ☐ Response/remedial action
        - ☐ Operation and maintenance
        - ☐ Monitoring
        - ☐ Close out

    c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?
        - ○ Yes
        - ○ No
        - ◉ Unknown

    d. Under what authority were/are response actions conducted?
        - ◉ CERCLA
        - ○ RCRA
        - ○ Both CERCLA and RCRA
        - ○ Unknown

○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - ☐ Emergency response actions
    - ☐ Time-critical removal actions
    - ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - ☐ Non-munitions response actions

      Explain:
    - ☐ None
    - ☐ Unknown
    - ☑ Other: **see comments**

22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)

23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
    Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

    What is the RAC Hazard Severity? ○ I ◉ II ○ III ○ IV ○ V

    What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

    What is the RAC? ○ I ◉ II ○ III ○ IV ○ V

24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
☐	☐	Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
☐	☐	Other:

25. How is access currently controlled? (select all that apply)
    - ☐ No controls
    - ☐ Not controlled, used for another purpose
    - ☑ Signs
    - ☐ Fencing around entire range/site
    - ☑ Partial fencing
    - ☑ Locked/secured gates
    - ☑ Log-in book/Office check-in
    - ☑ Security patrol

☐ Vessel ☐ Aircraft ☑ Other **vehicle**

☑ Other: **barricade, Signs, guard at gate and patrol by security is for the entire facility at the Stump Neck Annex**

26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

Lease to:

☐ Other DoD Component
☐ Federal agency
☐ Tribal government
☐ State agency
☐ Local agency
☐ Private entity
☐ Unknown

Ownership transfer to:

☐ Other DoD Component
☐ Federal agency
☐ Tribal government
☐ State agency
☐ Local agency
☐ Private entity
☐ Unknown

Reason for transfer:

☐ Termination of lease
☐ Revocation of withdrawn land
☐ Base Realignment and Closure action
☐ Other:

a. List the entity(ies) receiving the property:

☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)

☐ Unknown

27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

☑ Federal Agency
☐ State Government
☐ Local Government
☐ Private Sector
☐ Tribal Government
☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Area 8

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a

drinking water source.

Part II-C Question 21: Area 8 was identified as a SWMU#25, IR Site #63 in 1991 pursuant to the requirements of the RCRA CA permit issued in 1990 by the EPA. The Navy completed a verification investigation in June 1996 and will address the site as a site screening area as discussed in the FFA.

Part II-C Question 3: Area 8 was an area used by the EOD School for training. There was a 1-acre pond that was used for water-shots and approximately 20 acres of land used for air-shots. Water-shots were also conducted in mini-ponds that consisted of depressions a few feet in diamater and 6-9 feet deep. Surface water would fill these depressions. Area 8 was shut down when the EOD School relocated to Florida. This range will probably not be able to resume in the future because a new operation (magnetometer) is being planned within the Area 8 complex.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Area 8
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	**6**
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**6**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	**10**
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**10**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **16**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	**II**	**10 to 20**
MARGINAL	III	5 to 9
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	**2**
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.): **VALUE**

Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:
residential and industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway	**0**

access to the area).

Accessibility (largest single value) **4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility: **VALUE**

Expected 5

None anticipated **0**

Site Dynamics (largest single value) **0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30)) **24**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	**2**	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	**Serious Risk - Priority for further action.**
RAC 3	Moderate Risk - Recommend further action.
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Improvised Explosive Device (IED) Practical Training Area**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **CLOSED**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   - (●) Yes
   - ( ) No

   a. NORM Site Number: **4685**
   b. NORM Site Name: **SWMU 00026**
5. Range/Site Classification (check all that apply):
   - [x] Testing
   - [x] Training
   - [ ] Small Arms Only (.50 cal and under)
   - [ ] Emergency Destruction
   - [ ] Open Burn/Open Detonation (OB/OD)
   - [ ] Other:
6. Range/Site Type (check all that apply):
   - [ ] Air-to-Air

- ☐ Air-to-Water
- ☐ Air-to-Land
- ☐ Land-to-Air
- ☑ Land-to-Land
- ☐ Land-to-Water
- ☐ Water-to-Air
- ☐ Water-to-Land
- ☐ Water-to-Water
- ☐ Unknown

7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☐ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **51.0**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **51.0**
      ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?
   ◉ Yes
   ○ No
   a. If yes, is the map available in electronic format?
      ◉ Yes - what format?
      - ☑ .pdf ☐ .shp
      - ☐ .bmp ☐ .dwg
      - ☐ .tif ☐ .dgn
      - ☐ .gif ☐ .dxf
      - ☐ .jpg

      ○ No
   b. What information does the map (or maps) depict? (select all that apply)
      - ☑ Range location
      - ☑ Range boundaries
      - ☐ Target locations
      - ☑ Natural/cultural resources
      - ☑ Other: **Many other GIS layers**
10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☑ Small Arms (.50 cal and under)	○	○	○	◉
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☑ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☑ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☑ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
Less Sensitive Explosives (e.g.,				

☑ ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Barren or low grass
    - ◉ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ○ Heavily Wooded

- ○ Water Range

15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ○ Actual (known)
    - ○ Potential
    - ○ No Potential
    - ◉ Unknown

16. Are there any wetland areas associated with this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, what is the estimated acreage? **0.0**

17. Are threatened or endangered species present on this range/site?
    - ◉ Yes, please list: **The site is within a wildlife protection area with no eagles.**
    - ○ No
    - ○ Unknown

18. Does the range/site contain archeological or cultural sites?
    - ◉ Yes
    - ○ No
    - ○ Unknown

19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ○ Yes
    - ○ No

20. Have munitions response activities been initiated/conducted on the range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
    - ☑ Munitions and Explosives of Concern (includes UXO)
    - ☑ Munitions Constituents
    - ☑ Other chemical contamination
    - ☐ Unknown

b. What is the status of the munitions response activities? (select all that apply)
- ☑ Data collection
- ☑ Investigation
- ☐ Response/remedial action
- ☐ Operation and maintenance
- ☐ Monitoring
- ☐ Close out

c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?
- ○ Yes
- ○ No
- ◉ Unknown

d. Under what authority were/are response actions conducted?
- ◉ CERCLA
- ○ RCRA
- ○ Both CERCLA and RCRA
- ○ Unknown
- ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
- ☐ Emergency response actions
- ☐ Time-critical removal actions
- ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
- ☐ Non-munitions response actions

  Explain:
- ☐ None
- ☐ Unknown
- ☑ Other: **See comments**

22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)

23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

What is the RAC Hazard Severity? ○ I ◉ II ○ III ○ IV ○ V

What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

What is the RAC? ○ I ◉ II ○ III ○ IV ○ V

24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)

- ☐ ☐ Public access (vehicle parking)
- ☐ ☐ Public access (surface supply storage)
- ☐ ☐ Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
- ☐ ☐ Other:

25. How is access currently controlled? (select all that apply)
    - ☐ No controls
    - ☐ Not controlled, used for another purpose
    - ☑ Signs
    - ☐ Fencing around entire range/site
    - ☑ Partial fencing
    - ☑ Locked/secured gates
    - ☑ Log-in book/Office check-in
    - ☑ Security patrol
        - ☐ Vessel ☐ Aircraft ☑ Other **Vehicle**
    - ☑ Other: **Controls are for the entire facility at the Stump Neck Annex**
26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

    Lease to:
    - ☐ Other DoD Component
    - ☐ Federal agency
    - ☐ Tribal government
    - ☐ State agency
    - ☐ Local agency
    - ☐ Private entity
    - ☐ Unknown

    Ownership transfer to:
    - ☐ Other DoD Component
    - ☐ Federal agency
    - ☐ Tribal government
    - ☐ State agency
    - ☐ Local agency
    - ☐ Private entity
    - ☐ Unknown

    Reason for transfer:
    - ☐ Termination of lease
    - ☐ Revocation of withdrawn land
    - ☐ Base Realignment and Closure action
    - ☐ Other:

    a. List the entity(ies) receiving the property:

    - ☐ Unknown

    b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)
    - ☐ Unknown

27. **Known Land Interest**
    a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)
    - ☑ Federal Agency
    - ☐ State Government
    - ☐ Local Government
    - ☐ Private Sector
    - ☐ Tribal Government
    - ☐ None

    b. Provide a brief description of the organization with ownership/control interest:
    GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Improvised Explosive Device (IED) Practical Training Area

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 4: The IED area is included in the IR program but one section, the explosive tools demo area behind B2096, is not included. The Verification Investigation of the EOD School Sites stated that the IED area consists of 50 acres yet GIS map boundary covers only 5 acres. There may be other sections of IED that have not been identified.

Part II-C Question 21: The IED was identified as a SWMU#26 and IR Site #64 in 1991 pursuant to the requirements of the RCRA CA permit issued in 1990 by the EPA. The Navy completed a verficiation investigation in Jun 1996 and will address the site as a site screening area as discussed in the Federal Facilities Agreement. The VI states the site covers 50 acres yet only 5 acres are accounted for the site diagrams. The IED Area covers the explosive tools demo area behind B2096, however, this site is not included in the IR program. Some limited soil sampling has taken place at the explosive tools section of IED.

Part II-C Question 3: The Improvised Explosive Devices (IED) Practical training area was used by the Naval EOD School for training how household materials could be used to construct improved explosive devices. The IED area consisted of several different areas within the complex. The most important features of IED is the incendiary demonstration area, a demonstration arena with bleachers, a detonation demonstration area and an explosive tools demonstration area. IED was also used to test the explosive potential of chemical mixtures.The IED was shut down when the EOD school relocated to Florida. IED operations will probably not resume due to the detonations occurring directly on the soil.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Improvised Explosive Device (IED) Practical Training Area

Site Location IHDIVNAVSURFWARCEN

DERP Project #

Rater's Name Elaine Magdinec

Phone Number (301) 744-2264

Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN

Date Completed 09/22/2003 **Score** See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

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PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	10
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Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	**6**
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	**1**
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**6**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6

Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	**10**
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	**8**
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	**3**
High explosives (largest single value)	**10**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **16**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	**II**	**10 to 20**
MARGINAL	III	5 to 9
NEGLIGIBLE	IV	1 to 4

**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	**2**
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**

Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:
residential and industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **24**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY

FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	**2**	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	**Serious Risk - Priority for further action.**
RAC 3	Moderate Risk - Recommend further action.
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1.
Range/Site Name: **Inert Ordnance Devices (IOD) Site**
Range/Site FFID Number: **MD317002410900**(if different from installation)
Range/Site City(ies): **Indian Head**(if different from installation)
Range/Site County(ies): **Charles**(if different from installation)
Range/Site State(s): **Indian Head**(if different from installation)
Latitude: **38 32 54N**

Longitude: **77 11 40W**
(provide southernmost and westernmost coordinates)

2. Range/Site Status: **CLOSED**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   - (•) Yes
   - ( ) No

   a. NORM Site Number: **4686**
   b. NORM Site Name: **SWMU 00027**
5. Range/Site Classification (check all that apply):
   - [ ] Testing
   - [x] Training
   - [ ] Small Arms Only (.50 cal and under)
   - [ ] Emergency Destruction
   - [ ] Open Burn/Open Detonation (OB/OD)
   - [x] Other: **Buried inert ordnance**
6. Range/Site Type (check all that apply):
   - [ ] Air-to-Air
   - [ ] Air-to-Water
   - [ ] Air-to-Land
   - [ ] Land-to-Air
   - [x] Land-to-Land
   - [ ] Land-to-Water
   - [ ] Water-to-Air
   - [ ] Water-to-Land
   - [ ] Water-to-Water
   - [ ] Unknown
7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - [ ] Less than 3
   - [ ] Between 3 and 12
   - [ ] Between 12 and 200
   - [ ] Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **0.5**
      ( ) Known (•) Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ( ) Known (•) Estimated ( ) Unknown
   c. Acreage suspected or potentially containing UXO: **0.5**

○ Known ◉ Estimated ○ Unknown

d. Acreage confirmed with no UXO: **0.0**

○ Known ◉ Estimated ○ Unknown

9. Is a range/site map available?

◉ Yes

○ No

a. If yes, is the map available in electronic format?

◉ Yes - what format?

☑ .pdf ☐ .shp
☐ .bmp ☐ .dwg
☐ .tif ☐ .dgn
☐ .gif ☐ .dxf
☐ .jpg

○ No

b. What information does the map (or maps) depict? (select all that apply)

☑ Range location
☑ Range boundaries
☐ Target locations
☑ Natural/cultural resources
☑ Other: **Many other GIS layers**

10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☐ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○

☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☑ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☑ Other: **Unknown live ordnance. Most ordnance should have been inert.**	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):

- ○ Sand/Gravel-Sand
- ◉ Sand-Silt/Sand-Clay
- ○ Silt/Silty-Clay
- ○ Clay-Sand/Clay-Silt
- ○ Gravel/Gravel-Sand
- ○ Clay/Sand with Stone

- ○ Rock
- ○ Water Range

12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Barren or low grass
    - ○ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ◉ Shrubs and some trees
    - ○ Heavily Wooded
    - ○ Water Range
15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ○ Actual (known)
    - ○ Potential
    - ○ No Potential
    - ◉ Unknown
16. Are there any wetland areas associated with this range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, what is the estimated acreage? **0.25**
17. Are threatened or endangered species present on this range/site?

◉ Yes, please list: **The site is within an eagle protection area and a wildlife protection area**
○ No
○ Unknown

18. Does the range/site contain archeological or cultural sites?
○ Yes
◉ No
○ Unknown

19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
○ Yes
◉ No
○ Unknown

a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
○ Yes
○ No

20. Have munitions response activities been initiated/conducted on the range/site?
◉ Yes
○ No
○ Unknown

If yes, answer a, b, c, and d below.

a. What is the scope of the response activities? (select all that apply)
☑ Munitions and Explosives of Concern (includes UXO)
☐ Munitions Constituents
☐ Other chemical contamination
☐ Unknown

b. What is the status of the munitions response activities? (select all that apply)
☑ Data collection
☑ Investigation
☐ Response/remedial action
☐ Operation and maintenance
☐ Monitoring
☐ Close out

c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?
○ Yes
○ No
◉ Unknown

d. Under what authority were/are response actions conducted?
◉ CERCLA
○ RCRA
○ Both CERCLA and RCRA
○ Unknown
○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
☐ Emergency response actions

- ☐ Time-critical removal actions
- ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
- ☐ Non-munitions response actions

  Explain:
- ☐ None
- ☐ Unknown
- ☑ Other: **See comments**

22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)
23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
    Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

    What is the RAC Hazard Severity? ○ I ○ II ◉ III ○ IV ○ V

    What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

    What is the RAC? ○ I ○ II ◉ III ○ IV ○ V
24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
☐	☐	Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
☐	☐	Other:

25. How is access currently controlled? (select all that apply)
    - ☐ No controls
    - ☐ Not controlled, used for another purpose
    - ☑ Signs
    - ☐ Fencing around entire range/site
    - ☑ Partial fencing
    - ☑ Locked/secured gates
    - ☑ Log-in book/Office check-in
    - ☑ Security patrol
      - ☐ Vessel ☐ Aircraft ☑ Other **vehicle**
    - ☑ Other: **Signs, guard at gate and patrols by security are for the entire facility at the Stump Neck Annex**
26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed

transfer? (select all that apply)

Lease to:

- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Ownership transfer to:

- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Reason for transfer:

- ☐ Termination of lease
- ☐ Revocation of withdrawn land
- ☐ Base Realignment and Closure action
- ☐ Other:

a. List the entity(ies) receiving the property:

- ☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)

- ☐ Unknown

27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- ☑ Federal Agency
- ☐ State Government
- ☐ Local Government
- ☐ Private Sector
- ☐ Tribal Government
- ☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Inert Ordnance Devices (IOD) Site

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 21: The IOD was identified as a SWMU#7, IR Site #65 in 1991 pursuant to the requirements of the RCRA CA permit issued in 1990 by the EPA. The Navy completed a Verification Investigation in Jun 1996 and will address the site as a site screening area as discussed in the

Federal Facilities Agreement between EPA and the Navy.

Part II-C Question 3: The Inert Ordnance Disposal (IOD) area was used for the disposal of discarded inert ordnance (e.g., fuses). There is little information on IOD. S deteriorating concrete pad measuring 18x12 feet has 2 manholes on top of the concrete pad. A 4-5 foot depressions exists immediately below the concrete pad. The disposed ordnance can be seen underneath the pad directly below the circular opening on the east side of the pad. Concrete was poured into the hole in the concrete pad. The IOD may have also been used for training. An aircraft fuselage may have been situated stop the IOD and may have been used in training exercises (i.e., the training exercise would have simulated the deactivation of unexploded ordnance aboard a downed aircraft).

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Inert Ordnance Devices (IOD) Site
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition: **VALUE**

Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	**6**
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**6**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**0**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **6**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	II	10 to 20
MARGINAL	**III**	**5 to 9**
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	**2**
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4

0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:
residential and industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **24**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	2	3	4	5
MARGINAL III	2	**3**	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE

	RAC
RAC 1	High Risk - Highest priority for further action.
RAC 2	Serious Risk - Priority for further action.
RAC 3	**Moderate Risk - Recommend further action.**
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Air Blast Pond**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **CLOSED**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   - (•) Yes
   - ( ) No

   a. NORM Site Number: **179**
   b. NORM Site Name: **SWMU 00006**
5. Range/Site Classification (check all that apply):
   - [x] Testing
   - [ ] Training
   - [ ] Small Arms Only (.50 cal and under)
   - [ ] Emergency Destruction
   - [ ] Open Burn/Open Detonation (OB/OD)
   - [ ] Other:
6. Range/Site Type (check all that apply):
   - [x] Air-to-Air
   - [ ] Air-to-Water

- ☐ Air-to-Land
- ☐ Land-to-Air
- ☐ Land-to-Land
- ☐ Land-to-Water
- ☐ Water-to-Air
- ☐ Water-to-Land
- ☑ Water-to-Water
- ☐ Unknown

7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☑ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **2.0**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **2.0**
      ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?
   ◉ Yes
   ○ No
   a. If yes, is the map available in electronic format?
      ◉ Yes - what format?
      ☑ .pdf ☐ .shp
      ☐ .bmp ☐ .dwg
      ☐ .tif ☐ .dgn
      ☐ .gif ☐ .dxf
      ☐ .jpg
      ○ No
   b. What information does the map (or maps) depict? (select all that apply)
      - ☑ Range location
      - ☑ Range boundaries
      - ☐ Target locations
      - ☑ Natural/cultural resources
      - ☑ Other: **Many other GIS layers**
10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC

Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☐ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☑ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☑ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☑ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○

☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☑ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Barren or low grass
    - ○ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ○ Heavily Wooded
    - ○ Water Range

15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ○ Actual (known)
    - ○ Potential
    - ○ No Potential
    - ◉ Unknown

16. Are there any wetland areas associated with this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, what is the estimated acreage? **0.0**

17. Are threatened or endangered species present on this range/site?
    - ◉ Yes, please list: **The site is within a wildlife protection area (no eagles)**
    - ○ No
    - ○ Unknown

18. Does the range/site contain archeological or cultural sites?
    - ◉ Yes
    - ○ No
    - ○ Unknown

19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ○ Yes
    - ○ No

20. Have munitions response activities been initiated/conducted on the range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
    - ☑ Munitions and Explosives of Concern (includes UXO)
    - ☐ Munitions Constituents
    - ☐ Other chemical contamination
    - ☐ Unknown

    b. What is the status of the munitions response activities? (select all that apply)
    - ☑ Data collection

- ☑ Investigation
- ☐ Response/remedial action
- ☐ Operation and maintenance
- ☐ Monitoring
- ☐ Close out

c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?

- ○ Yes
- ○ No
- ◉ Unknown

d. Under what authority were/are response actions conducted?

- ◉ CERCLA
- ○ RCRA
- ○ Both CERCLA and RCRA
- ○ Unknown
- ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - ☐ Emergency response actions
    - ☐ Time-critical removal actions
    - ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - ☐ Non-munitions response actions

      Explain:
    - ☐ None
    - ☐ Unknown
    - ☑ Other: **See comments**
22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)
23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
    Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

    What is the RAC Hazard Severity? ○ I ◉ II ○ III ○ IV ○ V

    What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

    What is the RAC? ○ I ◉ II ○ III ○ IV ○ V
24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)

- ☐ ☐ Public access (surface supply storage)
- ☐ ☐ Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
- ☐ ☐ Other:

25. How is access currently controlled? (select all that apply)
    - ☐ No controls
    - ☐ Not controlled, used for another purpose
    - ☑ Signs
    - ☐ Fencing around entire range/site
    - ☑ Partial fencing
    - ☑ Locked/secured gates
    - ☑ Log-in book/Office check-in
    - ☑ Security patrol
        - ☐ Vessel ☐ Aircraft ☑ Other **vehicle**
    - ☑ Other: **These controls are for the entire facility at the Stump Neck Annex.**
26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

    Lease to:
    - ☐ Other DoD Component
    - ☐ Federal agency
    - ☐ Tribal government
    - ☐ State agency
    - ☐ Local agency
    - ☐ Private entity
    - ☐ Unknown

    Ownership transfer to:
    - ☐ Other DoD Component
    - ☐ Federal agency
    - ☐ Tribal government
    - ☐ State agency
    - ☐ Local agency
    - ☐ Private entity
    - ☐ Unknown

    Reason for transfer:
    - ☐ Termination of lease
    - ☐ Revocation of withdrawn land
    - ☐ Base Realignment and Closure action
    - ☐ Other:

    a. List the entity(ies) receiving the property:

    - ☐ Unknown

    b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)
    - ☐ Unknown
27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- [x] Federal Agency
- [ ] State Government
- [ ] Local Government
- [ ] Private Sector
- [ ] Tribal Government
- [ ] None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Air Blast Pond

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 21: The air blast pond was identified as SWMU6 in the draft Facilities Assessment in July 1990. In Dec 1990, EPA issued the RCRA CA permit for the SWMU which stated that further investigation must be performed. It became IR Site 62 and a Verification Investigation was performed in Jan 1998. The site is a site screening area and the VI will be included in the site screening process.

Part II-C Question 3: The Air Blast Pond was used to detonate explosives above and in the water in a 100 foot pond. The air blast pond was used by the Naval Research Laboratory to test concussion factor. The pond was an unlined earthen pit filled with water from the Chicamuxen Creek and discharged to an industrial outfall. The pond was empied and refilled 2-3 times per year. Operations ceased in 1975. Similar operations would probably not be able to continue because the pond is unlined and water discharges would be prohibited due to limitations on outfall discharges.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Air Blast Pond
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	**6**
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**6**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide,	10

Mercury Fulminate, Tetracene, etc.)	
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	**8**
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**8**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	**6**
Propellants	**6**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **20**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	**II**	**10 to 20**
MARGINAL	III	5 to 9
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used

Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	**2**
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:

residential, industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **24**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	**2**	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1 High Risk - Highest priority for further action.
RAC 2 Serious Risk - Priority for further action.
RAC 3 Moderate Risk - Recommend further action.
RAC 4 Low Risk - Recommend further action.
RAC 5 Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Old Demolition Range**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **CLOSED**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**

4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   - (•) Yes
   - ( ) No

   a. NORM Site Number: **148**
   b. NORM Site Name: **Site 00031**

5. Range/Site Classification (check all that apply):
   - [ ] Testing
   - [x] Training
   - [ ] Small Arms Only (.50 cal and under)
   - [ ] Emergency Destruction
   - [x] Open Burn/Open Detonation (OB/OD)
   - [ ] Other:

6. Range/Site Type (check all that apply):
   - [ ] Air-to-Air
   - [ ] Air-to-Water
   - [ ] Air-to-Land
   - [ ] Land-to-Air
   - [x] Land-to-Land
   - [ ] Land-to-Water
   - [ ] Water-to-Air
   - [ ] Water-to-Land
   - [ ] Water-to-Water
   - [ ] Unknown

7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - [ ] Less than 3
   - [ ] Between 3 and 12
   - [ ] Between 12 and 200
   - [ ] Greater than 200

8. Please indicate the:

   a. Total range/site acreage: **8.6**
      ( ) Known (•) Estimated

   b. Acreage confirmed as having UXO: **0.0**
      ( ) Known (•) Estimated ( ) Unknown

   c. Acreage suspected or potentially containing UXO: **8.6**
      ( ) Known (•) Estimated ( ) Unknown

   d. Acreage confirmed with no UXO: **0.0**
      ( ) Known (•) Estimated ( ) Unknown

9. Is a range/site map available?
   - (•) Yes
   - ( ) No

   a. If yes, is the map available in electronic format?

◉ Yes - what format?

☑ .pdf ☐ .shp
☐ .bmp ☐ .dwg
☐ .tif ☐ .dgn
☐ .gif ☐ .dxf
☐ .jpg

○ No

b. What information does the map (or maps) depict? (select all that apply)

☑ Range location
☑ Range boundaries
☐ Target locations
☑ Natural/cultural resources
☑ Other: **Many other GIS layers**

10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☐ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
Missiles, practice (w/spotting charges)				

☐	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☑ Bulk Propellant (solid or liquid)	○	○	○	◉
☑ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	◉
☑ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	◉
☑ Demolition Charges	○	○	○	◉
☐ CADs/PADs	○	○	○	○
☑ Primers, Detonators, Fuzes, Squibs	○	○	○	◉
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown

13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - (●) Flat
    - ( ) Flat w/gorges or gullies
    - ( ) Gently rolling
    - ( ) Heavily rolling
    - ( ) Mountainous
    - ( ) Rolling w/gorges or gullies
    - ( ) Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ( ) Barren or low grass
    - ( ) Heavy grass and many shrubs
    - (●) Heavy shrubs and trees
    - ( ) Low grass and few shrubs
    - ( ) Shrubs and some trees
    - ( ) Heavily Wooded
    - ( ) Water Range
15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ( ) Unknown
    - ( ) Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - (●) Yes
    - ( ) No
    - ( ) Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ( ) Actual (known)
    - ( ) Potential
    - ( ) No Potential
    - (●) Unknown
16. Are there any wetland areas associated with this range/site?
    - (●) Yes
    - ( ) No
    - ( ) Unknown

    If yes, what is the estimated acreage? **3.0**
17. Are threatened or endangered species present on this range/site?
    - (●) Yes, please list: **Range is within Eagle and wildlife protections areas. All near by: Threatened - large seed forget-me-not, bald eagle, sensitive joint-vetch, giant cane. Rare - nemophylla aphylla**
    - ( ) No
    - ( ) Unknown
18. Does the range/site contain archeological or cultural sites?
    - ( ) Yes
    - (●) No
    - ( ) Unknown

19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ○ Yes
    - ○ No

20. Have munitions response activities been initiated/conducted on the range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
    - ☑ Munitions and Explosives of Concern (includes UXO)
    - ☐ Munitions Constituents
    - ☐ Other chemical contamination
    - ☐ Unknown

    b. What is the status of the munitions response activities? (select all that apply)
    - ☑ Data collection
    - ☑ Investigation
    - ☐ Response/remedial action
    - ☐ Operation and maintenance
    - ☐ Monitoring
    - ☐ Close out

    c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?
    - ○ Yes
    - ○ No
    - ◉ Unknown

    d. Under what authority were/are response actions conducted?
    - ○ CERCLA
    - ○ RCRA
    - ◉ Both CERCLA and RCRA
    - ○ Unknown
    - ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - ☐ Emergency response actions
    - ☐ Time-critical removal actions
    - ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - ☐ Non-munitions response actions

      Explain:
    - ☐ None
    - ☐ Unknown
    - ☑ Other: **See comments**

22. What is the estimated/budgeted funding requirement associated with the response actions at

this range/site? (U=Unknown; N/A=Not applicable)

23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

What is the RAC Hazard Severity? ◉ I ○ II ○ III ○ IV ○ V

What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

What is the RAC? ◉ I ○ II ○ III ○ IV ○ V

24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
☐	☐	Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
☐	☐	Other:

25. How is access currently controlled? (select all that apply)
- ☐ No controls
- ☐ Not controlled, used for another purpose
- ☑ Signs
- ☐ Fencing around entire range/site
- ☑ Partial fencing
- ☑ Locked/secured gates
- ☑ Log-in book/Office check-in
- ☑ Security patrol
  - ☐ Vessel ☐ Aircraft ☑ Other **vehicle**
- ☑ Other: **Controls are for the entire facility at the Stump Neck Annex**

26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

Lease to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Ownership transfer to:

- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Reason for transfer:

- ☐ Termination of lease
- ☐ Revocation of withdrawn land
- ☐ Base Realignment and Closure action
- ☐ Other:

a. List the entity(ies) receiving the property:

- ☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)

- ☐ Unknown

27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- ☑ Federal Agency
- ☐ State Government
- ☐ Local Government
- ☐ Private Sector
- ☐ Tribal Government
- ☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Old Demolition Range

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 21: The Old Demo Range was identified as SWMU #23 in the 1983 Initial Assessment Study and the draft RCRA Facilities Assessment in July 1990. In Dec 1990 EPA issued a CA permit but under the FFA, the range is a site screening area and will undergo a site screening process. It is IR Site #31. The RCRA Facilities Investigation Verification Investigation Report of Jan 1998 (draft) on Chicamuxen Creek Dump Site B, adjacent to the Old Demo Range, had sampling done that spilled into the Old Demo Range. RDX was found in the groundwater.

Part II-C Question 3: The Old Demolition Range was used as a demolition training ground. This range is adjacent to an IR site, Chicamuxen Creek's Edge Dump Site B, and an active range, Range 2 Hypervelocity. Training exercises are believed to be similar to activities practiced at Range 6 and Range 3, an explosive ordnance disposal training range. The Old Demolition Range activities were stopped and relocated to either Range 6 or Range 3.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be*

edited/updated.

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Old Demolition Range
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	**6**
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1

Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**6**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	**10**
Demolition charges	**10**
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	**8**
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**10**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	**6**
Propellants	**6**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **22**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	**I**	**21 and/or greater**
CRITICAL	II	10 to 20
MARGINAL	III	5 to 9
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	**2**
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**

16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:
residential, industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **24**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	**1**	2	3	4
CRITICAL II	1	2	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	**High Risk - Highest priority for further action.**
RAC 2	Serious Risk - Priority for further action.
RAC 3	Moderate Risk - Recommend further action.
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Marine Rifle Range**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **CLOSED**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   ○ Yes
   ◉ No
   a. NORM Site Number:
   b. NORM Site Name:
5. Range/Site Classification (check all that apply):
   ☐ Testing
   ☐ Training
   ☑ Small Arms Only (.50 cal and under)
   ☐ Emergency Destruction
   ☐ Open Burn/Open Detonation (OB/OD)
   ☐ Other:
6. Range/Site Type (check all that apply):
   ☐ Air-to-Air
   ☐ Air-to-Water
   ☐ Air-to-Land
   ☐ Land-to-Air
   ☑ Land-to-Land
   ☐ Land-to-Water
   ☐ Water-to-Air
   ☐ Water-to-Land
   ☐ Water-to-Water
   ☐ Unknown

7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☐ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200

8. Please indicate the:
   a. Total range/site acreage: **30.0**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **30.0**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown

9. Is a range/site map available?
   - ◉ Yes
   - ○ No

   a. If yes, is the map available in electronic format?
      - ◉ Yes - what format?
        - ☑ .pdf ☐ .shp
        - ☐ .bmp ☐ .dwg
        - ☐ .tif ☐ .dgn
        - ☐ .gif ☐ .dxf
        - ☐ .jpg
      - ○ No

   b. What information does the map (or maps) depict? (select all that apply)
      - ☑ Range location
      - ☐ Range boundaries
      - ☑ Target locations
      - ☑ Natural/cultural resources
      - ☑ Other: **Many other GIS layers**

10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☑ Small Arms (.50 cal and under)	○	○	○	◉
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○

☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☐ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○

☐ Other:

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Barren or low grass
    - ◉ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ○ Heavily Wooded
    - ○ Water Range
15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ○ Actual (known)

- ○ Potential
- ○ No Potential
- ◉ Unknown

16. Are there any wetland areas associated with this range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, what is the estimated acreage? **1.0**
17. Are threatened or endangered species present on this range/site?
    - ◉ Yes, please list: **There are wildlife protection areas but no eagle nesting sites.**
    - ○ No
    - ○ Unknown
18. Does the range/site contain archeological or cultural sites?
    - ○ Yes
    - ◉ No
    - ○ Unknown
19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
        - ○ Yes
        - ○ No
20. Have munitions response activities been initiated/conducted on the range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
        - ☐ Munitions and Explosives of Concern (includes UXO)
        - ☐ Munitions Constituents
        - ☐ Other chemical contamination
        - ☐ Unknown

    b. What is the status of the munitions response activities? (select all that apply)
        - ☐ Data collection
        - ☐ Investigation
        - ☐ Response/remedial action
        - ☐ Operation and maintenance
        - ☐ Monitoring
        - ☐ Close out

    c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?
        - ○ Yes
        - ○ No
        - ○ Unknown

d. Under what authority were/are response actions conducted?
- ○ CERCLA
- ○ RCRA
- ○ Both CERCLA and RCRA
- ○ Unknown
- ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
- ☐ Emergency response actions
- ☐ Time-critical removal actions
- ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
- ☐ Non-munitions response actions

Explain:
- ☑ None
- ☐ Unknown
- ☐ Other:

22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)

23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

What is the RAC Hazard Severity? ○ I ○ II ○ III ◉ IV ○ V

What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

What is the RAC? ○ I ○ II ○ III ◉ IV ○ V

24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
☐	☐	Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
☐	☐	Other:

25. How is access currently controlled? (select all that apply)
- ☐ No controls
- ☐ Not controlled, used for another purpose
- ☑ Signs

- ☐ Fencing around entire range/site
- ☑ Partial fencing
- ☑ Locked/secured gates
- ☑ Log-in book/Office check-in
- ☑ Security patrol
  - ☐ Vessel ☐ Aircraft ☑ Other **vehicle**
- ☑ Other: **Controls are for entire facility at Stump Neck**

26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

Lease to:

- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Ownership transfer to:

- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Reason for transfer:

- ☐ Termination of lease
- ☐ Revocation of withdrawn land
- ☐ Base Realignment and Closure action
- ☐ Other:

a. List the entity(ies) receiving the property:

- ☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)

- ☐ Unknown

27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- ☑ Federal Agency
- ☐ State Government
- ☐ Local Government
- ☐ Private Sector
- ☐ Tribal Government
- ☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Marine Rifle Range

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 3: The Marine Rifle Range was identified on a historical map dating from 1917. No other information is known about the range. It is suspected to be a training ground for Marines when they came to Indian Head and Stump Neck to provide a security force. The Winthrop Rifle Range guard exchanged security duties between Indian Head and Stump Neck.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Marine Rifle Range
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition: **VALUE**

Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	6
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	**1**
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**1**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**0**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **1**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	II	10 to 20
MARGINAL	III	5 to 9
NEGLIGIBLE	**IV**	**1 to 4**
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	**2**
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4

0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:
residential, industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **24**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	2	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	**4**	4	5	5

RISK ASSESSMENT CODE

	RAC
RAC 1	High Risk - Highest priority for further action.
RAC 2	Serious Risk - Priority for further action.
RAC 3	Moderate Risk - Recommend further action.
RAC 4	**Low Risk - Recommend further action.**
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Test Area 1**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **CLOSED**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   ○ Yes
   ◉ No
   a. NORM Site Number:
   b. NORM Site Name:
5. Range/Site Classification (check all that apply):
   ☑ Testing
   ☐ Training
   ☐ Small Arms Only (.50 cal and under)
   ☐ Emergency Destruction
   ☐ Open Burn/Open Detonation (OB/OD)
   ☐ Other:
6. Range/Site Type (check all that apply):
   ☑ Air-to-Air
   ☐ Air-to-Water

- ☐ Air-to-Land
- ☐ Land-to-Air
- ☐ Land-to-Land
- ☐ Land-to-Water
- ☐ Water-to-Air
- ☐ Water-to-Land
- ☐ Water-to-Water
- ☐ Unknown

7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☐ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **0.88**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **0.88**
      ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?
   ◉ Yes
   ○ No
   a. If yes, is the map available in electronic format?
      ◉ Yes - what format?
      ☑ .pdf ☐ .shp
      ☐ .bmp ☐ .dwg
      ☐ .tif ☐ .dgn
      ☐ .gif ☐ .dxf
      ☐ .jpg
      ○ No
   b. What information does the map (or maps) depict? (select all that apply)
      - ☑ Range location
      - ☐ Range boundaries
      - ☐ Target locations
      - ☑ Natural/cultural resources
      - ☑ Other: **Many other GIS layers**
10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC

Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☐ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☑ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	◉
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☐ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○

☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Barren or low grass
    - ○ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ◉ Shrubs and some trees
    - ○ Heavily Wooded
    - ○ Water Range

15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ○ Actual (known)
    - ○ Potential
    - ○ No Potential
    - ◉ Unknown

16. Are there any wetland areas associated with this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, what is the estimated acreage? **0.0**

17. Are threatened or endangered species present on this range/site?
    - ○ Yes, please list:
    - ◉ No
    - ○ Unknown

18. Does the range/site contain archeological or cultural sites?
    - ○ Yes
    - ◉ No
    - ○ Unknown

19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ○ Yes
    - ○ No

20. Have munitions response activities been initiated/conducted on the range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
    - ☐ Munitions and Explosives of Concern (includes UXO)
    - ☐ Munitions Constituents
    - ☐ Other chemical contamination
    - ☐ Unknown

    b. What is the status of the munitions response activities? (select all that apply)
    - ☐ Data collection

- ☐ Investigation
- ☐ Response/remedial action
- ☐ Operation and maintenance
- ☐ Monitoring
- ☐ Close out

c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?

- ○ Yes
- ○ No
- ○ Unknown

d. Under what authority were/are response actions conducted?

- ○ CERCLA
- ○ RCRA
- ○ Both CERCLA and RCRA
- ○ Unknown
- ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - ☐ Emergency response actions
    - ☐ Time-critical removal actions
    - ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - ☐ Non-munitions response actions

      Explain:
    - ☑ None
    - ☐ Unknown
    - ☐ Other:
22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)
23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
    Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

    What is the RAC Hazard Severity? ○ I ○ II ◉ III ○ IV ○ V

    What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

    What is the RAC? ○ I ○ II ◉ III ○ IV ○ V
24. What are the land use restrictions? (select all that apply)

Current	**Future**	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)

- ☐ ☐ Public access (surface supply storage)
- ☐ ☐ Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
- ☐ ☐ Other:

25. How is access currently controlled? (select all that apply)
    - ☐ No controls
    - ☐ Not controlled, used for another purpose
    - ☑ Signs
    - ☐ Fencing around entire range/site
    - ☑ Partial fencing
    - ☑ Locked/secured gates
    - ☑ Log-in book/Office check-in
    - ☑ Security patrol
        - ☐ Vessel ☐ Aircraft ☑ Other **vehicle**
    - ☑ Other: **controls are the entire facility not just site**
26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

    Lease to:
    - ☐ Other DoD Component
    - ☐ Federal agency
    - ☐ Tribal government
    - ☐ State agency
    - ☐ Local agency
    - ☐ Private entity
    - ☐ Unknown

    Ownership transfer to:
    - ☐ Other DoD Component
    - ☐ Federal agency
    - ☐ Tribal government
    - ☐ State agency
    - ☐ Local agency
    - ☐ Private entity
    - ☐ Unknown

    Reason for transfer:
    - ☐ Termination of lease
    - ☐ Revocation of withdrawn land
    - ☐ Base Realignment and Closure action
    - ☐ Other:

    a. List the entity(ies) receiving the property:

    - ☐ Unknown

    b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)
    - ☐ Unknown
27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- ☑ Federal Agency
- ☐ State Government
- ☐ Local Government
- ☐ Private Sector
- ☐ Tribal Government
- ☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Test Area 1

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 3: Test Area 1 was identified through a historical search. The operations that may have been conducted are suspected to be similar to explosive testing conducted at the air blast pond. Very little else is known about the range.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Test Area 1
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	6
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**0**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	**8**
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**8**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **8**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	II	10 to 20
MARGINAL	**III**	**5 to 9**
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3

Subsurface	**2**
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:
residential, industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier	3

is intended to deny access to the site.	
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **24**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY	FREQUENT	PROBABLE	OCCASIONAL	REMOTE	IMPROBABLE

LEVEL	A	B	C	D	E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	2	3	4	5
MARGINAL III	2	**3**	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	Serious Risk - Priority for further action.
RAC 3	**Moderate Risk - Recommend further action.**
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Test Area 2**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **OTHER**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   ○ Yes
   ◉ No
   a. NORM Site Number:
   b. NORM Site Name:
5. Range/Site Classification (check all that apply):
   ☐ Disposal

- ☐ Emergency Destruction
- ☐ Open Burn/Open Detonation (OB/OD)
- ☑ Other: **training**

6. Range/Site Type (check all that apply):
   - ☑ Land
   - ☐ Water
7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☐ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **0.92**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **0.92**
      ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?
   - ◉ Yes
   - ○ No

   a. If yes, is the map available in electronic format?
      - ◉ Yes - what format?
        - ☑ .pdf ☐ .shp
        - ☐ .bmp ☐ .dwg
        - ☐ .tif ☐ .dgn
        - ☐ .gif ☐ .dxf
        - ☐ .jpg
      - ○ No

   b. What information does the map (or maps) depict? (select all that apply)
      - ☑ Range location
      - ☑ Range boundaries
      - ☐ Target locations
      - ☑ Natural/cultural resources
      - ☑ Other: **Many other GIS layers**
10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10,

M=10-50, H=>50, U=Unknown)

	L	M	H	U
☐ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☑ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☐ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○

☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☑ Other: **Unknown**	○	○	○	◉

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Barren or low grass
    - ○ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ○ Heavily Wooded
    - ○ Water Range
15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown

- ○ Not Applicable (water range/site)

a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?

- ◉ Yes
- ○ No
- ○ Unknown

b. What is the range's or site's potential for contamination to drinking water?

- ○ Actual (known)
- ○ Potential
- ○ No Potential
- ◉ Unknown

16. Are there any wetland areas associated with this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, what is the estimated acreage? **0.0**
17. Are threatened or endangered species present on this range/site?
    - ○ Yes, please list:
    - ◉ No
    - ○ Unknown
18. Does the range/site contain archeological or cultural sites?
    - ○ Yes
    - ◉ No
    - ○ Unknown
19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ○ Yes
    - ○ No
20. Have munitions response activities been initiated/conducted on the range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
    - ☐ Munitions and Explosives of Concern (includes UXO)
    - ☐ Munitions Constituents
    - ☐ Other chemical contamination
    - ☐ Unknown

    b. What is the status of the munitions response activities? (select all that apply)
    - ☐ Data collection
    - ☐ Investigation
    - ☐ Response/remedial action

- ☐ Operation and maintenance
- ☐ Monitoring
- ☐ Close out

c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?

- ○ Yes
- ○ No
- ○ Unknown

d. Under what authority were/are response actions conducted?

- ○ CERCLA
- ○ RCRA
- ○ Both CERCLA and RCRA
- ○ Unknown
- ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - ☐ Emergency response actions
    - ☐ Time-critical removal actions
    - ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - ☐ Non-munitions response actions

      Explain:
    - ☑ None
    - ☐ Unknown
    - ☐ Other:
22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)
23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
    Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

    What is the RAC Hazard Severity? ○ I ○ II ◉ III ○ IV ○ V

    What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

    What is the RAC? ○ I ○ II ◉ III ○ IV ○ V
24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
		Unrestricted (commercial, residential, utility, subsurface recreational, and

☐ ☐ construction)

☐ ☐ Other:

25. How is access currently controlled? (select all that apply)
- ☐ No controls
- ☐ Not controlled, used for another purpose
- ☑ Signs
- ☐ Fencing around entire range/site
- ☑ Partial fencing
- ☑ Locked/secured gates
- ☑ Log-in book/Office check-in
- ☑ Security patrol
  - ☐ Vessel ☐ Aircraft ☑ Other **vehicle**
- ☑ Other: **controls are for entire facility not just site**

26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

Lease to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Ownership transfer to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Reason for transfer:
- ☐ Termination of lease
- ☐ Revocation of withdrawn land
- ☐ Base Realignment and Closure action
- ☐ Other:

a. List the entity(ies) receiving the property:

- ☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)
- ☐ Unknown

27.

Known Land Interest

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- ☑ Federal Agency
- ☐ State Government
- ☐ Local Government
- ☐ Private Sector
- ☐ Tribal Government
- ☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Test Area 2

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 3: This site was identified through a historical search. Very little is known about this possible site. This site may have been used for ordnance testing and/or training.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Test Area 2
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	6
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**0**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	**8**
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**8**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **8**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	II	10 to 20
MARGINAL	**III**	**5 to 9**
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	**2**
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:

residential, industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2

Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **24**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY					

CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	2	3	4	5
MARGINAL III	2	**3**	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	Serious Risk - Priority for further action.
RAC 3	**Moderate Risk - Recommend further action.**
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Stump Neck Impact Area**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **CLOSED**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   - (•) Yes
   - ( ) No

   a. NORM Site Number: **147**
   b. NORM Site Name: **Site 00030**
5. Range/Site Classification (check all that apply):
   - [x] Testing
   - [ ] Training

     Small Arms Only (.50 cal and under)

- ☐
- ☐ Emergency Destruction
- ☐ Open Burn/Open Detonation (OB/OD)
- ☐ Other:

6. Range/Site Type (check all that apply):
   - ☐ Air-to-Air
   - ☐ Air-to-Water
   - ☐ Air-to-Land
   - ☐ Land-to-Air
   - ☑ Land-to-Land
   - ☐ Land-to-Water
   - ☐ Water-to-Air
   - ☐ Water-to-Land
   - ☐ Water-to-Water
   - ☐ Unknown
7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☐ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **40.0**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **40.0**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?
   ◉ Yes
   ○ No
   a. If yes, is the map available in electronic format?
      ◉ Yes - what format?
      - ☑ .pdf ☐ .shp
      - ☐ .bmp ☐ .dwg
      - ☐ .tif ☐ .dgn
      - ☐ .gif ☐ .dxf
      - ☐ .jpg

      ○ No
   b. What information does the map (or maps) depict? (select all that apply)
      ☑ Range location

- ☑ Range boundaries
- ☐ Target locations
- ☑ Natural/cultural resources
- ☑ Other: **Many other layers from GIS**

10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☐ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☑ Projectiles	○	○	○	◉
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☑ Rockets, explosive	○	○	○	◉
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○

☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☐ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is

known or suspected to be contaminated (check one):

- ○ Barren or low grass
- ○ Heavy grass and many shrubs
- ◉ Heavy shrubs and trees
- ○ Low grass and few shrubs
- ○ Shrubs and some trees
- ○ Heavily Wooded
- ○ Water Range

15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ○ Actual (known)
    - ○ Potential
    - ○ No Potential
    - ◉ Unknown

16. Are there any wetland areas associated with this range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, what is the estimated acreage? **40.0**

17. Are threatened or endangered species present on this range/site?
    - ◉ Yes, please list: **The range is within an eagle protection area and a wildlife protection area.**
    - ○ No
    - ○ Unknown

18. Does the range/site contain archeological or cultural sites?
    - ○ Yes
    - ◉ No
    - ○ Unknown

19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ○ Yes
    - ○ No

20. Have munitions response activities been initiated/conducted on the range/site?
    - ◉ Yes

- ○ No
- ○ Unknown

If yes, answer a, b, c, and d below.

a. What is the scope of the response activities? (select all that apply)
- ☑ Munitions and Explosives of Concern (includes UXO)
- ☑ Munitions Constituents
- ☐ Other chemical contamination
- ☐ Unknown

b. What is the status of the munitions response activities? (select all that apply)
- ☑ Data collection
- ☑ Investigation
- ☐ Response/remedial action
- ☐ Operation and maintenance
- ☐ Monitoring
- ☐ Close out

c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?
- ○ Yes
- ○ No
- ◉ Unknown

d. Under what authority were/are response actions conducted?
- ○ CERCLA
- ○ RCRA
- ◉ Both CERCLA and RCRA
- ○ Unknown
- ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
- ☐ Emergency response actions
- ☐ Time-critical removal actions
- ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
- ☐ Non-munitions response actions

  Explain:
- ☐ None
- ☐ Unknown
- ☑ Other: **see comments**

22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)

23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

What is the RAC Hazard Severity? ○ I ◉ II ○ III ○ IV ○ V

What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

What is the RAC? ○ I ◉ II ○ III ○ IV ○ V

24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
☐	☐	Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
☐	☐	Other:

25. How is access currently controlled? (select all that apply)
- ☐ No controls
- ☐ Not controlled, used for another purpose
- ☑ Signs
- ☐ Fencing around entire range/site
- ☑ Partial fencing
- ☑ Locked/secured gates
- ☑ Log-in book/Office check-in
- ☑ Security patrol
  - ☐ Vessel ☐ Aircraft ☑ Other **vehicle**
- ☑ Other: **controls are for entire facility at Stump Neck**

26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

Lease to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Ownership transfer to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Reason for transfer:
- ☐ Termination of lease
- ☐ Revocation of withdrawn land

☐ Base Realignment and Closure action
☐ Other:

a. List the entity(ies) receiving the property:

☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)

☐ Unknown

27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

☑ Federal Agency
☐ State Government
☐ Local Government
☐ Private Sector
☐ Tribal Government
☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Stump Neck Impact Area

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 21: The range was identified as SWMU #23 in the 1983 Initial Assessment Study. In 1990, a draft RCRA Facilities Assessment included the range as a SWMU. In 1990, a RCRA CA permit was issued and stated that no further action was needed. The Federal Facilities Agreement between EPA and the Navy included all CA sites. The range is IR Site 30 and is a site screening area which will undergo a site screening process.

Part II-C Question 3: The Stump Neck Impact Area was used as an impact area for projectives fired from the gun and rockets testing area in the Valley at Indian Head. iThere may have been a firing range over Stump Neck as well since the projectives/rockets did not always reach their intended targets. From this reason, the gun and rockets testing in the Valley was moved to Dahlgren, VA.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Stump Neck Impact Area
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	**10**
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	**10**
Detonators, blasting caps, fuzes, boosters, bursters	6
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**10**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4

Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**0**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **10**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	**CATEGORY**	**HAZARD SEVERITY VALUE**
CATASTROPHIC	I	21 and/or greater
CRITICAL	**II**	**10 to 20**
MARGINAL	III	5 to 9
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	5
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	**2**
Location (largest single value)	**2**

What evidence do you have regarding the location of MEC?

Can't see on surface.

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**

Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:
residential, industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **21**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY

FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	**2**	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	**Serious Risk - Priority for further action.**
RAC 3	Moderate Risk - Recommend further action.
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1.
Range/Site Name: **The Valley**
Range/Site FFID Number: **MD317002410900**(if different from installation)
Range/Site City(ies): **Indian Head**(if different from installation)
Range/Site County(ies): **Charles**(if different from installation)
Range/Site State(s): **Indian Head**(if different from installation)
Latitude: **38 32 54N**

Longitude: **77 11 40W**
(provide southernmost and westernmost coordinates)

2. Range/Site Status: **CLOSED**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   - (•) Yes
   - ( ) No

   a. NORM Site Number: **146**
   b. NORM Site Name: **Site 00029**
5. Range/Site Classification (check all that apply):
   - [x] Testing
   - [ ] Training
   - [ ] Small Arms Only (.50 cal and under)
   - [ ] Emergency Destruction
   - [ ] Open Burn/Open Detonation (OB/OD)
   - [ ] Other:
6. Range/Site Type (check all that apply):
   - [ ] Air-to-Air
   - [ ] Air-to-Water
   - [ ] Air-to-Land
   - [ ] Land-to-Air
   - [x] Land-to-Land
   - [ ] Land-to-Water
   - [ ] Water-to-Air
   - [ ] Water-to-Land
   - [ ] Water-to-Water
   - [ ] Unknown
7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - [x] Less than 3
   - [ ] Between 3 and 12
   - [ ] Between 12 and 200
   - [ ] Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **7.31**
      ( ) Known (•) Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ( ) Known (•) Estimated ( ) Unknown
   c. Acreage suspected or potentially containing UXO: **7.31**

○ Known ◉ Estimated ○ Unknown

d. Acreage confirmed with no UXO: **0.0**

○ Known ◉ Estimated ○ Unknown

9. Is a range/site map available?

◉ Yes

○ No

a. If yes, is the map available in electronic format?

◉ Yes - what format?

☑ .pdf ☐ .shp
☐ .bmp ☐ .dwg
☐ .tif ☐ .dgn
☐ .gif ☐ .dxf
☐ .jpg

○ No

b. What information does the map (or maps) depict? (select all that apply)

☑ Range location
☑ Range boundaries
☐ Target locations
☑ Natural/cultural resources
☑ Other: **Many other GIS layers**

10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☑ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☑ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○

☑ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☐ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☑ Other: **cannon balls**	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):

- ○ Sand/Gravel-Sand
- ○ Sand-Silt/Sand-Clay
- ○ Silt/Silty-Clay
- ○ Clay-Sand/Clay-Silt
- ○ Gravel/Gravel-Sand
- ○ Clay/Sand with Stone
- ○ Rock

- (●) Water Range

12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - [ ] 1-10 ft
    - [ ] 10-30 ft
    - [ ] 30-80 ft
    - [ ] Greater than 80 ft
    - [x] Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ( ) Flat
    - ( ) Flat w/gorges or gullies
    - ( ) Gently rolling
    - ( ) Heavily rolling
    - ( ) Mountainous
    - ( ) Rolling w/gorges or gullies
    - (●) Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ( ) Barren or low grass
    - ( ) Heavy grass and many shrubs
    - ( ) Heavy shrubs and trees
    - ( ) Low grass and few shrubs
    - ( ) Shrubs and some trees
    - ( ) Heavily Wooded
    - (●) Water Range
15. Estimate the average depth (in feet) to groundwater for this range/site: ft.
    - ( ) Unknown
    - (●) Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ( ) Yes
    - ( ) No
    - ( ) Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ( ) Actual (known)
    - ( ) Potential
    - ( ) No Potential
    - ( ) Unknown
16. Are there any wetland areas associated with this range/site?
    - ( ) Yes
    - (●) No
    - ( ) Unknown

    If yes, what is the estimated acreage? **0.0**
17. Are threatened or endangered species present on this range/site?
    - ( ) Yes, please list:

- (●) No
- ( ) Unknown

18. Does the range/site contain archeological or cultural sites?
    - ( ) Yes
    - (●) No
    - ( ) Unknown
19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ( ) Yes
    - (●) No
    - ( ) Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
        - ( ) Yes
        - ( ) No
20. Have munitions response activities been initiated/conducted on the range/site?
    - (●) Yes
    - ( ) No
    - ( ) Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
        - [x] Munitions and Explosives of Concern (includes UXO)
        - [ ] Munitions Constituents
        - [ ] Other chemical contamination
        - [ ] Unknown

    b. What is the status of the munitions response activities? (select all that apply)
        - [x] Data collection
        - [x] Investigation
        - [ ] Response/remedial action
        - [ ] Operation and maintenance
        - [ ] Monitoring
        - [ ] Close out

    c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?
        - ( ) Yes
        - ( ) No
        - (●) Unknown

    d. Under what authority were/are response actions conducted?
        - (●) CERCLA
        - ( ) RCRA
        - ( ) Both CERCLA and RCRA
        - ( ) Unknown
        - ( ) Other, please specify:
21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - [ ] Emergency response actions
    - [ ] Time-critical removal actions
    - [ ] Non-time-critical removal actions with Engineering Assessment/Cost Analysis

☐ Non-munitions response actions
Explain:
☐ None
☐ Unknown
☑ Other: **see comments**

22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)

23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

What is the RAC Hazard Severity? ○ I ◉ II ○ III ○ IV ○ V
What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E
What is the RAC? ○ I ◉ II ○ III ○ IV ○ V

24. What are the land use restrictions? (select all that apply)

Current	Future	
☐	☐	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
☐	☐	Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
☑	☑	Other: **Limited public access (only military residents/personnel)**

25. How is access currently controlled? (select all that apply)
☐ No controls
☐ Not controlled, used for another purpose
☐ Signs
☐ Fencing around entire range/site
☑ Partial fencing
☑ Locked/secured gates
☐ Log-in book/Office check-in
☑ Security patrol
☐ Vessel ☐ Aircraft ☑ Other **vehicle**
☑ Other: **Range is within a facility that has secured access. There are no restrictions to actual range once you are on the facility.**

26.
For transferred and transferring ranges/sites only: What was/is the nature of the proposed transfer? (select all that apply)
Lease to:

- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Ownership transfer to:

- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Reason for transfer:

- ☐ Termination of lease
- ☐ Revocation of withdrawn land
- ☐ Base Realignment and Closure action
- ☐ Other:

a. List the entity(ies) receiving the property:

- ☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)

- ☐ Unknown

27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- ☑ Federal Agency
- ☐ State Government
- ☐ Local Government
- ☐ Private Sector
- ☐ Tribal Government
- ☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for The Valley

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 21: The Valley is IR Site #29. It was identified in the 1983 Initial assessment Study. In the RCRA Facilities Assessment in 1988, the Valley was identified as an Area of Concern F. The Valley is a site screening area which will undergo a site screening process to determine if it should procedd to a RI/FS or removed from further study.

Part II-C Question 3: The Valley was an area used to prove guns and ordnance. A battery of guns

were lined up on the north side of the valley and were fired into targets on the butts of the valley walls. Ordnance clearing was not done due to cost. As encroachment continued and ordnance became more powerful, this operation was moved to Dahlgren, VA.

Part II-C Question 6: The guns fired from the Valley have shot unintended projectiles into the Potomac River, the Mattawoman Creek and the Chicamuxen Creek.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name The Valley
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

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TYPE OF ORDNANCE: (Select all that apply)

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Grenades, hand or rifle, explosive	10
Landmine, explosive	10

Rockets, guided missile, explosive	**10**
Detonators, blasting caps, fuzes, boosters, bursters	6
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	**1**
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**10**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**0**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20

Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **10**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	**II**	**10 to 20**
MARGINAL	III	5 to 9
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	5
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	**2**
Location (largest single value)	**2**

What evidence do you have regarding the location of MEC?

Can't see UXO

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1

Distance (largest single value) **5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:
residential, industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **21**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	**2**	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1 High Risk - Highest priority for further action.

RAC 2 Serious Risk - Priority for further action.

RAC 3	Moderate Risk - Recommend further action.
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Water Impact Areas**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **CLOSED**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   ○ Yes
   ◉ No
   a. NORM Site Number:
   b. NORM Site Name:
5. Range/Site Classification (check all that apply):
   ☑ Testing
   ☐ Training
   ☐ Small Arms Only (.50 cal and under)
   ☐ Emergency Destruction
   ☐ Open Burn/Open Detonation (OB/OD)
   ☐ Other:
6. Range/Site Type (check all that apply):
   ☐ Air-to-Air
   ☐ Air-to-Water
   ☐ Air-to-Land
   ☐ Land-to-Air
   ☐ Land-to-Land

- ☑ Land-to-Water
- ☐ Water-to-Air
- ☐ Water-to-Land
- ☑ Water-to-Water
- ☐ Unknown

7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☑ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **100.0**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **100.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?
   ○ Yes
   ◉ No
   a. If yes, is the map available in electronic format?
      ○ Yes - what format?
      ☐ .pdf ☐ .shp
      ☐ .bmp ☐ .dwg
      ☐ .tif ☐ .dgn
      ☐ .gif ☐ .dxf
      ☐ .jpg
      ○ No
   b. What information does the map (or maps) depict? (select all that apply)
      - ☐ Range location
      - ☐ Range boundaries
      - ☐ Target locations
      - ☐ Natural/cultural resources
      - ☐ Other:
10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)

	L	M	H	U
☐ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☑ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☑ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☑ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☐ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○

☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ○ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ◉ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☑ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ◉ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Barren or low grass
    - ○ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ○ Heavily Wooded
    - ◉ Water Range
15. Estimate the average depth (in feet) to groundwater for this range/site: ft.
    - ○ Unknown

- (●) Not Applicable (water range/site)

a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?

- ( ) Yes
- ( ) No
- ( ) Unknown

b. What is the range's or site's potential for contamination to drinking water?

- ( ) Actual (known)
- ( ) Potential
- ( ) No Potential
- ( ) Unknown

16. Are there any wetland areas associated with this range/site?
    - ( ) Yes
    - ( ) No
    - (●) Unknown

    If yes, what is the estimated acreage? **0.0**
17. Are threatened or endangered species present on this range/site?
    - (●) Yes, please list: **There are bald eagle nests location in the area around the site**
    - ( ) No
    - ( ) Unknown
18. Does the range/site contain archeological or cultural sites?
    - ( ) Yes
    - ( ) No
    - (●) Unknown
19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ( ) Yes
    - (●) No
    - ( ) Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ( ) Yes
    - ( ) No
20. Have munitions response activities been initiated/conducted on the range/site?
    - ( ) Yes
    - (●) No
    - ( ) Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
    - [ ] Munitions and Explosives of Concern (includes UXO)
    - [ ] Munitions Constituents
    - [ ] Other chemical contamination
    - [ ] Unknown

    b. What is the status of the munitions response activities? (select all that apply)
    - [ ] Data collection
    - [ ] Investigation
    - [ ] Response/remedial action

- ☐ Operation and maintenance
- ☐ Monitoring
- ☐ Close out

c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?

- ○ Yes
- ○ No
- ○ Unknown

d. Under what authority were/are response actions conducted?

- ○ CERCLA
- ○ RCRA
- ○ Both CERCLA and RCRA
- ○ Unknown
- ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - ☐ Emergency response actions
    - ☐ Time-critical removal actions
    - ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - ☐ Non-munitions response actions

      Explain:
    - ☑ None
    - ☐ Unknown
    - ☐ Other:
22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)
23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
    Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

    What is the RAC Hazard Severity? ○ I ◉ II ○ III ○ IV ○ V

    What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

    What is the RAC? ○ I ◉ II ○ III ○ IV ○ V
24. What are the land use restrictions? (select all that apply)

Current	Future	
☐	☐	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
		Unrestricted (commercial, residential, utility, subsurface recreational, and

☑ ☑ construction)

☐ ☐ Other:

25. How is access currently controlled? (select all that apply)
- ☑ No controls
- ☐ Not controlled, used for another purpose
- ☐ Signs
- ☐ Fencing around entire range/site
- ☐ Partial fencing
- ☐ Locked/secured gates
- ☐ Log-in book/Office check-in
- ☐ Security patrol
  - ☐ Vessel ☐ Aircraft ☐ Other
- ☐ Other:

26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

Lease to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Ownership transfer to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Reason for transfer:
- ☐ Termination of lease
- ☐ Revocation of withdrawn land
- ☐ Base Realignment and Closure action
- ☐ Other:

a. List the entity(ies) receiving the property:

- ☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)
- ☐ Unknown

27.

Known Land Interest

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- ☑ Federal Agency
- ☐ State Government
- ☐ Local Government
- ☐ Private Sector
- ☐ Tribal Government
- ☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Water Impact Areas

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 5: The Water Impact Areas include several different areas of operations: rockets and gun testing from the Valley where ordnance strayed from targets and landed in the water; remnants of ordnance and bulk propellant from large motor test incidents; and underwater testing done in the Potomac River.

Part II-C Question 8: The exact location of potential ordnance in the water is unknown. The estimate acreage is 100 acres but the range could extend from Chapman Point to the Chicamuxen Creek up through the Mattawoman Creek. It could even extend further down the Potomac towards Dahlgren since some of the intended impact areas were at Dahlgren.

Part II-C Question 3: The Water Impact Areas include several different areas of operations: rockets and gun testing from the Valley where ordnance strayed from targets and landed in the water; remnants of ordnance and bulk propellant from large motor test incidents; and underwater testing done in the Potomac River. The instances of ordnance landing into the water was not intentional except for the underwater testing done in the Potomac River. We are unsure if the underwater testing was energetic in nature but the building next to the water housed an explosive underwater development group (B62). Water traffic along the Potomac River, Mattawoman Creek and Chicamuxen Creek would not allow similar operations to continue in the future.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Water Impact Areas
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10.

The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	**10**
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	**10**
Detonators, blasting caps, fuzes, boosters, bursters	6
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**10**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	VALUE
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**0**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	VALUE
Solid or liquid propellants	**6**
Propellants	**6**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	VALUE
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **16**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	**II**	**10 to 20**
MARGINAL	III	5 to 9
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	5
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	**2**
Location (largest single value)	**2**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	**5**
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	4
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	0
Accessibility (largest single value)	**5**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **22**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	**2**	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	**Serious Risk - Priority for further action.**
RAC 3	Moderate Risk - Recommend further action.
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Igniter Area**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **OTHER**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation

Restoration Program database)?

- ○ Yes
- ◉ No

a. NORM Site Number:
b. NORM Site Name:

5. Range/Site Classification (check all that apply):
   - ☐ Disposal
   - ☐ Emergency Destruction
   - ☐ Open Burn/Open Detonation (OB/OD)
   - ☐ Other:
6. Range/Site Type (check all that apply):
   - ☑ Land
   - ☐ Water
7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☐ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **0.87**
   ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.87**
   ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **0.0**
   ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **0.0**
   ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?
   - ◉ Yes
   - ○ No

   a. If yes, is the map available in electronic format?
   - ◉ Yes - what format?
     - ☑ .pdf ☐ .shp
     - ☐ .bmp ☐ .dwg
     - ☐ .tif ☐ .dgn
     - ☐ .gif ☐ .dxf
     - ☐ .jpg
   - ○ No

   b. What information does the map (or maps) depict? (select all that apply)
   - ☑ Range location
   - ☐ Range boundaries
   - ☐ Target locations
   - ☑ Natural/cultural resources

☑ Other: **many other GIS layers**

10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☐ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○

☐ CADs/PADs	○	○	○	○
☑ Primers, Detonators, Fuzes, Squibs	○	○	○	◉
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Barren or low grass
    - ○ Heavy grass and many shrubs

- ○ Heavy shrubs and trees
- ○ Low grass and few shrubs
- ○ Shrubs and some trees
- ○ Heavily Wooded
- ○ Water Range

15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ○ Actual (known)
    - ○ Potential
    - ○ No Potential
    - ◉ Unknown

16. Are there any wetland areas associated with this range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, what is the estimated acreage? **0.5**

17. Are threatened or endangered species present on this range/site?
    - ◉ Yes, please list: **The site is within a wildlife protection area (no eagles)**
    - ○ No
    - ○ Unknown

18. Does the range/site contain archeological or cultural sites?
    - ◉ Yes
    - ○ No
    - ○ Unknown

19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ○ Yes
    - ○ No

20. Have munitions response activities been initiated/conducted on the range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.
    a. What is the scope of the response activities? (select all that apply)

- ☐ Munitions and Explosives of Concern (includes UXO)
- ☐ Munitions Constituents
- ☐ Other chemical contamination
- ☐ Unknown

b. What is the status of the munitions response activities? (select all that apply)

- ☐ Data collection
- ☐ Investigation
- ☐ Response/remedial action
- ☐ Operation and maintenance
- ☐ Monitoring
- ☐ Close out

c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?

- ○ Yes
- ○ No
- ○ Unknown

d. Under what authority were/are response actions conducted?

- ○ CERCLA
- ○ RCRA
- ○ Both CERCLA and RCRA
- ○ Unknown
- ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - ☐ Emergency response actions
    - ☐ Time-critical removal actions
    - ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - ☐ Non-munitions response actions

      Explain:
    - ☑ None
    - ☐ Unknown
    - ☐ Other:
22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)
23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
    Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

    What is the RAC Hazard Severity? ○ I ○ II ◉ III ○ IV ○ V

    What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

    What is the RAC? ○ I ○ II ◉ III ○ IV ○ V
24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
		Limited public access (wildlife refuge)

☐	☐	
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
☐	☐	Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
☐	☐	Other:

25. How is access currently controlled? (select all that apply)
- ☐ No controls
- ☐ Not controlled, used for another purpose
- ☑ Signs
- ☐ Fencing around entire range/site
- ☑ Partial fencing
- ☑ Locked/secured gates
- ☑ Log-in book/Office check-in
- ☑ Security patrol
  - ☐ Vessel ☐ Aircraft ☑ Other **vehicle**
- ☑ Other: **controls are for entire Restricted Area at IHDIVNAVSURFWARCEN**

26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

Lease to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Ownership transfer to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Reason for transfer:
- ☐ Termination of lease
- ☐ Revocation of withdrawn land
- ☐ Base Realignment and Closure action
- ☐ Other:

a. List the entity(ies) receiving the property:

☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)

☐ Unknown

27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

☑ Federal Agency
☐ State Government
☐ Local Government
☐ Private Sector
☐ Tribal Government
☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Igniter Area

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 3: Igniters have washed up on shore during low tide. Their source isis unknown. There are several burning grounds located near the shore north and south of the igniter area (Caffee Road Thermal Treatment Point, NG Slum Burning Ground, Original Burning Ground, Strauss Ave. Thermal Treatment Point) and may be the source of these igniters. Igniter burning would not be allowed because magazines are located near the area.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Igniter Area
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental

Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	**6**
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**6**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**

Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**0**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **6**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	**CATEGORY**	**HAZARD SEVERITY VALUE**
CATASTROPHIC	I	21 and/or greater
CRITICAL	II	10 to 20
MARGINAL	**III**	**5 to 9**
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the

presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	2
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:

residential, industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **24**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	**LEVEL**	**HAZARD PROBABILITY**
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	2	3	4	5
MARGINAL III	2	**3**	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	Serious Risk - Priority for further action.
RAC 3	**Moderate Risk - Recommend further action.**
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Battle Range Firing**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **CLOSED**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**

d. E-mail: **MagdinecEA@ih.navy.mil**

4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   - ○ Yes
   - ◉ No

   a. NORM Site Number:
   b. NORM Site Name:

5. Range/Site Classification (check all that apply):
   - ☑ Testing
   - ☐ Training
   - ☐ Small Arms Only (.50 cal and under)
   - ☐ Emergency Destruction
   - ☐ Open Burn/Open Detonation (OB/OD)
   - ☐ Other:

6. Range/Site Type (check all that apply):
   - ☐ Air-to-Air
   - ☐ Air-to-Water
   - ☐ Air-to-Land
   - ☐ Land-to-Air
   - ☑ Land-to-Land
   - ☐ Land-to-Water
   - ☐ Water-to-Air
   - ☐ Water-to-Land
   - ☐ Water-to-Water
   - ☐ Unknown

7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☐ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200

8. Please indicate the:

   a. Total range/site acreage: **10.0**
      ○ Known ◉ Estimated

   b. Acreage confirmed as having UXO: **10.0**
      ○ Known ◉ Estimated ○ Unknown

   c. Acreage suspected or potentially containing UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown

   d. Acreage confirmed with no UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown

9. Is a range/site map available?
   - ○ Yes
   - ◉ No

a. If yes, is the map available in electronic format?

- ○ Yes - what format?
  - ☐ .pdf ☐ .shp
  - ☐ .bmp ☐ .dwg
  - ☐ .tif ☐ .dgn
  - ☐ .gif ☐ .dxf
  - ☐ .jpg
- ○ No

b. What information does the map (or maps) depict? (select all that apply)

- ☐ Range location
- ☐ Range boundaries
- ☐ Target locations
- ☐ Natural/cultural resources
- ☐ Other:

10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☐ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☑ Projectiles	○	○	○	◉
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○

☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☐ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☑ Other: **Unknown ordnance fired from 1910**	○	○	○	◉

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft

☐ Unknown

13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Flat
    - ○ Flat w/gorges or gullies
    - ◉ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Barren or low grass
    - ○ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ◉ Heavily Wooded
    - ○ Water Range
15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ○ Actual (known)
    - ○ Potential
    - ○ No Potential
    - ◉ Unknown
16. Are there any wetland areas associated with this range/site?
    - ○ Yes
    - ○ No
    - ◉ Unknown

    If yes, what is the estimated acreage? **0.0**
17. Are threatened or endangered species present on this range/site?
    - ○ Yes, please list:
    - ○ No
    - ◉ Unknown
18. Does the range/site contain archeological or cultural sites?
    - ○ Yes
    - ○ No
    - ◉ Unknown

19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ○ Yes
    - ○ No

20. Have munitions response activities been initiated/conducted on the range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
    - ☐ Munitions and Explosives of Concern (includes UXO)
    - ☐ Munitions Constituents
    - ☐ Other chemical contamination
    - ☐ Unknown

    b. What is the status of the munitions response activities? (select all that apply)
    - ☐ Data collection
    - ☐ Investigation
    - ☐ Response/remedial action
    - ☐ Operation and maintenance
    - ☐ Monitoring
    - ☐ Close out

    c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?
    - ○ Yes
    - ○ No
    - ○ Unknown

    d. Under what authority were/are response actions conducted?
    - ○ CERCLA
    - ○ RCRA
    - ○ Both CERCLA and RCRA
    - ○ Unknown
    - ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - ☐ Emergency response actions
    - ☐ Time-critical removal actions
    - ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - ☐ Non-munitions response actions

    Explain:
    - ☑ None
    - ☐ Unknown
    - ☐ Other:

22. What is the estimated/budgeted funding requirement associated with the response actions at

this range/site? (U=Unknown; N/A=Not applicable)

23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

What is the RAC Hazard Severity? ○ I ◉ II ○ III ○ IV ○ V

What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

What is the RAC? ○ I ◉ II ○ III ○ IV ○ V

24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
☐	☐	Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
☐	☐	Other:

25. How is access currently controlled? (select all that apply)
- ☐ No controls
- ☐ Not controlled, used for another purpose
- ☑ Signs
- ☐ Fencing around entire range/site
- ☑ Partial fencing
- ☑ Locked/secured gates
- ☑ Log-in book/Office check-in
- ☑ Security patrol
  - ☐ Vessel ☐ Aircraft ☑ Other **vehicle**
- ☑ Other: **controls are for entire facility at Stump Neck**

26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

Lease to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Ownership transfer to:

- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Reason for transfer:

- ☐ Termination of lease
- ☐ Revocation of withdrawn land
- ☐ Base Realignment and Closure action
- ☐ Other:

a. List the entity(ies) receiving the property:

- ☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)

- ☐ Unknown

27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- ☑ Federal Agency
- ☐ State Government
- ☐ Local Government
- ☐ Private Sector
- ☐ Tribal Government
- ☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Battle Range Firing

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 3: There very little information on this potential range. It was identified through a historical search.

Part II-C Question 3: The Battle Range Firing area was discovered during a historical search. Very little is known about it. It was developed on the north bluff at Stump Neck in 1910. They used pasteboard or similar targets. It is suspected that guns and rockets were fired from the Valley at Indian Head to this location. This seems to be a different location from the Stump Neck impact area since that area was located on a south central swamp and this area is located on a north bluff.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Battle Range Firing
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	**10**
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	6
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**10**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**0**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **10**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	**II**	**10 to 20**
MARGINAL	III	5 to 9
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	2
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2

1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F **24**

(maximum of 30)
Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	**2**	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	**Serious Risk - Priority for further action.**
RAC 3	Moderate Risk - Recommend further action.
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Former Pinkwater Treatment Facility**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **OTHER**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   ○ Yes
   ◉ No
   a. NORM Site Number:
   b. NORM Site Name:
5. Range/Site Classification (check all that apply):
   ☐ Disposal
   ☐ Emergency Destruction
   ☐ Open Burn/Open Detonation (OB/OD)
   ☑ Other: **see comments**
6. Range/Site Type (check all that apply):
   ☑ Land
   ☐ Water
7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   ☐ Less than 3
   ☐ Between 3 and 12
   ☐ Between 12 and 200
   ☐ Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **0.68**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **0.68**
      ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?

- (●) Yes
- ( ) No

a. If yes, is the map available in electronic format?

- (●) Yes - what format?
  - [x] .pdf [ ] .shp
  - [ ] .bmp [ ] .dwg
  - [ ] .tif [ ] .dgn
  - [ ] .gif [ ] .dxf
  - [ ] .jpg
- ( ) No

b. What information does the map (or maps) depict? (select all that apply)

- [x] Range location
- [x] Range boundaries
- [ ] Target locations
- [x] Natural/cultural resources
- [x] Other: **Many other GIS layers**

10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
[ ] Small Arms (.50 cal and under)	( )	( )	( )	( )
[ ] Hand Grenades, explosive	( )	( )	( )	( )
[ ] Hand Grenades, practice (w/spotting charges)	( )	( )	( )	( )
[ ] Rifle Grenades, explosive	( )	( )	( )	( )
[ ] Rifle Grenades, practice (w/spotting charges)	( )	( )	( )	( )
[ ] Projected Grenades, explosive	( )	( )	( )	( )
[ ] Projected Grenades, practice (w/spotting charges)	( )	( )	( )	( )
[ ] Mortars, explosive	( )	( )	( )	( )
[ ] Mortars, practice (w/spotting charges)	( )	( )	( )	( )
[x] Projectiles	(●)	( )	( )	( )
[x] Bombs, Explosive	(●)	( )	( )	( )
[ ] Bombs, practice (w/spotting charges)	( )	( )	( )	( )
[x] Rockets, explosive	(●)	( )	( )	( )
[ ] Rockets, practice (w/spotting charges)	( )	( )	( )	( )
[ ] Large Rocket Motors (>1,000 lbs)	( )	( )	( )	( )
[x] Warheads	(●)	( )	( )	( )

☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☑ Torpedoes	◉	○	○	○
☑ Mines, Explosive	◉	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☐ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☑ Other: **Various foreign ordnance**	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft

- ☐ 30-80 ft
- ☐ Greater than 80 ft
- ☐ Unknown

13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Barren or low grass
    - ○ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ○ Heavily Wooded
    - ○ Water Range
15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ○ Actual (known)
    - ○ Potential
    - ◉ No Potential
    - ○ Unknown
16. Are there any wetland areas associated with this range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, what is the estimated acreage? **0.3**
17. Are threatened or endangered species present on this range/site?
    - ○ Yes, please list:
    - ◉ No
    - ○ Unknown
18. Does the range/site contain archeological or cultural sites?
    - ○ Yes

- (●) No
- ( ) Unknown

19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ( ) Yes
    - (●) No
    - ( ) Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
        - ( ) Yes
        - ( ) No

20. Have munitions response activities been initiated/conducted on the range/site?
    - (●) Yes
    - ( ) No
    - ( ) Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
        - [x] Munitions and Explosives of Concern (includes UXO)
        - [x] Munitions Constituents
        - [ ] Other chemical contamination
        - [ ] Unknown

    b. What is the status of the munitions response activities? (select all that apply)
        - [x] Data collection
        - [x] Investigation
        - [ ] Response/remedial action
        - [ ] Operation and maintenance
        - [x] Monitoring
        - [ ] Close out

    c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?
        - (●) Yes
        - ( ) No
        - ( ) Unknown

    d. Under what authority were/are response actions conducted?
        - ( ) CERCLA
        - (●) RCRA
        - ( ) Both CERCLA and RCRA
        - ( ) Unknown
        - ( ) Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - [ ] Emergency response actions
    - [ ] Time-critical removal actions
    - [ ] Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - [ ] Non-munitions response actions

    Explain:

    - [ ] None
    - [ ] Unknown

☑ Other: **see comments**

22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)

23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

What is the RAC Hazard Severity? ○ I ◉ II ○ III ○ IV ○ V

What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

What is the RAC? ○ I ◉ II ○ III ○ IV ○ V

24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
☐	☐	Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
☐	☐	Other:

25. How is access currently controlled? (select all that apply)

☐ No controls
☐ Not controlled, used for another purpose
☑ Signs
☐ Fencing around entire range/site
☑ Partial fencing
☑ Locked/secured gates
☑ Log-in book/Office check-in
☑ Security patrol
☐ Vessel ☐ Aircraft ☑ Other **vehicle**
☑ Other: **controls are for entire facility at Stump Neck**

26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

Lease to:

☐ Other DoD Component
☐ Federal agency
☐ Tribal government
☐ State agency
☐ Local agency

- ☐ Private entity
- ☐ Unknown

Ownership transfer to:

- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Reason for transfer:

- ☐ Termination of lease
- ☐ Revocation of withdrawn land
- ☐ Base Realignment and Closure action
- ☐ Other:

a. List the entity(ies) receiving the property:

- ☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)

- ☐ Unknown

27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- ☑ Federal Agency
- ☐ State Government
- ☐ Local Government
- ☐ Private Sector
- ☐ Tribal Government
- ☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Former Pinkwater Treatment Facility

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source. The groundwater monitoring and human health risk assessments have shown that the contaminant levels are not a risk to human health.

Part II-C Question 4: This site is being considered by the IR program because RDX found in an upgradient well as led us to believe that there is a potential source of explosive contamination beyond the pinkwater treatment facility.

Part II-C Question 5: Pinkwater and explosives contaminated wastewater generated by steaming out explosives from munitions.

Part II-C Question 10: There will be no full up rounds but explosive residues in the soil and groundwater.

Part II-C Question 17: The area is sandwiched between eagle protection areas.

Part II-C Question 20: MDE has requested groundwater monitoring due to metals and RDX detected

in the soil, sediment and groundwater.

Part II-C Question 21: The Former PWTF was permitted for pinkwater (K047) treatment under the Maryland Department of the Environment. It was identified as SWMU#13 in the RCRA Facilities Assessment of July 1990. It will not be investgated further unless there is evidence of the potential to harm the environment. The site is undergoing RCRA closure and groundwater monitoring. RDX has been detected in upgradient well and RDX source may be of another ordnance source. CERCLA is considering taking this site from RCRA to ensure complete clean up of entire site.

Part II-C Question 3: The former pinkwater treatment facility (PWTF) was used to steam out various ordnance (the majority was foreign) to render it inert. The condensate had TNT (;inkwater) and was either discharged directly to the creek or later filtered through activated carbon and discharged. The pinkwater treatment was permitted through the Maryland Department of the Environment. The site is undergoing RCRA closure but during the monitoring, RDX has been identified in an upgradient well. This source of RDX is unknown and may be from another ordnance site. CERLCA is considering investigating the site to ensure complete clean up of the entire site. RCRA closure applies only to the contamination associated with the permitted process which does not address the explosive contamination upgradient. The PWTF was relocated to another building at Stump Neck.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Former Pinkwater Treatment Facility
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	**10**
Bombs, explosive	**10**
Grenades, hand or rifle, explosive	10
Landmine, explosive	**10**
Rockets, guided missile, explosive	**10**
Detonators, blasting caps, fuzes, boosters, bursters	6
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**10**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**0**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **10**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	**II**	**10 to 20**
MARGINAL	III	5 to 9
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	5
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	**2**
Location (largest single value)	**2**

What evidence do you have regarding the location of MEC?

Sampling

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	VALUE
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	VALUE
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	VALUE
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:

residential, industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	VALUE
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2

Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	0
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **21**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY					

CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	**2**	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	**Serious Risk - Priority for further action.**
RAC 3	Moderate Risk - Recommend further action.
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Torpedo Burial Site**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **OTHER**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   - (•) Yes
   - ( ) No

   a. NORM Site Number: **152**
   b. NORM Site Name: **Site 00035**
5. Range/Site Classification (check all that apply):
   - ☐ Disposal
   - ☐ Emergency Destruction

     Open Burn/Open Detonation (OB/OD)

☐

☐ Other:

6. Range/Site Type (check all that apply):
   - ☑ Land
   - ☐ Water
7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☐ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **0.84**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **0.84**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?
   - ◉ Yes
   - ○ No

   a. If yes, is the map available in electronic format?
      - ◉ Yes - what format?
        - ☑ .pdf ☐ .shp
        - ☐ .bmp ☐ .dwg
        - ☐ .tif ☐ .dgn
        - ☐ .gif ☐ .dxf
        - ☐ .jpg
      - ○ No

   b. What information does the map (or maps) depict? (select all that apply)
      - ☑ Range location
      - ☑ Range boundaries
      - ☐ Target locations
      - ☑ Natural/cultural resources
      - ☑ Other: **Many other GIS layers**
10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)

	L	M	H	U
☐ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☑ Torpedoes	○	○	○	◉
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☑ Primers, Detonators, Fuzes, Squibs	○	○	○	◉
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○

☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Barren or low grass
    - ◉ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ○ Heavily Wooded
    - ○ Water Range
15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown

- ○ Not Applicable (water range/site)

a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?

- ◉ Yes
- ○ No
- ○ Unknown

b. What is the range's or site's potential for contamination to drinking water?

- ○ Actual (known)
- ○ Potential
- ○ No Potential
- ◉ Unknown

16. Are there any wetland areas associated with this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, what is the estimated acreage? **0.0**
17. Are threatened or endangered species present on this range/site?
    - ◉ Yes, please list: **The site is on a wildlife protection area (no eagles)**
    - ○ No
    - ○ Unknown
18. Does the range/site contain archeological or cultural sites?
    - ◉ Yes
    - ○ No
    - ○ Unknown
19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ○ Yes
    - ○ No
20. Have munitions response activities been initiated/conducted on the range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
    - ☑ Munitions and Explosives of Concern (includes UXO)
    - ☐ Munitions Constituents
    - ☐ Other chemical contamination
    - ☐ Unknown

    b. What is the status of the munitions response activities? (select all that apply)
    - ☑ Data collection
    - ☑ Investigation
    - ☐ Response/remedial action

- ☐ Operation and maintenance
- ☐ Monitoring
- ☐ Close out

c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?

- ○ Yes
- ○ No
- ◉ Unknown

d. Under what authority were/are response actions conducted?

- ◉ CERCLA
- ○ RCRA
- ○ Both CERCLA and RCRA
- ○ Unknown
- ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - ☐ Emergency response actions
    - ☐ Time-critical removal actions
    - ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - ☐ Non-munitions response actions
      Explain:
    - ☐ None
    - ☐ Unknown
    - ☑ Other: **see comments**
22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)
23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
    Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

    What is the RAC Hazard Severity? ○ I ◉ II ○ III ○ IV ○ V

    What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

    What is the RAC? ○ I ◉ II ○ III ○ IV ○ V

24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
		Unrestricted (commercial, residential, utility, subsurface recreational, and

☐ ☐ construction)

☐ ☐ Other:

25. How is access currently controlled? (select all that apply)
- ☐ No controls
- ☐ Not controlled, used for another purpose
- ☑ Signs
- ☐ Fencing around entire range/site
- ☑ Partial fencing
- ☑ Locked/secured gates
- ☑ Log-in book/Office check-in
- ☑ Security patrol
  - ☐ Vessel ☐ Aircraft ☑ Other **vehicle**
- ☑ Other: **controls are for entire facility at Stump Neck**

26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

Lease to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Ownership transfer to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Reason for transfer:
- ☐ Termination of lease
- ☐ Revocation of withdrawn land
- ☐ Base Realignment and Closure action
- ☐ Other:

a. List the entity(ies) receiving the property:

- ☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)
- ☐ Unknown

27.

Known Land Interest

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- ☑ Federal Agency
- ☐ State Government
- ☐ Local Government
- ☐ Private Sector
- ☐ Tribal Government
- ☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Torpedo Burial Site

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 21: The Torpedo Burial Site is IR Site #35. It was identified in the 1983 Initial Assessment Study. Under the FFA between EPA and the Navy, the site was identified as a site screening area, which will undergo a site screening process to determine if it should proceed to a rememdial investigation and feasibility study or removed for further study.

Part II-C Question 3: The Torpedo Burial Pit was an unlined earthen pit used to dispose of inert torpedo shells and associated hardware from the torpedo station in Washington, DC. It is unknown if any live ordnance or explosive residues were buried.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Torpedo Burial Site
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved

based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	**10**
Detonators, blasting caps, fuzes, boosters, bursters	**6**
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**10**

What evidence do you have regarding conventional unexploded ordnance?

IAS identified potential buried torpedos that may not have been rendered safe.

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6

Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**0**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **10**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	**II**	**10 to 20**
MARGINAL	III	5 to 9
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	5

Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	**2**
Location (largest single value)	**2**

What evidence do you have regarding the location of MEC?
IAS of 1983

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:
residential, industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5

Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **21**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3

RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	**2**	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1 High Risk - Highest priority for further action.
RAC 2 Serious Risk - Priority for further action.
RAC 3 Moderate Risk - Recommend further action.
RAC 4 Low Risk - Recommend further action.
RAC 5 Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Single Base Propellant Grains Spill Area**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **OTHER**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   (•) Yes
   ( ) No
   a. NORM Site Number: **157**

b. NORM Site Name: **Site 00010**

5. Range/Site Classification (check all that apply):
   - ☐ Disposal
   - ☐ Emergency Destruction
   - ☐ Open Burn/Open Detonation (OB/OD)
   - ☑ Other: **Spill of propellant grains**
6. Range/Site Type (check all that apply):
   - ☑ Land
   - ☐ Water
7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☐ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **42.0**
   ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **42.0**
   ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **0.0**
   ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **0.0**
   ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?
   ◉ Yes
   ○ No
   a. If yes, is the map available in electronic format?
   ◉ Yes - what format?
   ☑ .pdf ☐ .shp ☐ .bmp ☐ .dwg ☐ .tif ☐ .dgn ☐ .gif ☐ .dxf ☐ .jpg
   ○ No
   b. What information does the map (or maps) depict? (select all that apply)
   - ☑ Range location
   - ☑ Range boundaries
   - ☐ Target locations
   - ☑ Natural/cultural resources
   - ☑ Other: **Many other GIS layers**
10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☐ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☑ Bulk Propellant (solid or liquid)	○	○	◉	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☐ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
Less Sensitive Explosives (e.g.,				

☐ ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Barren or low grass
    - ◉ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ○ Heavily Wooded

- ○ Water Range

15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ○ Actual (known)
    - ○ Potential
    - ○ No Potential
    - ◉ Unknown

16. Are there any wetland areas associated with this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, what is the estimated acreage? **0.0**

17. Are threatened or endangered species present on this range/site?
    - ○ Yes, please list:
    - ◉ No
    - ○ Unknown

18. Does the range/site contain archeological or cultural sites?
    - ◉ Yes
    - ○ No
    - ○ Unknown

19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ○ Yes
    - ○ No

20. Have munitions response activities been initiated/conducted on the range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
    - ☑ Munitions and Explosives of Concern (includes UXO)
    - ☐ Munitions Constituents
    - ☐ Other chemical contamination
    - ☐ Unknown

b. What is the status of the munitions response activities? (select all that apply)
- ☑ Data collection
- ☑ Investigation
- ☐ Response/remedial action
- ☐ Operation and maintenance
- ☐ Monitoring
- ☐ Close out

c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?
- ○ Yes
- ○ No
- ◉ Unknown

d. Under what authority were/are response actions conducted?
- ◉ CERCLA
- ○ RCRA
- ○ Both CERCLA and RCRA
- ○ Unknown
- ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
- ☐ Emergency response actions
- ☐ Time-critical removal actions
- ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
- ☐ Non-munitions response actions

  Explain:
- ☐ None
- ☐ Unknown
- ☑ Other: **see comments**

22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)

23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

What is the RAC Hazard Severity? ○ I ○ II ◉ III ○ IV ○ V

What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

What is the RAC? ○ I ○ II ◉ III ○ IV ○ V

24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)

☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
☐	☐	Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
☐	☐	Other:

25. How is access currently controlled? (select all that apply)
    - ☐ No controls
    - ☐ Not controlled, used for another purpose
    - ☑ Signs
    - ☐ Fencing around entire range/site
    - ☑ Partial fencing
    - ☑ Locked/secured gates
    - ☑ Log-in book/Office check-in
    - ☑ Security patrol
        - ☐ Vessel ☐ Aircraft ☑ Other **vehicle**
    - ☑ Other: **controls are for restricted area at IHDIVNAVSURFWARCEN**
26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

    Lease to:
    - ☐ Other DoD Component
    - ☐ Federal agency
    - ☐ Tribal government
    - ☐ State agency
    - ☐ Local agency
    - ☐ Private entity
    - ☐ Unknown

    Ownership transfer to:
    - ☐ Other DoD Component
    - ☐ Federal agency
    - ☐ Tribal government
    - ☐ State agency
    - ☐ Local agency
    - ☐ Private entity
    - ☐ Unknown

    Reason for transfer:
    - ☐ Termination of lease
    - ☐ Revocation of withdrawn land
    - ☐ Base Realignment and Closure action
    - ☐ Other:

    a. List the entity(ies) receiving the property:

    - ☐ Unknown

    b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)
    - ☐ Unknown

27. **Known Land Interest**
    a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)
    - ☑ Federal Agency
    - ☐ State Government
    - ☐ Local Government
    - ☐ Private Sector
    - ☐ Tribal Government
    - ☐ None

    b. Provide a brief description of the organization with ownership/control interest:
    GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Single Base Propellant Grains Spill Area

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 21: The Initial Assessment Study of 1983 identified the site as IR site 10. The FFA between EPA and the Navy describes it as a site screening area.

Part II-C Question 3: Single base propellant grains were spilled along the railroad tracks and around the power dry houses. Grains are visible on the surface soil.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Single Base Propellant Grains Spill Area

Site Location IHDIVNAVSURFWARCEN

DERP Project #

Date Completed 09/22/2003

Rater's Name Elaine Magdinec

Phone Number (301) 744-2264

Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN

Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions,

field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	6
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**0**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6

Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**0**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	**6**
Propellants	**6**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **6**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	II	10 to 20
MARGINAL	**III**	**5 to 9**
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**

Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	2
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:
residential, educational, industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site).	**4**

Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **24**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	2	3	4	5
MARGINAL III	2	**3**	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	Serious Risk - Priority for further action.
RAC 3	**Moderate Risk - Recommend further action.**
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Causeway**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **OTHER**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   (•) Yes
   ( ) No
   a. NORM Site Number: **154**
   b. NORM Site Name: **IR Site 00037**

5. Range/Site Classification (check all that apply):
   - ☐ Disposal
   - ☐ Emergency Destruction
   - ☐ Open Burn/Open Detonation (OB/OD)
   - ☐ Other:
6. Range/Site Type (check all that apply):
   - ☑ Land
   - ☐ Water
7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☐ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **2.4**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **2.4**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?
   - ◉ Yes
   - ○ No

   a. If yes, is the map available in electronic format?
      - ◉ Yes - what format?
        - ☑ .pdf ☐ .shp
        - ☐ .bmp ☐ .dwg
        - ☐ .tif ☐ .dgn
        - ☐ .gif ☐ .dxf
        - ☐ .jpg
      - ○ No

   b. What information does the map (or maps) depict? (select all that apply)
      - ☑ Range location
      - ☑ Range boundaries
      - ☐ Target locations
      - ☑ Natural/cultural resources
      - ☑ Other: **many other GIS layers**
10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☐ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☑ Torpedoes	○	○	○	◉
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☐ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○

☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Barren or low grass
    - ○ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ○ Heavily Wooded
    - ○ Water Range

15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ○ Actual (known)
    - ○ Potential
    - ○ No Potential
    - ◉ Unknown

16. Are there any wetland areas associated with this range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, what is the estimated acreage? **0.2**

17. Are threatened or endangered species present on this range/site?
    - ◉ Yes, please list: **The site is within a wildlife protection area**
    - ○ No
    - ○ Unknown

18. Does the range/site contain archeological or cultural sites?
    - ○ Yes
    - ◉ No
    - ○ Unknown

19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ○ Yes
    - ○ No

20. Have munitions response activities been initiated/conducted on the range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
    - ☑ Munitions and Explosives of Concern (includes UXO)
    - ☐ Munitions Constituents
    - ☐ Other chemical contamination
    - ☐ Unknown

    b. What is the status of the munitions response activities? (select all that apply)
    - ☑ Data collection

- ☑ Investigation
- ☐ Response/remedial action
- ☐ Operation and maintenance
- ☐ Monitoring
- ☐ Close out

c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?

- ○ Yes
- ○ No
- ◉ Unknown

d. Under what authority were/are response actions conducted?

- ◉ CERCLA
- ○ RCRA
- ○ Both CERCLA and RCRA
- ○ Unknown
- ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - ☐ Emergency response actions
    - ☐ Time-critical removal actions
    - ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - ☐ Non-munitions response actions

      Explain:
    - ☐ None
    - ☐ Unknown
    - ☑ Other: **See Comments**
22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)
23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
    Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

    What is the RAC Hazard Severity? ○ I ◉ II ○ III ○ IV ○ V

    What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

    What is the RAC? ○ I ◉ II ○ III ○ IV ○ V
24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)

- ☐ ☐ Public access (surface supply storage)
- ☐ ☐ Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
- ☐ ☐ Other:

25. How is access currently controlled? (select all that apply)
    - ☐ No controls
    - ☐ Not controlled, used for another purpose
    - ☑ Signs
    - ☐ Fencing around entire range/site
    - ☑ Partial fencing
    - ☑ Locked/secured gates
    - ☑ Log-in book/Office check-in
    - ☑ Security patrol
        - ☐ Vessel ☐ Aircraft ☑ Other **Vehicle**
    - ☑ Other: **Controls are the facility at Stump Neck**
26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

    Lease to:
    - ☐ Other DoD Component
    - ☐ Federal agency
    - ☐ Tribal government
    - ☐ State agency
    - ☐ Local agency
    - ☐ Private entity
    - ☐ Unknown

    Ownership transfer to:
    - ☐ Other DoD Component
    - ☐ Federal agency
    - ☐ Tribal government
    - ☐ State agency
    - ☐ Local agency
    - ☐ Private entity
    - ☐ Unknown

    Reason for transfer:
    - ☐ Termination of lease
    - ☐ Revocation of withdrawn land
    - ☐ Base Realignment and Closure action
    - ☐ Other:

    a. List the entity(ies) receiving the property:

    - ☐ Unknown

    b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)
    - ☐ Unknown
27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- [x] Federal Agency
- [ ] State Government
- [ ] Local Government
- [ ] Private Sector
- [ ] Tribal Government
- [ ] None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Causeway

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 21: In the 1983 Initial Assessment Study, the site was identified as SWMU #24. The RCRA Facilities Assessment of July 1990 identifed SWMU #24 also. The Federal Facilities Agreement between EPA and the Navy addresses it as Site #37 and a site screening area and will continue under the site screening process.

Part II-C Question 3: The causeway is an area that was built up with fill material that included old torpedo casings. It is unknown if the casings could have included energetics or their residues.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Causeway
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions,

field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	**10**
Detonators, blasting caps, fuzes, boosters, bursters	6
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**10**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6

Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**0**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **10**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	**II**	**10 to 20**
MARGINAL	III	5 to 9
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	5

Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	**2**
Location (largest single value)	**2**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:
residential, industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site).	**4**

Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **21**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	**2**	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	**Serious Risk - Priority for further action.**
RAC 3	Moderate Risk - Recommend further action.
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **NG Slums Burning Ground**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **OTHER**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   - (•) Yes
   - ( ) No

   a. NORM Site Number: **139**
   b. NORM Site Name: **IR Site 00022**

5. Range/Site Classification (check all that apply):
   - ☐ Disposal
   - ☐ Emergency Destruction
   - ☑ Open Burn/Open Detonation (OB/OD)
   - ☐ Other:
6. Range/Site Type (check all that apply):
   - ☑ Land
   - ☐ Water
7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☐ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **0.5**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **0.5**
      ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?
   - ◉ Yes
   - ○ No

   a. If yes, is the map available in electronic format?
      - ◉ Yes - what format?
        - ☑ .pdf ☐ .shp
        - ☐ .bmp ☐ .dwg
        - ☐ .tif ☐ .dgn
        - ☐ .gif ☐ .dxf
        - ☐ .jpg
      - ○ No

   b. What information does the map (or maps) depict? (select all that apply)
      - ☑ Range location
      - ☑ Range boundaries
      - ☐ Target locations
      - ☑ Natural/cultural resources
      - ☑ Other: **Many other GIS layers**
10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☐ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☑ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	◉	○	○	○
☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☐ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○

☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Barren or low grass
    - ◉ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ○ Heavily Wooded
    - ○ Water Range

15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ○ Actual (known)
    - ○ Potential
    - ○ No Potential
    - ◉ Unknown

16. Are there any wetland areas associated with this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, what is the estimated acreage? **0.0**

17. Are threatened or endangered species present on this range/site?
    - ◉ Yes, please list: **The site is within a wildlife protection area**
    - ○ No
    - ○ Unknown

18. Does the range/site contain archeological or cultural sites?
    - ○ Yes
    - ◉ No
    - ○ Unknown

19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ○ Yes
    - ○ No

20. Have munitions response activities been initiated/conducted on the range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
    - ☑ Munitions and Explosives of Concern (includes UXO)
    - ☐ Munitions Constituents
    - ☐ Other chemical contamination
    - ☐ Unknown

    b. What is the status of the munitions response activities? (select all that apply)
    - ☑ Data collection

- ☑ Investigation
- ☐ Response/remedial action
- ☐ Operation and maintenance
- ☐ Monitoring
- ☐ Close out

c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?

- ○ Yes
- ○ No
- ◉ Unknown

d. Under what authority were/are response actions conducted?

- ◉ CERCLA
- ○ RCRA
- ○ Both CERCLA and RCRA
- ○ Unknown
- ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - ☐ Emergency response actions
    - ☐ Time-critical removal actions
    - ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - ☐ Non-munitions response actions

      Explain:
    - ☐ None
    - ☐ Unknown
    - ☑ Other: **see comments**
22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)
23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
    Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

    What is the RAC Hazard Severity? ○ I ◉ II ○ III ○ IV ○ V

    What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

    What is the RAC? ○ I ◉ II ○ III ○ IV ○ V
24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)

- ☐ ☐ Public access (surface supply storage)
- ☐ ☐ Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
- ☐ ☐ Other:

25. How is access currently controlled? (select all that apply)
    - ☐ No controls
    - ☐ Not controlled, used for another purpose
    - ☑ Signs
    - ☐ Fencing around entire range/site
    - ☑ Partial fencing
    - ☑ Locked/secured gates
    - ☑ Log-in book/Office check-in
    - ☑ Security patrol
        - ☐ Vessel ☐ Aircraft ☑ Other **vehicle**
    - ☑ Other: **controls are for restricted area at IHDIVNAVSURFWARCEN**
26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

    Lease to:
    - ☐ Other DoD Component
    - ☐ Federal agency
    - ☐ Tribal government
    - ☐ State agency
    - ☐ Local agency
    - ☐ Private entity
    - ☐ Unknown

    Ownership transfer to:
    - ☐ Other DoD Component
    - ☐ Federal agency
    - ☐ Tribal government
    - ☐ State agency
    - ☐ Local agency
    - ☐ Private entity
    - ☐ Unknown

    Reason for transfer:
    - ☐ Termination of lease
    - ☐ Revocation of withdrawn land
    - ☐ Base Realignment and Closure action
    - ☐ Other:

    a. List the entity(ies) receiving the property:

    - ☐ Unknown

    b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)
    - ☐ Unknown
27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- ☑ Federal Agency
- ☐ State Government
- ☐ Local Government
- ☐ Private Sector
- ☐ Tribal Government
- ☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for NG Slums Burning Ground

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 21: The Initial Assessment Study of 1983 identified site as Site 22. The RCRA Facility Assessment of 1988 identified site as SWMU 77. Federal facilities Agreement between EPA and the Navy calls it a site screening area.

Part II-C Question 3: NG slums generated from the NG plant were burned here. It may have served as a disposal site for other wastes as it was operated prior to the opening of the main burning point.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name NG Slums Burning Ground
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

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based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

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Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**0**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	**10**
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3

High explosives (largest single value)	**10**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **10**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	**II**	**10 to 20**
MARGINAL	III	5 to 9
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	5
Within tanks, pipes, vessels, or other confined areas	4

Inside walls, ceilings, or other building/structure	3
Subsurface	**2**
Location (largest single value)	**2**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:

residential, industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**

A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **21**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	**2**	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	**Serious Risk - Priority for further action.**
RAC 3	Moderate Risk - Recommend further action.
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Original Burning Ground**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **OTHER**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   - (•) Yes
   - ( ) No

   a. NORM Site Number: **145**
   b. NORM Site Name: **IR Site 00028**
5. Range/Site Classification (check all that apply):

- ☐ Disposal
- ☐ Emergency Destruction
- ☑ Open Burn/Open Detonation (OB/OD)
- ☐ Other:

6. Range/Site Type (check all that apply):
   - ☑ Land
   - ☐ Water
7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☐ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **1.5**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **1.5**
      ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?
   - ◉ Yes
   - ○ No

   a. If yes, is the map available in electronic format?
      - ◉ Yes - what format?
        - ☑ .pdf ☐ .shp
        - ☐ .bmp ☐ .dwg
        - ☐ .tif ☐ .dgn
        - ☐ .gif ☐ .dxf
        - ☐ .jpg
      - ○ No

   b. What information does the map (or maps) depict? (select all that apply)
      - ☑ Range location
      - ☑ Range boundaries
      - ☐ Target locations
      - ☑ Natural/cultural resources
      - ☑ Other: **Many other GIS layers**
10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☐ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☑ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	◉
☑ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	◉
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☐ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above)				

(e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Flat
    - ○ Flat w/gorges or gullies
    - ◉ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Barren or low grass
    - ◉ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ○ Heavily Wooded
    - ○ Water Range
15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.

- ○ Unknown
- ○ Not Applicable (water range/site)

a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?

- ◉ Yes
- ○ No
- ○ Unknown

b. What is the range's or site's potential for contamination to drinking water?

- ○ Actual (known)
- ○ Potential
- ○ No Potential
- ◉ Unknown

16. Are there any wetland areas associated with this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, what is the estimated acreage? **0.0**
17. Are threatened or endangered species present on this range/site?
    - ○ Yes, please list:
    - ◉ No
    - ○ Unknown
18. Does the range/site contain archeological or cultural sites?
    - ◉ Yes
    - ○ No
    - ○ Unknown
19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ○ Yes
    - ○ No
20. Have munitions response activities been initiated/conducted on the range/site?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
    - ☑ Munitions and Explosives of Concern (includes UXO)
    - ☑ Munitions Constituents
    - ☐ Other chemical contamination
    - ☐ Unknown

    b. What is the status of the munitions response activities? (select all that apply)
    - ☑ Data collection
    - ☑ Investigation

- ☐ Response/remedial action
- ☐ Operation and maintenance
- ☐ Monitoring
- ☐ Close out

c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?

- ○ Yes
- ○ No
- ◉ Unknown

d. Under what authority were/are response actions conducted?

- ◉ CERCLA
- ○ RCRA
- ○ Both CERCLA and RCRA
- ○ Unknown
- ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - ☐ Emergency response actions
    - ☐ Time-critical removal actions
    - ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - ☐ Non-munitions response actions
      Explain:
    - ☐ None
    - ☐ Unknown
    - ☑ Other: **see comments**
22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)
23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
    Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

    What is the RAC Hazard Severity? ○ I ◉ II ○ III ○ IV ○ V

    What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

    What is the RAC? ○ I ◉ II ○ III ○ IV ○ V

24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)

☐ ☐ Unrestricted (commercial, residential, utility, subsurface recreational, and construction)

☐ ☐ Other:

25. How is access currently controlled? (select all that apply)
    - ☐ No controls
    - ☐ Not controlled, used for another purpose
    - ☑ Signs
    - ☐ Fencing around entire range/site
    - ☑ Partial fencing
    - ☑ Locked/secured gates
    - ☑ Log-in book/Office check-in
    - ☑ Security patrol
        - ☐ Vessel ☐ Aircraft ☑ Other **vehicle**
    - ☑ Other: **controls are for restricted area at IHDIVNAVSURFWARCEN**

26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

Lease to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Ownership transfer to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Reason for transfer:
- ☐ Termination of lease
- ☐ Revocation of withdrawn land
- ☐ Base Realignment and Closure action
- ☐ Other:

a. List the entity(ies) receiving the property:

- ☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)

- ☐ Unknown

27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- ☑ Federal Agency
- ☐ State Government
- ☐ Local Government
- ☐ Private Sector
- ☐ Tribal Government
- ☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Original Burning Ground

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 21: The Initial Assessment Study of 1983 identified the Original Burning Ground as Site 28. In the Federal Facilities Agreement between EPA and the Navy, it is a site screening area.

Part II-C Question 3: The Original Burning Ground was an area used to burn explosive wastes such as smokeless powder. It was operational until 1942.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Original Burning Ground
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	6
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**0**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	**10**
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	**8**
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**10**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **10**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	**II**	**10 to 20**
MARGINAL	III	5 to 9
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3

Subsurface	**2**
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:
residential, industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier	3

is intended to deny access to the site.	
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **24**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY	FREQUENT	PROBABLE	OCCASIONAL	REMOTE	IMPROBABLE

LEVEL	A	B	C	D	E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	**2**	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	**Serious Risk - Priority for further action.**
RAC 3	Moderate Risk - Recommend further action.
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Torpedo Casing Disposal Area**
   Range/Site FFID Number: **MD317002410900**(if different from installation)
   Range/Site City(ies): **Indian Head**(if different from installation)
   Range/Site County(ies): **Charles**(if different from installation)
   Range/Site State(s): **Indian Head**(if different from installation)
   Latitude: **38 32 54N**
   Longitude: **77 11 40W**
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **OTHER**
3. Range/Site Point of Contact:
   a. Name: **Elaine Magdinec**
   b. Organization: **Environmental Office Code 044EM IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MagdinecEA@ih.navy.mil**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   ○ Yes
   ◉ No
   a. NORM Site Number:
   b. NORM Site Name:
5. Range/Site Classification (check all that apply):
   ☐ Disposal

- ☐ Emergency Destruction
- ☐ Open Burn/Open Detonation (OB/OD)
- ☐ Other:

6. Range/Site Type (check all that apply):
   - ☑ Land
   - ☐ Water
7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☐ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **1.0**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **1.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?
   - ◉ Yes
   - ○ No

   a. If yes, is the map available in electronic format?
      - ◉ Yes - what format?
        - ☑ .pdf ☐ .shp
        - ☐ .bmp ☐ .dwg
        - ☐ .tif ☐ .dgn
        - ☐ .gif ☐ .dxf
        - ☐ .jpg
      - ○ No

   b. What information does the map (or maps) depict? (select all that apply)
      - ☑ Range location
      - ☑ Range boundaries
      - ☐ Target locations
      - ☑ Natural/cultural resources
      - ☑ Other: **Many other GIS layers**
10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10,

M=10-50, H=>50, U=Unknown)

	L	M	H	U
☐ Small Arms (.50 cal and under)	○	○	○	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☑ Torpedoes	○	○	○	◉
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☐ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○

☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Barren or low grass
    - ○ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ○ Heavily Wooded
    - ○ Water Range
15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown

- ○ Not Applicable (water range/site)

a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?

- ◉ Yes
- ○ No
- ○ Unknown

b. What is the range's or site's potential for contamination to drinking water?

- ○ Actual (known)
- ○ Potential
- ○ No Potential
- ◉ Unknown

16. Are there any wetland areas associated with this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, what is the estimated acreage? **0.0**
17. Are threatened or endangered species present on this range/site?
    - ◉ Yes, please list: **site is within a wildlife protection area**
    - ○ No
    - ○ Unknown
18. Does the range/site contain archeological or cultural sites?
    - ○ Yes
    - ◉ No
    - ○ Unknown
19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ○ Yes
    - ○ No
20. Have munitions response activities been initiated/conducted on the range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
    - ☐ Munitions and Explosives of Concern (includes UXO)
    - ☐ Munitions Constituents
    - ☐ Other chemical contamination
    - ☐ Unknown

    b. What is the status of the munitions response activities? (select all that apply)
    - ☐ Data collection
    - ☐ Investigation
    - ☐ Response/remedial action

- ☐ Operation and maintenance
- ☐ Monitoring
- ☐ Close out

c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?

- ○ Yes
- ○ No
- ○ Unknown

d. Under what authority were/are response actions conducted?

- ○ CERCLA
- ○ RCRA
- ○ Both CERCLA and RCRA
- ○ Unknown
- ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - ☐ Emergency response actions
    - ☐ Time-critical removal actions
    - ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - ☐ Non-munitions response actions

      Explain:
    - ☑ None
    - ☐ Unknown
    - ☐ Other:
22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)
23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
    Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

    What is the RAC Hazard Severity? ○ I ◉ II ○ III ○ IV ○ V

    What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

    What is the RAC? ○ I ◉ II ○ III ○ IV ○ V
24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
		Unrestricted (commercial, residential, utility, subsurface recreational, and

☐ ☐ construction)

☐ ☐ Other:

25. How is access currently controlled? (select all that apply)
- ☐ No controls
- ☐ Not controlled, used for another purpose
- ☑ Signs
- ☐ Fencing around entire range/site
- ☑ Partial fencing
- ☑ Locked/secured gates
- ☑ Log-in book/Office check-in
- ☑ Security patrol
  - ☐ Vessel ☐ Aircraft ☑ Other **vehicle**
- ☑ Other: **controls are for the entire facility at Stump Neck**

26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

Lease to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Ownership transfer to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Reason for transfer:
- ☐ Termination of lease
- ☐ Revocation of withdrawn land
- ☐ Base Realignment and Closure action
- ☐ Other:

a. List the entity(ies) receiving the property:

- ☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)
- ☐ Unknown

27.

Known Land Interest

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- ☑ Federal Agency
- ☐ State Government
- ☐ Local Government
- ☐ Private Sector
- ☐ Tribal Government
- ☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the property of IHDIVNAVSURFWARCEN.

Comments for Torpedo Casing Disposal Area

Part II_C Question 15. The average depth to the Patapsco Aquifer (our drinking water source) is 300 feet. The average depth to shallow groundwater is 15 feet. The shallow groundwater is not used as a drinking water source.

Part II-C Question 3: The Torpedo Casing Disposal Area is an alleged area where inert torpedo casings were buried. There is very little information on this site. It is unknown if any energetics or residues were buried.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Torpedo Casing Disposal Area
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name Elaine Magdinec
Phone Number (301) 744-2264
Organization Environmental Office Code 044EM IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	**10**
Detonators, blasting caps, fuzes, boosters, bursters	6
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	1
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**10**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**0**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **10**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	**II**	**10 to 20**
MARGINAL	III	5 to 9
NEGLIGIBLE	IV	1 to 4
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	5
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	**2**

Location (largest single value)	**2**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	**4**
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:
residential, industrial

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3

Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	**0**
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**
Site Dynamics (largest single value)	**0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **21**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E

SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	**2**	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	**Serious Risk - Priority for further action.**
RAC 3	Moderate Risk - Recommend further action.
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Old Skeet and Trap Range**
   Range/Site FFID Number: _____(if different from installation)
   Range/Site City(ies): _____(if different from installation)
   Range/Site County(ies): _____(if different from installation)
   Range/Site State(s): _____(if different from installation)
   Latitude:
   Longitude:
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **CLOSED**
3. Range/Site Point of Contact:
   a. Name: **ELAINE MAGDINEC**
   b. Organization: **IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MAGDINECEA@IH.NAVY.MIL**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   ○ Yes
   ◉ No
   a. NORM Site Number:
   b. NORM Site Name:
5. Range/Site Classification (check all that apply):
   ☐ Testing
   ☐ Training

- [x] Small Arms Only (.50 cal and under)
- [ ] Emergency Destruction
- [ ] Open Burn/Open Detonation (OB/OD)
- [ ] Other:

6. Range/Site Type (check all that apply):
   - [ ] Air-to-Air
   - [ ] Air-to-Water
   - [ ] Air-to-Land
   - [x] Land-to-Air
   - [ ] Land-to-Land
   - [ ] Land-to-Water
   - [ ] Water-to-Air
   - [ ] Water-to-Land
   - [ ] Water-to-Water
   - [ ] Unknown
7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - [x] Less than 3
   - [ ] Between 3 and 12
   - [ ] Between 12 and 200
   - [ ] Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **1.0**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ○ Estimated ◉ Unknown
   c. Acreage suspected or potentially containing UXO: **0.0**
      ○ Known ○ Estimated ◉ Unknown
   d. Acreage confirmed with no UXO: **1.0**
      ○ Known ○ Estimated ◉ Unknown
9. Is a range/site map available?
   ◉ Yes
   ○ No
   a. If yes, is the map available in electronic format?
      ◉ Yes - what format?
      - [x] .pdf
      - [ ] .shp
      - [ ] .bmp
      - [ ] .dwg
      - [ ] .tif
      - [ ] .dgn
      - [ ] .gif
      - [ ] .dxf
      - [ ] .jpg

      ○ No
   b. What information does the map (or maps) depict? (select all that apply)
      - [x] Range location

- ☐ Range boundaries
- ☐ Target locations
- ☐ Natural/cultural resources
- ☐ Other:

10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☑ Small Arms (.50 cal and under)	○	○	◉	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○

☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☐ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☑ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is

known or suspected to be contaminated (check one):

- (•) Barren or low grass
- ( ) Heavy grass and many shrubs
- ( ) Heavy shrubs and trees
- ( ) Low grass and few shrubs
- ( ) Shrubs and some trees
- ( ) Heavily Wooded
- ( ) Water Range

15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ( ) Unknown
    - ( ) Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - (•) Yes
    - ( ) No
    - ( ) Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ( ) Actual (known)
    - ( ) Potential
    - ( ) No Potential
    - (•) Unknown

16. Are there any wetland areas associated with this range/site?
    - ( ) Yes
    - (•) No
    - ( ) Unknown

    If yes, what is the estimated acreage? **0.0**

17. Are threatened or endangered species present on this range/site?
    - ( ) Yes, please list:
    - (•) No
    - ( ) Unknown

18. Does the range/site contain archeological or cultural sites?
    - (•) Yes
    - ( ) No
    - ( ) Unknown

19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ( ) Yes
    - (•) No
    - ( ) Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
    - ( ) Yes
    - ( ) No

20. Have munitions response activities been initiated/conducted on the range/site?
    - (•) Yes
    - ( ) No

○ Unknown

If yes, answer a, b, c, and d below.

a. What is the scope of the response activities? (select all that apply)

- ☐ Munitions and Explosives of Concern (includes UXO)
- ☑ Munitions Constituents
- ☐ Other chemical contamination
- ☐ Unknown

b. What is the status of the munitions response activities? (select all that apply)

- ☑ Data collection
- ☑ Investigation
- ☐ Response/remedial action
- ☐ Operation and maintenance
- ☐ Monitoring
- ☐ Close out

c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?

- ○ Yes
- ○ No
- ◉ Unknown

d. Under what authority were/are response actions conducted?

- ◉ CERCLA
- ○ RCRA
- ○ Both CERCLA and RCRA
- ○ Unknown
- ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)

- ☐ Emergency response actions
- ☐ Time-critical removal actions
- ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
- ☐ Non-munitions response actions

Explain:

- ☑ None
- ☐ Unknown
- ☐ Other:

22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)

23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

What is the RAC Hazard Severity? ○ I ○ II ○ III ◉ IV ○ V

What is the RAC Hazard Probability? ◉ A ○ B ○ C ○ D ○ E

What is the RAC? ○ I ○ II ◉ III ○ IV ○ V

24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
☐	☐	Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
☐	☐	Other:

25. How is access currently controlled? (select all that apply)
- ☐ No controls
- ☐ Not controlled, used for another purpose
- ☑ Signs
- ☐ Fencing around entire range/site
- ☑ Partial fencing
- ☑ Locked/secured gates
- ☑ Log-in book/Office check-in
- ☑ Security patrol
  - ☐ Vessel ☐ Aircraft ☑ Other **vehicle**
- ☐ Other:

26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

Lease to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Ownership transfer to:
- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Reason for transfer:
- ☐ Termination of lease
- ☐ Revocation of withdrawn land

☐ Base Realignment and Closure action
☐ Other:

a. List the entity(ies) receiving the property:

☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)

☐ Unknown

27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

☑ Federal Agency
☐ State Government
☐ Local Government
☐ Private Sector
☐ Tribal Government
☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns land

Comments for Old Skeet and Trap Range

Part II-C Question 4: The range is currently not in NORM but it is addressed in the Federal Facilities Agreement with EPA as Stump Neck SWMU#28. It is currently a site screening area.

Part II-C Question 5: This skeet range was used for recreational purposes only. Military munitions were never used on this range. The range was added to the Navy Range Inventory at the request of NAVSEA because the range is closed.

Part II-C Question 6: The range was partially on land, partially over water.

Part II-C Question 13: The range extends into the water also.

Part II-C Question 14: The range extends into the water also.

Part II-C Question 15: The depth to groundwater is for drinking water. Depth to shallow groundwater is about 15 feet.

Part II-C Question 17: There are no threatened or endangered species present on the range but there are threatened or endangered species on the facility.

Part II-C Question 20: The constituent of concern is lead. The range is currently a site screening area and addressed in the Federal Facilities Agreement. We anticipate sampling the area for contamination.

Part II-C Question 24:

Part II-C Question 25:

Part II-C Question 4:

Part II-C Question 4:

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Old Skeet and Trap Range
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name ELAINE MAGDINEC
Phone Number (301) 744-2264
Organization IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	6
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	**1**
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**1**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**0**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **1**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1

HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	II	10 to 20
MARGINAL	III	5 to 9
NEGLIGIBLE	**IV**	**1 to 4**
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	2
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1

0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	4
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	0
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	**5**
None anticipated	0
Site Dynamics (largest single value)	**5**

Describe the site dynamics:

Severe erosion on the shoreline

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30)	**29**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	**A**	**27 or greater**
PROBABLE	B	21 to 26
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	2	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	**3**	4	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	Serious Risk - Priority for further action.
RAC 3	**Moderate Risk - Recommend further action.**
RAC 4	Low Risk - Recommend further action.
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **Rum Point Skeet Range**
   Range/Site FFID Number: _____(if different from installation)
   Range/Site City(ies): _____(if different from installation)
   Range/Site County(ies): _____(if different from installation)
   Range/Site State(s): _____(if different from installation)
   Latitude:
   Longitude:
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **CLOSED**
3. Range/Site Point of Contact:
   a. Name: **ELAINE MAGDINEC**
   b. Organization: **IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MAGDINECEA@IH.NAVY.MIL**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   - ○ Yes
   - ◉ No

   a. NORM Site Number:
   b. NORM Site Name:
5. Range/Site Classification (check all that apply):
   - ☐ Testing
   - ☐ Training
   - ☑ Small Arms Only (.50 cal and under)
   - ☐ Emergency Destruction
   - ☐ Open Burn/Open Detonation (OB/OD)
   - ☐ Other:
6. Range/Site Type (check all that apply):
   - ☐ Air-to-Air
   - ☐ Air-to-Water
   - ☐ Air-to-Land
   - ☑ Land-to-Air
   - ☐ Land-to-Land
   - ☐ Land-to-Water
   - ☐ Water-to-Air
   - ☐ Water-to-Land
   - ☐ Water-to-Water
   - ☐ Unknown
7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☐ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200

☐ Greater than 200

8. Please indicate the:
   a. Total range/site acreage: **30.0**
      ◉ Known ○ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   c. Acreage suspected or potentially containing UXO: **0.0**
      ○ Known ◉ Estimated ○ Unknown
   d. Acreage confirmed with no UXO: **30.0**
      ○ Known ◉ Estimated ○ Unknown
9. Is a range/site map available?
   ◉ Yes
   ○ No
   a. If yes, is the map available in electronic format?
      ◉ Yes - what format?
      ☑ .pdf ☐ .shp
      ☐ .bmp ☐ .dwg
      ☐ .tif ☐ .dgn
      ☐ .gif ☐ .dxf
      ☐ .jpg
      ○ No
   b. What information does the map (or maps) depict? (select all that apply)
      ☑ Range location
      ☑ Range boundaries
      ☐ Target locations
      ☐ Natural/cultural resources
      ☑ Other: **Many other layers**
10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☑ Small Arms (.50 cal and under)	○	○	◉	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting charges)	○	○	○	○
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○

☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☐ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○
☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):

○ Sand/Gravel-Sand

- ○ Sand-Silt/Sand-Clay
- ◉ Silt/Silty-Clay
- ○ Clay-Sand/Clay-Silt
- ○ Gravel/Gravel-Sand
- ○ Clay/Sand with Stone
- ○ Rock
- ○ Water Range

12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ◉ Flat
    - ○ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Barren or low grass
    - ◉ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ○ Heavily Wooded
    - ○ Water Range
15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No
    - ○ Unknown

    b. What is the range's or site's potential for contamination to drinking water?
    - ○ Actual (known)
    - ○ Potential
    - ○ No Potential
    - ◉ Unknown
16. Are there any wetland areas associated with this range/site?

- (●) Yes
- ( ) No
- ( ) Unknown

If yes, what is the estimated acreage? **10.0**

17. Are threatened or endangered species present on this range/site?
    - (●) Yes, please list: **Range is within the Eagle Protection Area**
    - ( ) No
    - ( ) Unknown
18. Does the range/site contain archeological or cultural sites?
    - (●) Yes
    - ( ) No
    - ( ) Unknown
19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ( ) Yes
    - (●) No
    - ( ) Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
        - ( ) Yes
        - ( ) No
20. Have munitions response activities been initiated/conducted on the range/site?
    - ( ) Yes
    - (●) No
    - ( ) Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
        - [ ] Munitions and Explosives of Concern (includes UXO)
        - [ ] Munitions Constituents
        - [ ] Other chemical contamination
        - [ ] Unknown

    b. What is the status of the munitions response activities? (select all that apply)
        - [ ] Data collection
        - [ ] Investigation
        - [ ] Response/remedial action
        - [ ] Operation and maintenance
        - [ ] Monitoring
        - [ ] Close out

    c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?
        - ( ) Yes
        - ( ) No
        - ( ) Unknown

    d. Under what authority were/are response actions conducted?
        - ( ) CERCLA
        - ( ) RCRA
        - ( ) Both CERCLA and RCRA
        - ( ) Unknown

○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - ☐ Emergency response actions
    - ☐ Time-critical removal actions
    - ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - ☐ Non-munitions response actions

      Explain:
    - ☑ None
    - ☐ Unknown
    - ☐ Other:

22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)

23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
    Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

    What is the RAC Hazard Severity? ○ I ○ II ○ III ◉ IV ○ V

    What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

    What is the RAC? ○ I ○ II ○ III ◉ IV ○ V

24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
☐	☐	Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
☐	☐	Other:

25. How is access currently controlled? (select all that apply)
    - ☐ No controls
    - ☐ Not controlled, used for another purpose
    - ☑ Signs
    - ☐ Fencing around entire range/site
    - ☑ Partial fencing
    - ☑ Locked/secured gates
    - ☐ Log-in book/Office check-in
    - ☑ Security patrol

☐ Vessel ☐ Aircraft ☑ Other **Vehicle Patrols**

☐ Other:

26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

Lease to:

☐ Other DoD Component
☐ Federal agency
☐ Tribal government
☐ State agency
☐ Local agency
☐ Private entity
☐ Unknown

Ownership transfer to:

☐ Other DoD Component
☐ Federal agency
☐ Tribal government
☐ State agency
☐ Local agency
☐ Private entity
☐ Unknown

Reason for transfer:

☐ Termination of lease
☐ Revocation of withdrawn land
☐ Base Realignment and Closure action
☐ Other:

a. List the entity(ies) receiving the property:

☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)

☐ Unknown

27. **Known Land Interest**

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

☑ Federal Agency
☐ State Government
☐ Local Government
☐ Private Sector
☐ Tribal Government
☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the land.

Comments for Rum Point Skeet Range

Part II-C Question 5: This skeet range was used for recreational purposes only. Military munitions were never fired on the range. This range was added to the Navy Range Inventory as advised from NAVSEA because the range is closed.

Part II-C Question 15: Depth to shallow groundwater is approximately 15 feet.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name Rum Point Skeet Range
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name ELAINE MAGDINEC
Phone Number (301) 744-2264
Organization IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	6
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4

Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	**1**
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**1**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**0**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6
Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **1**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	CATEGORY	HAZARD SEVERITY VALUE
CATASTROPHIC	I	21 and/or greater
CRITICAL	II	10 to 20
MARGINAL	III	5 to 9
NEGLIGIBLE	**IV**	**1 to 4**
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	2
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard (road, park, playground, building, etc.):	**VALUE**
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area,

not the installation boundary:	**VALUE**
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	**VALUE**
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	4
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:
Smallwood State Park is nearby as well as residential homes.

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	**VALUE**
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television monitors, locked entrances, or controlled roadway access to the area).	0
Accessibility (largest single value)	**4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility:	**VALUE**
Expected	5
None anticipated	**0**

Site Dynamics (largest single value) **0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **24**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	2	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	**4**	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	Serious Risk - Priority for further action.
RAC 3	Moderate Risk - Recommend further action.
RAC 4	**Low Risk - Recommend further action.**
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no

documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

C. Detailed Range/Site Information

1. Range/Site Name: **FDR Skeet Range**
   Range/Site FFID Number: _____(if different from installation)
   Range/Site City(ies): _____(if different from installation)
   Range/Site County(ies): _____(if different from installation)
   Range/Site State(s): _____(if different from installation)
   Latitude:
   Longitude:
   (provide southernmost and westernmost coordinates)
2. Range/Site Status: **CLOSED**
3. Range/Site Point of Contact:
   a. Name: **ELAINE MAGDINEC**
   b. Organization: **IHDIVNAVSURFWARCEN**
   c. Phone: **(301) 744-2264**
   d. E-mail: **MAGDINECEA@IH.NAVY.MIL**
4. Is this range/site currently being tracked in the Navy's NORM database (Navy Installation Restoration Program database)?
   - ○ Yes
   - ◉ No

   a. NORM Site Number:
   b. NORM Site Name:
5. Range/Site Classification (check all that apply):
   - ☐ Testing
   - ☐ Training
   - ☑ Small Arms Only (.50 cal and under)
   - ☐ Emergency Destruction
   - ☐ Open Burn/Open Detonation (OB/OD)
   - ☐ Other:
6. Range/Site Type (check all that apply):
   - ☐ Air-to-Air
   - ☐ Air-to-Water
   - ☐ Air-to-Land
   - ☑ Land-to-Air
   - ☐ Land-to-Land
   - ☐ Land-to-Water
   - ☐ Water-to-Air
   - ☐ Water-to-Land
   - ☐ Water-to-Water

☐ Unknown

7. If the range is a water range, how many miles from shore is it located? (If the range extends through more than one selection, please check all that apply.):
   - ☐ Less than 3
   - ☐ Between 3 and 12
   - ☐ Between 12 and 200
   - ☐ Greater than 200
8. Please indicate the:
   a. Total range/site acreage: **5.0**
      ○ Known ◉ Estimated
   b. Acreage confirmed as having UXO: **0.0**
      ○ Known ○ Estimated ◉ Unknown
   c. Acreage suspected or potentially containing UXO: **0.0**
      ○ Known ○ Estimated ◉ Unknown
   d. Acreage confirmed with no UXO: **5.0**
      ○ Known ○ Estimated ◉ Unknown
9. Is a range/site map available?
   ○ Yes
   ◉ No
   a. If yes, is the map available in electronic format?
      ○ Yes - what format?
      ☐ .pdf ☐ .shp
      ☐ .bmp ☐ .dwg
      ☐ .tif ☐ .dgn
      ☐ .gif ☐ .dxf
      ☐ .jpg
      ○ No
   b. What information does the map (or maps) depict? (select all that apply)
      - ☐ Range location
      - ☐ Range boundaries
      - ☐ Target locations
      - ☐ Natural/cultural resources
      - ☐ Other:
10. Based on the best information available (interviews, usage records, surveys, etc.), what types of ordnance and/or potential UXO exist or were used at the range or other site? (Please indicate the estimated residual density for each type of ordnance/UXO listed below.)

    Note: This information will be used to populate the first section of the interactive RAC Worksheet (Question #23) for non-water ranges.

	Estimated residual density of ordnance/UXO on affected range/site area (Items per acre) (L=<10, M=10-50, H=>50, U=Unknown)			
	L	**M**	**H**	**U**
☑ Small Arms (.50 cal and under)	○	○	◉	○
☐ Hand Grenades, explosive	○	○	○	○
☐ Hand Grenades, practice (w/spotting	○	○	○	○

charges)				
☐ Rifle Grenades, explosive	○	○	○	○
☐ Rifle Grenades, practice (w/spotting charges)	○	○	○	○
☐ Projected Grenades, explosive	○	○	○	○
☐ Projected Grenades, practice (w/spotting charges)	○	○	○	○
☐ Mortars, explosive	○	○	○	○
☐ Mortars, practice (w/spotting charges)	○	○	○	○
☐ Projectiles	○	○	○	○
☐ Bombs, Explosive	○	○	○	○
☐ Bombs, practice (w/spotting charges)	○	○	○	○
☐ Rockets, explosive	○	○	○	○
☐ Rockets, practice (w/spotting charges)	○	○	○	○
☐ Large Rocket Motors (>1,000 lbs)	○	○	○	○
☐ Warheads	○	○	○	○
☐ Guided Missiles, explosive	○	○	○	○
☐ Ballistic Missiles, explosive	○	○	○	○
☐ Missiles, practice (w/spotting charges)	○	○	○	○
☐ Submunitions	○	○	○	○
☐ Torpedoes	○	○	○	○
☐ Mines, Explosive	○	○	○	○
☐ Mines, practice (w/spotting charges)	○	○	○	○
☐ Depth Charges	○	○	○	○
☐ Bulk Propellant (solid or liquid)	○	○	○	○
☐ Bulk High Explosives, (Primary/Initiating) (e.g., lead styphnate, nitroglycerin)	○	○	○	○
☐ Bulk High Explosives, (Secondary) (e.g., PETN, Comp A/B/C, RDX, HMX)	○	○	○	○
☐ Demolition Charges	○	○	○	○
☐ CADs/PADs	○	○	○	○
☐ Primers, Detonators, Fuzes, Squibs	○	○	○	○
☐ Military Dynamite	○	○	○	○
☐ Less Sensitive Explosives (e.g., ammonium nitrate, explosive D)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., pyrophoric materials like white phosphorous)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., incendiary materials like napalm)	○	○	○	○
☐ Other Pyrotechnics (not counted above) (e.g., flares, signals, screening smokes)	○	○	○	○
☐ Riot Control Agents (Vomiting, Tear)	○	○	○	○

☐ War Gas Identification Sets (CAS)	○	○	○	○
☐ Radiological (DU)	○	○	○	○
☐ Other:	○	○	○	○

11. Please indicate the predominant soil type associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Sand/Gravel-Sand
    - ◉ Sand-Silt/Sand-Clay
    - ○ Silt/Silty-Clay
    - ○ Clay-Sand/Clay-Silt
    - ○ Gravel/Gravel-Sand
    - ○ Clay/Sand with Stone
    - ○ Rock
    - ○ Water Range
12. If the range or site is located in water, please check the appropriate depth (select all that apply):
    - ☐ 1-10 ft
    - ☐ 10-30 ft
    - ☐ 30-80 ft
    - ☐ Greater than 80 ft
    - ☐ Unknown
13. Please indicate the predominant topography associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Flat
    - ◉ Flat w/gorges or gullies
    - ○ Gently rolling
    - ○ Heavily rolling
    - ○ Mountainous
    - ○ Rolling w/gorges or gullies
    - ○ Water Range
14. Please indicate the predominant type of vegetation associated with the area of range/site that is known or suspected to be contaminated (check one):
    - ○ Barren or low grass
    - ○ Heavy grass and many shrubs
    - ○ Heavy shrubs and trees
    - ○ Low grass and few shrubs
    - ○ Shrubs and some trees
    - ◉ Heavily Wooded
    - ○ Water Range
15. Estimate the average depth (in feet) to groundwater for this range/site: **300.0** ft.
    - ○ Unknown
    - ○ Not Applicable (water range/site)

    a. Is this range/site located over or near (i.e., within 1 mile) an aquifer used as a drinking water source?
    - ◉ Yes
    - ○ No

- ○ Unknown

b. What is the range's or site's potential for contamination to drinking water?

- ○ Actual (known)
- ○ Potential
- ○ No Potential
- ◉ Unknown

16. Are there any wetland areas associated with this range/site?
    - ○ Yes
    - ○ No
    - ◉ Unknown

    If yes, what is the estimated acreage? **0.0**
17. Are threatened or endangered species present on this range/site?
    - ○ Yes, please list:
    - ○ No
    - ◉ Unknown
18. Does the range/site contain archeological or cultural sites?
    - ○ Yes
    - ○ No
    - ◉ Unknown
19. Has a RCRA Subpart X permit for OB/OD operations been pursued at this range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    a. If yes, does the permit or permit application have RCRA corrective action requirements that apply at this range/site?
        - ○ Yes
        - ○ No
20. Have munitions response activities been initiated/conducted on the range/site?
    - ○ Yes
    - ◉ No
    - ○ Unknown

    If yes, answer a, b, c, and d below.

    a. What is the scope of the response activities? (select all that apply)
        - ☐ Munitions and Explosives of Concern (includes UXO)
        - ☐ Munitions Constituents
        - ☐ Other chemical contamination
        - ☐ Unknown

    b. What is the status of the munitions response activities? (select all that apply)
        - ☐ Data collection
        - ☐ Investigation
        - ☐ Response/remedial action
        - ☐ Operation and maintenance
        - ☐ Monitoring
        - ☐ Close out

    c. Is contamination monitoring (i.e., groundwater, sampling and analysis) needed?

- ○ Yes
- ○ No
- ○ Unknown

d. Under what authority were/are response actions conducted?

- ○ CERCLA
- ○ RCRA
- ○ Both CERCLA and RCRA
- ○ Unknown
- ○ Other, please specify:

21. What type(s) of munitions response actions have been initiated/conducted on the range/site? (check all that apply)
    - ☐ Emergency response actions
    - ☐ Time-critical removal actions
    - ☐ Non-time-critical removal actions with Engineering Assessment/Cost Analysis
    - ☐ Non-munitions response actions

      Explain:
    - ☑ None
    - ☐ Unknown
    - ☐ Other:
22. What is the estimated/budgeted funding requirement associated with the response actions at this range/site? (U=Unknown; N/A=Not applicable)
23. Using the U.S. Army Engineering and Support Center risk assessment procedure as specified in the DERP Management Guidance, determine the Risk Assessment Code (RAC) for this range/site through completion of the interactive worksheet.
    Note: the items in Hazard Severity are automatically populated from the items checked in Question 10 of this questionnaire.

    What is the RAC Hazard Severity? ○ I ○ II ○ III ◉ IV ○ V

    What is the RAC Hazard Probability? ○ A ◉ B ○ C ○ D ○ E

    What is the RAC? ○ I ○ II ○ III ◉ IV ○ V
24. What are the land use restrictions? (select all that apply)

Current	Future	
☑	☑	No public access authorized
☐	☐	Limited public access (wildlife refuge)
☐	☐	Limited public access (livestock grazing)
☐	☐	Public access (agriculture/forestry)
☐	☐	Public access (surface recreation)
☐	☐	Public access (vehicle parking)
☐	☐	Public access (surface supply storage)
☐	☐	Unrestricted (commercial, residential, utility, subsurface recreational, and construction)
☐	☐	Other:

25. How is access currently controlled? (select all that apply)

- ☐ No controls
- ☐ Not controlled, used for another purpose
- ☑ Signs
- ☐ Fencing around entire range/site
- ☑ Partial fencing
- ☑ Locked/secured gates
- ☑ Log-in book/Office check-in
- ☑ Security patrol
  - ☐ Vessel ☐ Aircraft ☑ Other **vehicle patrols**
- ☐ Other:

26. **For transferred and transferring ranges/sites only:** What was/is the nature of the proposed transfer? (select all that apply)

Lease to:

- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Ownership transfer to:

- ☐ Other DoD Component
- ☐ Federal agency
- ☐ Tribal government
- ☐ State agency
- ☐ Local agency
- ☐ Private entity
- ☐ Unknown

Reason for transfer:

- ☐ Termination of lease
- ☐ Revocation of withdrawn land
- ☐ Base Realignment and Closure action
- ☐ Other:

a. List the entity(ies) receiving the property:

- ☐ Unknown

b. What is/was the actual, planned, or mandated date for transfer of the range/site? (MM/DD/YYYY)

- ☐ Unknown

27.

Known Land Interest

a. Indicate the known entities, other than a DoD component, with current ownership or control of the land or its resources. (select all that apply)

- ☑ Federal Agency
- ☐ State Government
- ☐ Local Government
- ☐ Private Sector

☐ Tribal Government
☐ None

b. Provide a brief description of the organization with ownership/control interest:
GSA owns the land

Comments for FDR Skeet Range

Part II-C Question 5: There is not much information on the existence of this range. There are stories that this range was used for shooting skeet by President Roosevelt and there is physical evidence of a trap house and an ice house.

Part II-C Question 15: The depth to shallow groundwater is approximately 15 feet. Shallow groundwater is not used for drinking water.

Part II-C Question 25: Controls are for entire restricted area not just range.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

September 2001

RISK ASSESSMENT CODE
MANAGEMENT GUIDANCE FOR THE
DEFENSE ENVIRONMENTAL RESTORATION PROGRAM

Site Name FDR Skeet Range
Site Location IHDIVNAVSURFWARCEN
DERP Project #
Date Completed 09/22/2003

Rater's Name ELAINE MAGDINEC
Phone Number (301) 744-2264
Organization IHDIVNAVSURFWARCEN
Score See RAC Assesment Below

BACKGROUND:

These risk assessment procedures were developed by the U.S. Army Engineering and Support Center, Huntsville, Ordnance and Explosives Team to prioritize the response action(s) at formerly used defense sites. The procedures were developed in accordance with MIL-STD 882C and AR 385-10. The Department of Defense (DoD) is adopting the procedures, as an interim DoD-wide standard, to provide a set of uniform procedures for assessing explosives safety risks at Defense Environmental Restoration Program (DERP) sites.

Risk Assessment Code (RAC) scores developed using these procedures will be used by DoD for risk assessment at sites suspected to contain munitions and explosives of concern (MEC) or other explosive safety hazards. The risk assessment should be based on the best available information resulting from record searches, reports of Explosive Ordnance Disposal (EOD) Detachments actions, field observations, interviews, and measurements. This information is used to assess the risk involved based on the potential explosives safety hazards identified at the site. The risk assessment is composed of two factors, hazard severity and hazard probability.

PROCEDURE:

PART I. Hazard Severity. Hazard severity categories are defined to provide a qualitative measure of the worst credible event resulting from personnel exposure to various types and quantities of unexploded ordnance.

TYPE OF ORDNANCE: (Select all that apply)

A. Conventional ordnance and ammunition:	**VALUE**
Medium/large caliber (20mm and larger)	10
Bombs, explosive	10
Grenades, hand or rifle, explosive	10
Landmine, explosive	10
Rockets, guided missile, explosive	10
Detonators, blasting caps, fuzes, boosters, bursters	6
Bombs, practice (w/spotting charges)	6
Grenades, practice (w/spotting charges)	4
Landmine, practice (w/spotting charges)	4
Small arms, complete round (.22 cal -.50 cal)	**1**
Small arms, expended	0
Practice ordnance (w/o spotting charges)	0
Conventional ordnance and ammunition (largest single value)	**1**

What evidence do you have regarding conventional unexploded ordnance?

B. Pyrotechnics (for munitions not described above):	**VALUE**
Munition (containers) containing White Phosphorus (WP) or other pyrophoric material (i.e., spontaneously flammable)	10
Munition containing a flame or incendiary material (i.e., Napalm, Triethylaluminum metal incendiaries)	6
Flares, signals, simulators, screening smokes (other than WP)	4
Pyrotechnics (largest single value)	**0**

What evidence do you have regarding pyrotechnics?

C. Bulk High Explosives (HE) (not an integral part of conventional ordnance; uncontainerized):	**VALUE**
Primary or initiating explosives (Lead Styphnate, Lead Azide, Nitroglycerin, Mercury Azide, Mercury Fulminate, Tetracene, etc.)	10
Demolition charges	10
Secondary explosives (PETN, Compositions A, B, C, Tetryl, TNT, RDX, HMX, HBX, Black Powder, etc.)	8
Military dynamite	6
Less sensitive explosives (Ammonium Nitrate, Explosive D, etc.)	3
High explosives (largest single value)	**0**

What evidence do you have regarding bulk explosives?

D. Bulk propellants (not an integral part of rockets, guided missiles, or other conventional ordnance; uncontainerized):	**VALUE**
Solid or liquid propellants	6

Propellants	**0**

What evidence do you have regarding bulk propellants?

E. Chemical Warfare Materiel and Radiological Weapons:	**VALUE**
Toxic chemical agents (choking, nerve, blood, blister)	25
War Gas Identification Sets (CAS)	20
Radiological	15
Riot Control Agents (vomiting, tear)	5
Chemical and Radiological (largest single value)	**0**

What evidence do you have regarding chemical or radiological?

TOTAL HAZARD SEVERITY VALUE (Sum of values A through E (maximum of 61)) **1**

Apply this value to Table 1 to determine Hazard Severity Category

TABLE 1
HAZARD SEVERITY*

DESCRIPTION	**CATEGORY**	**HAZARD SEVERITY VALUE**
CATASTROPHIC	I	21 and/or greater
CRITICAL	II	10 to 20
MARGINAL	III	5 to 9
NEGLIGIBLE	**IV**	**1 to 4**
**NONE	V	0

*Apply Hazard Severity Category to Table 3

**If hazard severity value is 0, you do not need to complete Part II of this form. Proceed to Part III and use a RAC score of 5 to determine your appropriate action.

PART II. Hazard Probability. The probability that a hazard has been, or will be, created due to the presence and other rated factors of unexploded ordnance or explosive materials on a formerly used Department of Defense (DOD) site.

AREA, EXTENT, ACCESSIBILITY OF MEC HAZARD (Select all that apply)

A. Location of MEC Hazards:	**VALUE**
On the surface	**5**
Within tanks, pipes, vessels, or other confined areas	4
Inside walls, ceilings, or other building/structure	3
Subsurface	2
Location (largest single value)	**5**

What evidence do you have regarding the location of MEC?

B. Distance to nearest inhabited location/structure likely to be at risk from MEC hazard

(road, park, playground, building, etc.):	VALUE
Less than 1,250 feet	**5**
1,250 feet to 0.5 mile	4
0.5 mile to 1.0 mile	3
1.0 mile to 2.0 Miles	2
Over 2 Miles	1
Distance (largest single value)	**5**

What are the nearest inhabited structues/buildings?

C. Number(s) of building(s) within a 2-mile radius measured from the MEC hazard area, not the installation boundary:	VALUE
26 and over	**5**
16 to 25	4
11 to 15	3
6 to 10	2
1 to 5	1
0	0
Number of buildings (largest single value)	**5**

Narrative:

D. Types of Buildings (within a 2 mile radius):	VALUE
Educational, child care, residential, hospitals, hotels, commercial, shopping centers	**5**
Industrial, warehouse, etc.	4
Agricultural, forestry, etc.	3
Detention, correctional	2
No buildings	0
Types of buildings (largest single value)	**5**

Describe the types of buildings:

E. Accessibility to site refers to access by humans to MEC. Use the following guidance:	VALUE
No barrier nor security system	5
Barrier is incomplete (e.g., in disrepair or does not completely surround the site). Barrier is intended to deny egress from the site, as for a barbed wire fence for grazing.	**4**
A barrier (any kind of fence in good repair) but no separate means to control entry. Barrier is intended to deny access to the site.	3
Security Guard, but no barrier	2
Isolated site	1
	0
A 24-hour surveillance system (e.g., television monitoring or surveillance by guards or facility personnel continuously monitors and controls entry; or, an artificial or natural barrier (e.g., fence combined with a cliff) which completely surrounds the area; and, a means to control entry at all times through the gates or other entrances (e.g., an attendant, television	

monitors, locked entrances, or controlled roadway access to the area).

Accessibility (largest single value) **4**

Describe the site accessibility:

F. Site Dynamics. This deals with site conditions are subject to change in the future, but may be stable at the present. Examples would be excessive soil erosion on beaches or streams, increasing land development that could reduce distances from the site to inhabited areas or otherwise increase accessibility: **VALUE**

Expected 5

None anticipated **0**

Site Dynamics (largest single value) **0**

Describe the site dynamics:

TOTAL HAZARD PROBABILITY VALUE (sum of largest values for A through F (maximum of 30) **24**

Apply this value to Hazard Probability Table 2 to determine the Hazard Probability Level.

TABLE 2
HAZARD PROBABILITY

DESCRIPTION VALUE	LEVEL	HAZARD PROBABILITY
FREQUENT	A	27 or greater
PROBABLE	**B**	**21 to 26**
OCCASIONAL	C	15 to 20
REMOTE	D	8 to 14
IMPROBABLE	E	less than 8

*Apply Hazard Probability Level to Table 3

PART III. Risk Assessment. The risk assessment value for this site is determined using the following table. Enter the results of the Hazard Probability and Hazard Severity values.

TABLE 3
RISK ASSESSMENT

PROBABILITY LEVEL	FREQUENT A	PROBABLE B	OCCASIONAL C	REMOTE D	IMPROBABLE E
SEVERITY CATEGORY					
CATASTROPHIC I	1	1	2	3	4
CRITICAL II	1	2	3	4	5
MARGINAL III	2	3	4	4	5
NEGLIGIBLE IV	3	**4**	4	5	5

RISK ASSESSMENT CODE
RAC

RAC 1	High Risk - Highest priority for further action.
RAC 2	Serious Risk - Priority for further action.
RAC 3	Moderate Risk - Recommend further action.
RAC 4	**Low Risk - Recommend further action.**
RAC 5	Negligible Risk - Indicates that no DoD action is necessary.

PART IV. Narrative. Summarize the documented evidence that supports this risk assessment. If no documented evidence was available, explain all the assumptions that were made.

*Note: The questionnaire for **IHDIVNAVSURFWARCEN** has been certified. It is no longer subject to be edited/updated.*

horizons is 0-10 cmbs dark grayish brown (2.5Y 4/2) silt loam; 10-19 cmbs light yellowish brown (2.5Y 6/4) slightly clayey silt loam; and 19-35 cmbs yellowish brown (10YR 5/6) clay silt loam. This profile corresponds to the Keyport silt loam soils mapped for Area D (USDA 1985).

Significant disturbance was documented within Area D. A large portion of the area currently is used as a wooded buffer zone around the explosives testing station. The southeast corner of Area D was disturbed completely by the buildings and equipment associated with the explosives testing. Directly across Archer Avenue from this area is a fenced compound containing subterranean munitions bunkers. Another bunker complex is located in the northwest corner of Area D, near Porter Road. One other small building stands along Archer Avenue, just north of the explosives area. Soil profiles of shovel tests placed in a grassy field around Building 2107 at the end of Porter Road exhibited deep disturbance. Grading and pushpiles were common inside the treeline on either side of Archer Avenue. A particularly large earthen berm was located on the slopes facing Chicamuxen Creek at approximately N640/E1100. A small area of fill was identified at the western end of Porter Road. Erosion was present along the small drainages on the Potomac side of the peninsula and the slopes down the terraces on the east.

The datum for Area D was placed at the southeast corner of the intersection of Archer Avenue and Porter Road. The baseline followed the east side of Archer Avenue at a bearing of 224°, south to the boundary with Area A. Thirty-one transects were placed both east and west off of the baseline on bearings of 134/314°. Most shovel tests on the baseline were not excavated because of the disturbance from the construction of Archer Avenue. Only the area west of Archer Road was tested in the western portion of Area D. Extensive disturbance was present east of Archer Road between Transects N560 and N400; this included grading and excavation associated with the Explosives Testing Area. A total of 267 shovel tests were excavated in Area D; 88 additional planned tests were not dug as a result of surface disturbances.

Phase I shovel testing identified one small prehistoric site of an unknown age, and portions of Site 18CH624 from Area A, and Site 18CH632 from Area E-1. Nineteen isolated artifacts were also recovered from 13 shovel tests. Two of these isolated finds were discarded after analysis as

fragments of modern bottle glass. The 11 historic isolated finds included 5 fragments of lamp glass, 1 fragment of window glass, 1 dark green non machine made bottle fragment, 1 late white industrial stoneware sherd, an iron strap, and 1 large lead shot. The remaining eight prehistoric artifacts included 1 very thick quartz biface with a fracture plane break, 1 possible rhyolite Poplar Island point/knife (Figure 42; FS #655) with impact fracture at the tip; 1 quartzite point/knife tip of a long narrow blade with alternate bevelling, 3 secondary flakes, 1 block/shatter, and 1 non-cortical flake.

Portions of Sites 18CH624 and 18CH632 were located within Area D. Approximately 20 m (65.6 ft) of Site 18CH624 extended into the southern portion of Area D from Area A. The two positive shovel tests associated with the site contained only three prehistoric artifacts. The artifacts were 2 unmodified non-cortical quartz flakes and 1 utilized secondary flake. The site is discussed above in the section on Area A.

Three positive shovel tests in the northeastern portion of Area D extended the boundaries of Site 18CH632 approximately 70 m (229.7 ft) to the south. The site may have been partially destroyed or at least disturbed by the construction of the northern bunker complex. The three artifacts from the shovel tests in Area D included 1 primary quartz flake, 1 quartzite fire-cracked rock fragment, and 1 possible Late Archaic Macpherson side-notched rhyolite point/knife. Site 18CH632 is discussed fully in the section on Area E-1.

Site 18CH645. Site 18CH645 is small prehistoric lithic scatter identified on the basis of five positive shovel tests and one surface find. The site measures 40 x 80 m (131.2 x 262.5 ft) and is located on the high ground along the center of the ridge beside Archer Avenue, immediately north of the southern bunker compound. The site may have been disturbed by the construction of the bunkers and by the construction of Archer Avenue, since the site was present on both sides of the road. No diagnostic artifacts were recovered during the survey. The assemblage from the site contains seven prehistoric artifacts, including 5 pieces of debitage, 1 quartz biface base fragment with cobble cortex at the base, and 1 quartzite core. The debitage was probably the result of a brief primary or secondary reduction episode; the debitage included two primary quartz flakes, two secondary quartz flakes, and one non-cortical quartz flake. Three of the artifacts were recovered

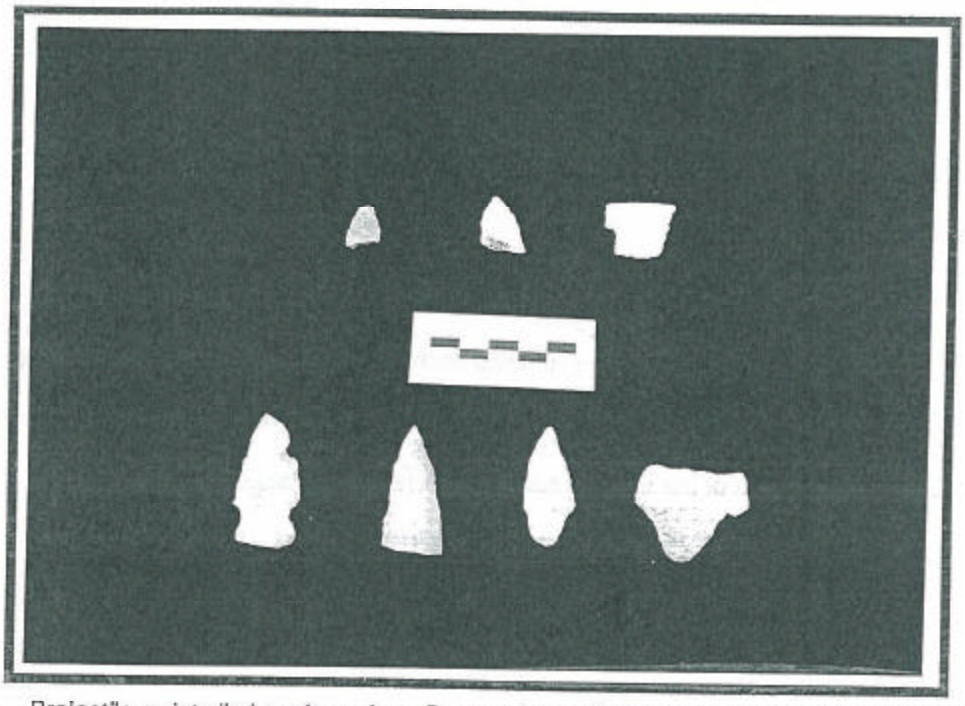

Figure 42. Projectile points/knives from Area D non-site, and Area E-2 non-site, and Sites 18CH632, 18CH631, and 18CH634. (Clock-wise from upper left) [a] FS# 241; [b] FS# 227; [c] FS# 303; [d] FS# 251; [e] FS# 655; [f] FS# 658; [g] FS# 661

from the A horizon and one was a surface find. The remaining three artifacts were recovered from the B horizon to a maximum depth of 45 cmbs. A majority of the site was disturbed by grading associated with construction of the road and bunker. Many soil profiles within the area were truncated. The extensive disturbance and shallow depths at which most of the artifacts were recovered suggest that the site does not retain a sufficient level integrity to warrant further investigation.

Area E

Area E was located on the central portion of the Stump Neck peninsula between Areas D and B. A ridge ran from the southwest to the northeast across the center of the area. The ridge forms a bluff, ranging from 5 to 20 m (16.4 x 65.6 ft) in height, above the Potomac River on the western margin of the area. A rocky beach lies at the base of the bluff. Several small drainages bisect the bluff and empty into the river to the northwest. The land to the south and east of the ridge forms a slight terrace before sloping gently down towards the large marsh at the edge of Chicamuxen Creek. The area was subdivided into two survey areas, E-1 and E-2, on the basis of topographic features and the presence of surface disturbances. These smaller areas provided additional horizontal control for the testing. Area E-1 was located between Porter Road on the southwest and Lewis Road on the northeast. Area E-2 stretched between Lewis Road and the boundary with Area B at Quarters A. Area E encompassed a total of 121.6 acres.

The soils in Area E belong to the Evesboro-Keyport-Elkton soil association. The surveyed areas mainly were mapped as Keyport silt loam with much smaller areas of Elkton silt loam and Bibb silt loam. The large area mapped as tidal marsh at the southern edge of the area was not tested and was not included in the overall acreage calculation.

The vegetation in Area E primarily was mature forest with minimal undergrowth except around the numerous military buildings scattered throughout the area; these buildings were surrounded by grassy cleared land. Tree species included white oak, red oak, pine, cherry, beech, sweet gum, yellow poplar, and holly. A dense greenbriar thicket was located on the southeast side

of Archer Avenue within Area E-1. The northeastern end of Area E-2 was forested with regrowth including small pines, briars and vines.

A large portion of Area E was highly disturbed by military activities that had included grading, filling, and disturbance from heavy machinery. Area E contained many buildings constructed on levelled land such as the commissary and surrounding buildings. An explosives testing corridor, comprised of an embankment surrounding a testing range, also was present. Isolated parcels of land also appeared to have been graded and filled, and evidence of recent logging was observed. Archer Avenue bisects the area. Natural disturbance was limited to erosion of the bluff edge into the Potomac River.

Phase I survey identified one small prehistoric site, two prehistoric sites with limited historic components, and one larger multi-component site. Three of the four sites identified within Area E were located on the Potomac side of the peninsula. The fourth site was located on high ground in Area E-2, near the channel of Chicamuxen Creek.

Area E-1

Area E-1 included a portion of a gently sloping, eroded terrace and the floodplain of Chicamuxen Creek (Figure 43). The northwestern boundary of the area was the Potomac River and the southeastern boundary was the tidal marsh at the edge of Chicamuxen Creek. Area E-1 was bounded on the southwest by Area D at Porter Road and on the northeast by Area E-2 at Lewis Road.

The vegetation in Area E-1 was characterized primarily by mature mixed hardwood and conifer forest. The dominant tree species were oak, pine, cherry and holly. West of Archer Avenue the forest contained minimal undergrowth, but on the eastern side there was a high concentration greenbriar and other low plants. The military buildings scattered throughout the area were surrounded by cleared grassy areas.

The soils of Area E-1 were mapped as Keyport silt loam in the southwestern half and Elkton silt loam towards the northwest. A representative soil profile from the area mapped as Keyport silt

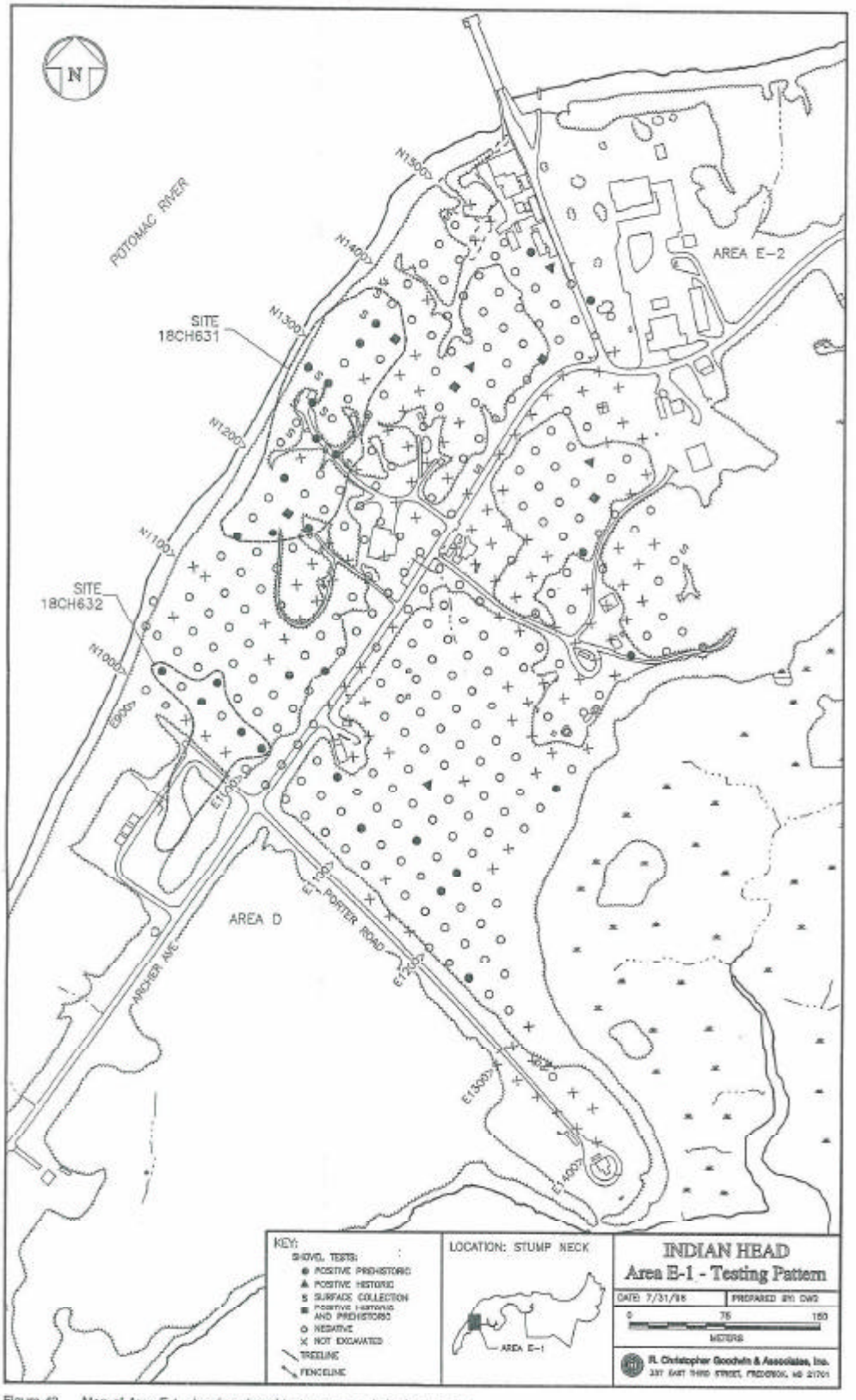

Figure 43. Map of Area E-1, showing shovel test pattern and site boundaries

loam includes: a 0-9 cmbs dark grayish brown (2.5Y 4/2) silt; a 9-21 cmbs light yellowish brown (2.5Y 6/4) slightly clayey silt; and, a 21-40 cmbs yellowish brown (10YR 5/6) sticky silt loam. None of the shovel tests recorded a typical Elkton series profile; most profiles in the area indicate disturbance, truncation, and/or grading.

Area E-1 contained large areas of disturbance and nearly 30 per cent of the planned shovel tests were not excavated for this reason. The disturbances were primarily a result of military activities, although along the Potomac River there was some erosion off the bluff. The disturbances included various buildings, a bomb shelter, a well monitoring area, landfills, and bulldozed and graded fields.

The N1000/E1000 datum for Area E-1 was a telephone pole at the northwest corner of the intersection of Porter Road and Archer Avenue. The baseline followed the edge of Archer Avenue north on a bearing of 45° (magnetic north). Twenty-six transects extended off the baseline on a bearing of 135/315° from N940 to N1460. A total of 283 shovel tests were excavated within Area E-1 and 117 planned shovel tests were not dug because of disturbances. Two archeological sites were identified in Area E-1. Site 18CH631 was a Late Woodland period site with a very small late nineteenth century historic component. Site 18CH632 was a small Late Woodland site. The survey also recovered 32 artifacts from 20 isolated positive shovel tests and two surface finds. The historic artifacts not designated part of the sites within the area included pearlware, whiteware, and later hard paste porcelain sherds, a ball clay pipe bowl, as well as brick fragments, and coal slag. The non-site prehistoric artifacts included 1 unidentified sand-tempered body sherd, 1 coarse sand-tempered Potomac Creek Plain sherds, 13 quartz or quartzite flakes, 3 pieces of block/shatter, 2 pieces of fire-cracked rock, a small Late Woodland site, and 1 quartzite core.

Site 18CH631. Site 18CH631 was situated on the bluff edge overlooking the Potomac River in the northern portion of Area E-1. The 60 m (196.8 ft) wide site extended along the bluff for approximately 220 m (721.8 ft) and was actively eroding out of the bank. The area in the vicinity of this site was disturbed partially by construction of Buildings 2157 and A2120 and gravel paths and other activities evidenced by pushpiles. A total of 74 artifacts were recovered from 14 of the 28

shovel tests placed in the site. Only seven of these artifacts were historic. Six of the historic artifacts came from two shovel tests placed in the vicinity of a series of underground storage tanks and a small rubbish dump. These artifacts included two pieces of plastic, one unidentified iron or steel object, one piece of coal, and one later hard paste porcelain sherd. The remaining historic artifact was a machine cut nail from a shovel test placed in the northeastern corner of the site. The historic material recovered on the site appear to be the result of modern activities such as refuse disposal.

A total of 67 prehistoric artifacts were recovered from 10 positive shovel tests, 3 mixed historic and prehistoric shovel tests, and 7 surface finds. Nearly two-thirds of the assemblage was debitage. The 44 pieces of debitage included 36 flakes and 9 pieces of block/shatter. The majority of the flakes (n=28) were non-cortical; only one primary and six secondary flakes were recovered. Most of the debitage was quartz and quartzite; three rhyolite and one slate flake also were recovered. The balance of the prehistoric assemblage included 2 point tips, 1 utilized flake, 1 retouched flake, 3 quartz-tempered sherds, and 16 pieces of fire-cracked rock. The two projectile point tips were recovered from surface artifact concentrations along the edge of the bluff (Figure 42; FS #241 and 227). The three coarse sand-tempered ceramics were not attributable to Potomac Creek ware; two had a burnished Plain exterior surface treatment similar to relatively late prehistoric assemblages in the region. The diversity of artifacts from the site and the presence of fire-cracked rock and ceramics at the site are indicative of a substantial prehistoric occupation at the site, possibly as a base camp. Activities minimally represented at the site included tool maintenance and food preparation activities.

The highest concentrations of prehistoric artifacts in shovel tests and on the surface of the site were located in the central portion of the site. Artifacts were recovered from the surface in eroded areas located along the margins of the bluff in the central and northern portions of the site. Although 57 per cent of the prehistoric artifacts recovered in shovel tests at the site were from below the A horizon, extensive disturbance across the site and variation in soil profiles indicate that the site may be seriously compromised by erosion and military activities.

Site 18CH632. Site 18CH632 was a small probable Late Archaic and Late Woodland site located in the wooded area just Northwest of Archer Avenue, north and east of a bunker including Buildings 2044, 2045, and 2046. The site was approximately 80 x 100 m (262.5 x 328.1 ft), northeast from the bunker to 30 m (98.4 ft) beyond Porter Road and from Archer Avenue northwest to the bluff above the Potomac River. The artifact density at the site was low; a total of nine artifacts were recovered from eight of the 12 shovel tests placed in the site. These artifacts included 1 projectile point, 4 ceramic sherds, 1 core, 1 piece of fire-cracked rock, a retouched primary flake, and a unmodified primary flake. All of the four coarse sand-tempered prehistoric ceramic sherds were attributable to Potomac Creek ware (Stephenson et al. 1963). These sherds were probably burnished Plain body sherds. The fourth sherd was decorated with parallel cord impressions. One cord-marked rim sherd was sufficiently intact to attribute to the Accokeek type (Stephenson et al. 1963). The retouched quartz primary flake exhibited two flake scars on its dorsal face. The jasper core was classified as a tested cobble and retained approximately 80 per cent of it cortical surface. The rhyolite projectile point was crudely flaked with shallow side notches, wide shoulders, and a slightly convex base. The point is similar to the Late Archaic MacPherson type (Kinsey 1972)(Figure 42; FS #661). The overall assemblage from the site may indicate a transitory resource procurement or base camp. The very small assemblage from the site restricts interpretation of the character of the site.

Although many of the artifacts recovered from this site were from the second stratigraphic horizon, none were from below 33 cmbs. The first horizon was characterized by a very high organic content and could be characterized as an A0 or A1 horizon. The second stratum was brown silt loam that generally corresponded to the A2 horizon of Keyport Silt loam mapped for the area in the vicinity of the site. Although the soil profiles on portions of the site were not disturbed, construction of Porter Road and the bunker area in Survey Area D severely compromised the integrity of the southern portion of the site.

Area E-2

Area E-2 was located in the eastern portion of Area E, between Area E-1 and Area B. The area is situated on the same landform as these adjacent areas and is bounded on the north by the Potomac River and on the south by the tidal marsh at the edge of Chicamuxen Creek (Figure 44).

As in Area E-1, Area E-2 was forested primarily with mature mixed hardwood and pine forests of the same species seen in the other area. The northeastern section of Area E-2 was covered by green briar, heavy undergrowth and other forms of regrowth. Many of the highly disturbed areas were covered in grass.

Almost all of the soils in Area E-2 are mapped as Keyport silt loam, with only a small section of Bibb silt loam in the southeast corner. A representative soil profile from the area was 0-6 cmbs dark grayish brown (2.5Y 4/2) silt loam; 6-27 cmbs light yellowish brown (2.5Y 6/4) silt clay; and 27-39 cmbs yellowish brown (10YR 5/6) sticky silt loam. The Bibb soils were seen only occasionally. Disturbed land was characterized by highly mottled soils, missing strata, and highly compacted soils.

Disturbance was more extensive in Area E-2 than it was in Area E-1; 40.3 per cent of the planned shovel tests were not excavated because of modern activities. A large graded field on which the commissary and other buildings are located lies at the western end of Area E-2. The eastern corner of the area south of Archer Avenue was disturbed completely by a large complex of buildings, and small buildings, numerous pushpiles, and evidence of grading was present across most of Area E-2. A small testing range surrounded by an embankment also was located within the area. Natural disturbance in the form of small drainages along the Potomac was present.

The baseline for Area E-2 was established relative to a datum point located 65 m (213.2 ft) north of the northeast corner of Archer Avenue and Lewis Road, on a bearing of 348°. The baseline was then oriented to 86° and 33 transects extended off of it on a bearing of 176/356° to the north and south. A total of 348 shovel tests were excavated in Area E-2; 235 planned shovel tests were not excavated as a result of the widespread disturbance. The Phase I survey identified two multi-component sites and 43 artifacts from 12 isolated shovel tests and four surface scatters across

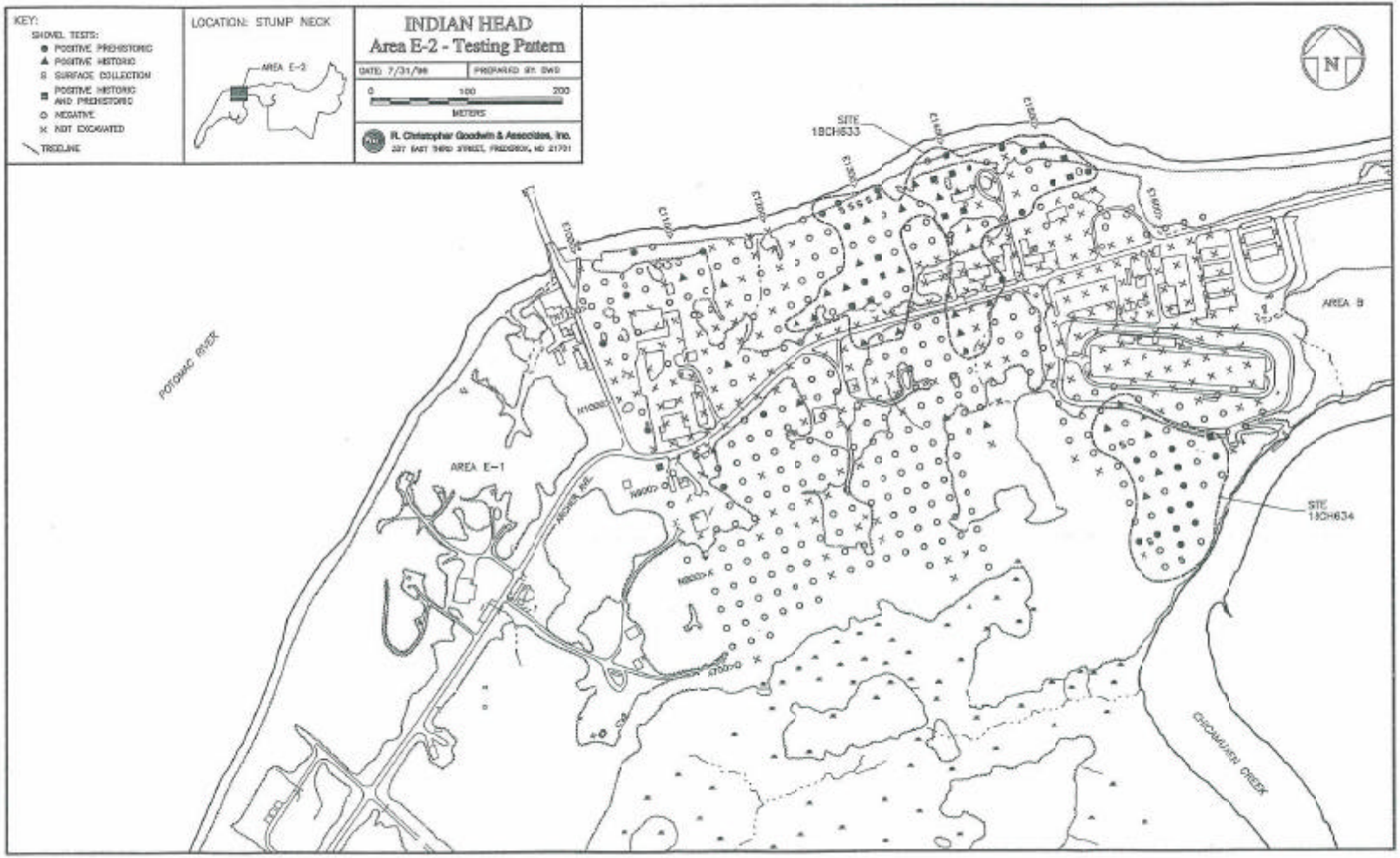

Figure 44. Map of Area E-2, showing shovel test pattern and site boundaries

the site. The six historic isolates included 3 later hard paste porcelain and 1 undecorated pearlware sherds, lead shot, a wire nail, and 1 fragment of non-machine made dark green bottle glass. Seven pieces of modern bottle glass also were recovered. The isolated prehistoric artifacts included the base of a possible quartzite Morrow Mountain point/knife that was collected on the beach, an eroded coarse sand-tempered unidentified sherd, and 2 utilized quartzite non-cortex flakes, one of which may be a broken blade. The remaining artifacts included 23 pieces of debitage and one piece of fire-cracked rock.

Site 18CH633. Site 18CH633 was identified in the northern half of Area E-2, between Archer Avenue and the bank of the Potomac (Figure 44). A small portion of the site extends south of the road. Several parts of the site appear to have been disturbed by a landfill and houses with associated parking lots and driveways. A total of 168 artifacts including 70 prehistoric and 98 historic artifacts, were recovered. The 200 x 260 m (656.2 x 853 ft) site was defined on the basis of 9 prehistoric shovel tests, 20 historic shovel tests, 13 mixed prehistoric and historic tests, and 5 areas in which artifacts were observed on the surface of the site.

The prehistoric assemblage from Site 18CH633 was composed principally of debitage (79 per cent) and fire-cracked rock (14 per cent). Four utilized flakes and one ceramic sherd also were recovered from the site. The debitage predominately was quartz and quartzite, although rhyolite, chert, slate, sandstone, and silicified sandstone also were represented. The proportion of cortical debitage is relatively low (16 per cent) compared to other assemblages on Stump Neck. The variety of lithic materials and low cortical percentage suggests that late stage tool manufacture and maintenance dominated the lithic reduction activities on the site. The four utilized flakes included secondary and non-cortical flakes of quartzite, quartz and sandstone. The sole diagnostic artifact recovered from the site was an eroded coarse sand-tempered body sherd of Potomac Creek ware (Stephenson et al. 1963). Nearly all of the prehistoric artifacts were found in disturbed or mixed contexts. The highest concentration of prehistoric artifacts was at the far eastern end of the site, where 28 artifacts were recovered from eight shovel tests; three of these tests also contained historic artifacts in the first stratigraphic level.

Modern disturbance to the site was extensive. Fill and disturbed soils were encountered across most of the site and push piles were frequently observed in the area. Only four shovel tests placed in the northeastern portion of the site appear to possess potentially intact prehistoric cultural horizons. Prehistoric artifacts were recovered from contexts below the historic disturbance within intact B or C horizons in four shovel tests immediately adjacent to the Potomac River, between Transects E1320 and E1460. The prehistoric artifacts recovered from these areas was limited to debitage and fire-cracked rock.

A majority of the prehistoric component at the site was disturbed; only a very small portion remained potentially intact. The overall homogeneous character of the prehistoric assemblage from the site and the near absence of diagnostic artifacts such as projectile points and ceramics suggest that regardless of the integrity of the site, it has little to contribute to our current understanding of prehistory.

The historic assemblage from Site 18CH633 was characterized primarily by kitchen-related refuse; only four artifacts were architectural. The ceramics and bottle glass that comprise the bulk of the historic assemblage overwhelmingly date from the twentieth century; 29 pieces of bottle glass were modern. With the exception of three artifacts (1 pearlware sherd, a piece of light green non-machine made bottle glass, and 1 cut nail) all artifacts types present in the assemblage continue to be manufactured to this day. The highest concentration of historic debris were in the southwestern and central portions of the site; at least some of this material was associated with the fill encountered intermittently across the site. The near absence of architectural debris on the site suggests that the historic component at the site was probably the result of historic refuse disposal. This "field dumping" occurred in the twentieth century and perhaps very recently. None of these artifacts could be associated confidently with the early twentieth century hamlet of Winthrop that is located on this portion of Stump Neck on USGS quadrangle maps between 1913 and 1953.

Site 18CH634. Site 18CH634 was located in the extreme southwest corner of Area E-2, situated between a large complex of buildings and the edge of Chicamuxen Creek. This portion of Area E-2 was wooded, with mature hardwoods dominating the forest canopy. Several small

drainages crosscut this portion of Area E-2 forming low finger ridges sloping down toward Chicamuxen Creek. Unlike other portions of Area E-2, the soils in Site 18CH634 appeared to be relatively intact.

The multi-component site measured approximately 100 x 180 m (328 x 590.5 ft). The prehistoric component was confined largely to the southern two-thirds of the site, with the greatest concentration of prehistoric artifacts located on a low rise or finger ridge between one of the drainages and the marsh. The historic use of the site was most clearly defined in the northern half of the site and was characterized principally by the disposal of domestic refuse during the twentieth century; a large trash dump was located immediately south and west of the building complex in the northern portion of the site. The scatter of historic refuse was approximately 40 x 40 m (131.2 x 131.2 ft) in size.

The 26 prehistoric artifacts recovered from the site included 22 pieces of debitage, a piece of fire-cracked rock, a projectile point base, a grinding stone, and a eroded coarse sand-tempered ceramic body sherd. The debitage was primarily quartz and non-cortical. The quartz projectile point base was asymmetrical, with a well defined, squared shoulder and a wide, square stem and a flat base (Figure 42; FS #303). The fragmentary and resharpened state of the point precluded identification of its type; however, its general morphology was similar to Late Archaic points such as Holmes and Bare Island. The grinding stone fragment was a medium sized sandstone piece with a flat, partially polished surface. The sherd exhibited faint impressions, possibly of fabric. The temper, paste, and thickness characteristics suggest that this sherd is Potomac Creek ware (Stephenson et al. 1963). Prehistoric artifacts were recovered from 12 shovel tests and two surface locations spread evenly across the southern portion of the site. Only one of the shovel tests contained both historic and prehistoric artifacts; the soils in this test were disturbed. Half of the prehistoric artifacts were recovered from the second stratigraphic level (A2 or B horizon) which averaged between 10-30 cmbs. The remaining prehistoric artifacts were from the A horizon or the surface, including six flakes collected on the beach of Chicamuxen Creek.

The historic component of Site 18CH634 was restricted, with three exceptions, to the twentieth century trash dump located in the vicinity of Shovel Test N820/E1500. One sherd of eighteenth century imported British brown stoneware was recovered from the upper 10 cmbs of a shovel test 60 m (196.8 ft) south of the dump. The other isolated historic artifacts included a lead shot from a shovel test nearly the swampy margin of Chicamuxen Creek and several pieces of twentieth century ceramics and bottle glass in a shovel test in the eastern portion of the site. Only a sample of the artifacts visible on the surface of the trash dump was collected. These artifacts included several fragments of modern machine made bottles, embossed panel bottle fragments, later hard paste porcelain sherds, butchered bone, annular whiteware, blown in mold bottle fragments, hand finished bottle lips and 2 fragments of a machine made glass tumbler.

The general character of the prehistoric component at the site is indicative of a resource procurement or temporary camp site. The apparent integrity of the prehistoric component at the site and the recovery of diagnostic artifacts with which the occupation can be dated suggests that the prehistoric component at the site may possess research potential. The historic component, characterized by a twentieth century dump lacks such potential.

Area F

Area F encompassed approximately 49.33 acres of mature growth forest on a broad upland terrace overlooking the mouth of Mattawoman Creek. The terrace was cut by two drainages that flow to the southwest and drain into Chicamuxen Creek, and one drainage that drains into Mattawoman Creek. Area F was bounded by Archer Avenue to the south, Mattawoman Creek to the north, a deep drainage to the east and the Radiological compound and related disturbance to the west (Figure 45). The bluff along Mattawoman Creek showed signs of active erosion and slumping. Slumped soils formed several small low terraces near the bottom of the bluff, one of which was tested.

The soils within Area F were characterized as part of the Evesboro-Keyport-Elkton soil association, although the soil series mapped for the area was Beltsville silt loam (Hall and Matthews

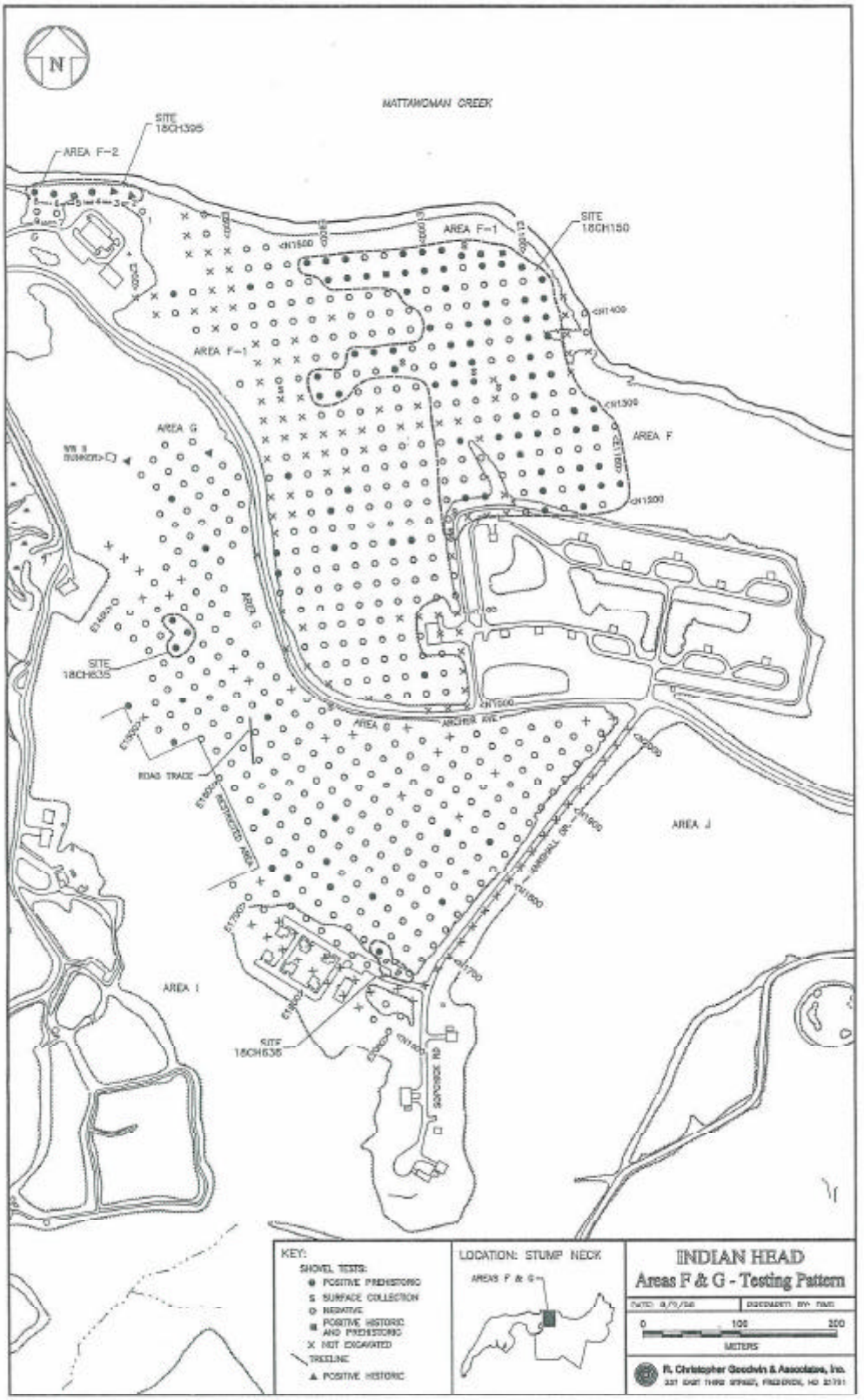

Figure 45. Map of Areas F and G, showing shovel test pattern and site boundaries

1974). A representative soil profile from Area F consisted of: a 0-10 cmbs grayish brown (2.5Y 5/2) silt loam; a 10-28 cmbs pale yellow (2.5Y 7/4) slightly clayey silt; and, a 28-40 cmbs light yellowish brown (10YR 6/4) silt clay. This profile generally corresponded to those described for Beltsville series soils.

The vegetation in Area F was almost entirely mature, open growth hardwood forest; this was consistent with its current primary use as a woodlot and/or wildlife preserve. The dominant tree species within the area included red oak, white oak, beech, maple, and sweetgum, with diameters up to 70 cm. A high density of mature hollies also were observed, especially in the north-central part of the area. Undergrowth was sparse and was limited to greenbriar, mountain laurel, and smaller shrubs. Occasional pines were also present. Grass was the dominant ground cover in the far western end of the area, around the radiology complex, which includes Buildings 2009 and 2020.

The datum for Area F (N1000/E1000) was established in northwest corner of the intersection between Archer Avenue and the unnamed access road leading to the main magazine. The baseline was laid in at a bearing of 0° (magnetic north), and 26 transects were extended off the baseline at 90/270°. A total of 295 shovel tests were excavated in Area F; 86 planned tests were not excavated because of either human or natural disturbance.

Construction of military structures resulted in a moderate amount of disturbance within Area F. The western portion of the area near the radiology complex was disturbed by the construction of Buildings 2020 and 2009, and by electric cable transformers. Similar disturbance was associated with the construction of Building 2132 in the southern portion of the area. A large borrow pit was located between the broad terrace on which most of Area F was located, and a narrower ridge to the west containing the radiology buildings and the electrical transformers. The trench was approximately 3-9 m (10-30 ft) deep and was probably abandoned within the last 25 years; the vegetation covering the surface of the borrow pit consisted primarily of hardwood saplings of less than 10-20 cm in diameter. The soils in the trench exhibited little or no soil development and contained large amounts of gravel. Occasional push piles and depressions were observed on the margins of Area F and near the buildings. Erosion along the bluff along Mattawoman Creek and

the drainages within the survey area also was observed. A majority of this disturbance was confined mainly to the western half of Area F.

Phase I survey confirmed the location of a previously identified prehistoric site (18CH150), expanding its boundaries to encompass more than three times its original area. Twelve positive prehistoric shovel tests were scattered across the area and could not be attributed to a site. The isolated finds consisted of 21 artifacts, including 16 pieces of debitage, 3 fragments of fire-cracked rock, a core, and a silicified sandstone abrader. Quartz and quartzite were the most common materials recovered.

Site 18CH150. Site 18CH150 was first identified by Wilke and Thompson during their survey of coastal Maryland in 1977 (Wilke and Thompson 1977). They characterized the site as a Woodland period occupation containing decorated ceramics. The site was relocated during reconnaissance survey of the Stump Neck Annex by John Milner & Associates in 1995 (Stevens et al. 1995). Debitage and fire-cracked rock were recovered through pedestrian survey of the exposed ground surface and one shovel test at the site. In contrast to Wilke and Thompson, Milner recovered no prehistoric ceramics. The report classified the site as a probable seasonal camp of an unknown temporal association (Steven et al. 1995:47). Diagnostic artifacts ranging in age from the Middle Archaic through the Late Woodland periods were recovered during the Phase I Intensive Survey of the Stump Neck Annex. It is likely that these materials result from a series of seasonal resource procurement and/or base camps situated on the bluff overlooking the mouth of Mattawoman Creek.

Intensive Phase I survey determined that Site 18CH150 measured approximately 200 x 280 m (656.2 x 918.6 ft)(Figure 45). The site occupies the entire eastern half of Area F, along the bluff overlooking Mattawoman Creek. This portion of the survey area was largely undisturbed. Disturbance is confined to the southern margin of the survey area, where the access road to the Main Magazine crosses the area and on the bluff where the site is slumping into Mattawoman Creek. Areas of standing water on the site during the survey prevented testing of some areas. Soil profiles were remarkably consistent across the site and corresponded to the Beltsville silt loam soil series

mapped for the area (Hall and Matthews 1974). A total of 69 shovel tests contained prehistoric artifacts; two more shovel tests contained both prehistoric and historic materials, and six areas produced artifacts on the surface. The 222 artifacts recovered from the site included only two historic artifacts, both lead slugs that probably relate to modern military activities in the area.

Among the 222 prehistoric artifacts recovered were 168 pieces of debitage, 4 cores, 5 projectile points, 1 projectile point tip, 1 biface, 2 retouched flakes, 7 utilized flakes, 32 pieces of fire-cracked rock, and 2 ceramic sherds. The debitage was predominately (88.1 per cent) quartz and quartzite, with a lesser amount of rhyolite and trace amounts of chalcedony, chert, sandstone, and silicified sandstone present in the assemblage. The debitage is mainly non-cortical, with only 25 per cent of the identified as primary or secondary flakes. All four of the cores recovered on the site were quartzite; three retained only 25 per cent of their original cortex, the fourth retained approximately 75 per cent of its cortex. The moderate frequency of cortical debitage and occasional partially reduced core indicate that both primary reduction and tool production/maintenance occurred on the site.

The five projectile points from the site range from the Late Archaic to the Middle Woodland periods (Figure 46). One quartzite point (FS# 59) was characterized by a steeply resharpened blade, weak shoulders, and wide, square stem with a concave base. Although sharpening had obscured the original shape of this point, the weak shoulders and broad base were typical of Middle Woodland lanceolate/stemmed points such as Fox Creek and Selby Bay types. A second quartzite point (FS# 58) exhibited a similar form, although the shoulders were slightly better defined and the tip was missing. A third quartz point (FS# 19) exhibited a thick cross-section, weak shoulders, and a contracting stem. The point is morphologically similar to Piscataway or Rossville points (Stephenson et al. 1963; Ritchie 1971). A chalcedony side-notched point (FS# 62) had weak shoulders and a flat base similar to Halifax points (Coe 1964). Although the blade of this point was well formed, step fractures were common along the blade margins; most of these fractures appear to result from material flaws rather than use. A quartz point tip (FS# 12) also was recovered. The finely flaked tip had a relatively narrow blade.

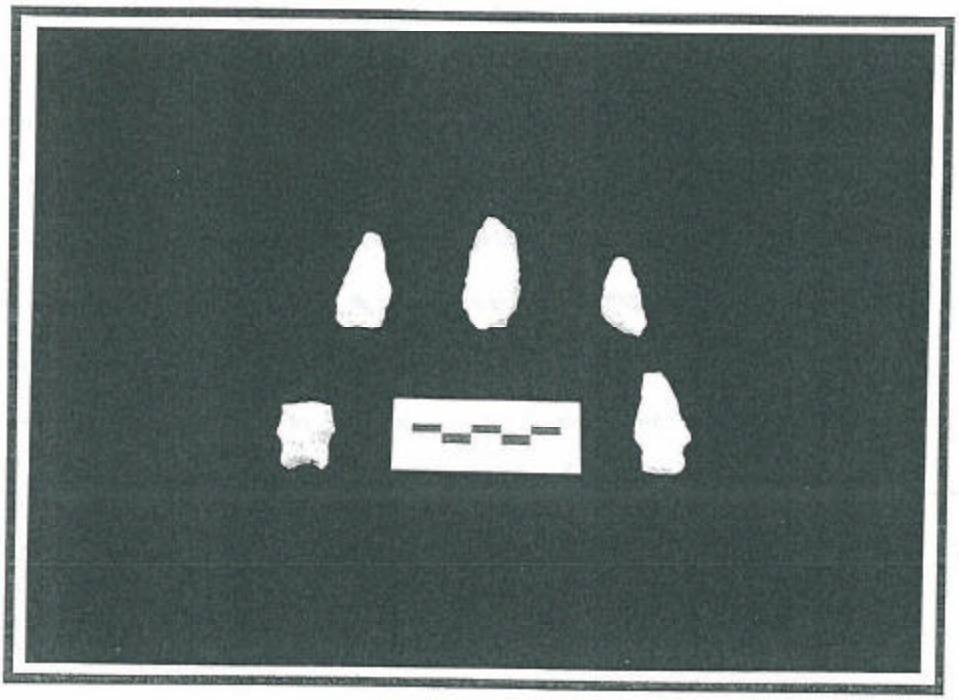

Figure 46. Projectile points/knives from Site 18CH150. (Clock-wise from upper left) [a] FS# 59; [b] FS# 19; [c] FS# 12; [d] FS# 62; [e] FS# 58

The two ceramic sherds were both Late Woodland period sand-tempered Potomac Creek ware (Stephenson et al. 1963). One sherd was plain with a burnished exterior, the other was eroded. The prehistoric assemblage from the site suggests a wide variety of activities occurred at the site during the Middle Archaic through Late Woodland periods. The presence of cores and cortical debitage indicated that the reduction or cores and/or bifaces occurred on the site. Flake tools, points, ceramics, and fire-cracked rock all suggest an encampment.

The majority of the artifacts (60.8 per cent or n=135) were recovered from the second stratigraphic level (A2 horizon), which had an average depth of 10-26 cmbs. Sixty-five of the artifacts came from the A1 horizon; 13 from the B2 horizon, and 9 artifacts were recovered from exposed ground surface or treefalls. No artifacts were recovered from depths greater than 45 cmbs. The Selby Bay-like point was recovered from a prehistoric artifact surface scatter at the edge of the Main Magazine access road on transect N1200. Because of their proximity to the road, it is likely that the points represent secondary deposition. The Halifax side-notched point was recovered from the second stratum 20 m north of the surface scatter. One Potomac Creek sherd was recovered from the first level of shovel test N1340/E1120. The other sherd came from the second stratum of shovel test N1460/E1080. The eight positive shovel tests east of the baseline on transects N1460 and N1475 formed a distinct artifact concentration containing a total of 71 artifacts, or almost one third of the total assemblage. Transect N1475, which ran along the edge of the cliff overlooking Mattawoman Creek, contained the largest concentration of artifacts; this may indicate that a significant part of the site was lost to erosion. One of the shovel tests on this transect, N1475/E1080, contained a possible fire-cracked rock feature containing 14 fragments (825.57 g) in the second stratigraphic level. Despite erosion of the bluff, the uniformity of the soils across the site suggests that intact cultural remains are present on the site, particularly in the northern end of the site along Mattawoman Creek.

Area F-2

Area F-2 was defined as the level terrace and slope down to the water in the far northwestern corner of Area F (Figure 45). The area was disturbed partially by the presence of the fenced radiology complex and a series of electrical transformers. Two prehistoric sites were identified previously along the bluff overlooking Mattawoman Creek during the Phase IA reconnaissance survey of Stump Neck (Stevens et al. 1995). One of these sites (18CH395) was relocated during Phase IB intensive testing. The site was described as a scatter of debitage situated on a terrace or bench at an elevation of ca. 30 ft amsl. No evidence of the second site (18CH394) was recovered; only a single fire-cracked rock fragment was recovered in the mapped location of the site on a very small bench or terrace remnant at an elevation of approximately 40 ft. amsl.

A series of nine shovel tests were excavated at 20 m intervals on the undisturbed portion of the terrace. The first shovel test on the transect was placed 6 m from the northeast corner of the perimeter fence around the radiology complex at a bearing of 110°. The remaining shovel tests were placed along the center of the undisturbed wooded strip between the fence and the bluff. The wooded area that extended down the gentle slope from the level top was tested in a similar manner.

Site 18CH395. Site 18CH395 was characterized as a small exploitative camp containing a scatter of primary and secondary flakes during the Phase IA reconnaissance survey (Stevens et al. 1995:47). The site was located on a terrace 9 m (30 ft) amsl. Five of the nine shovel tests excavated in the site during the Phase IB testing contained artifacts. Intensive Phase IB testing of the site determined that it covered an area approximately 15 x 100 m (49.2 x 328 ft) in size along the edge of the terrace.

A total of 36 prehistoric artifacts were recovered from the site, including 3 ceramic sherds, 26 pieces of debitage, 1 utilized flake, 1 retouched flake, 3 pieces of fire-cracked rock, 1 core, and 1 silicified sandstone hammerstone. One historic artifact, a piece of lamp glass was recovered from the site; this artifact was from the A horizon in Shovel Test 5. The debitage was indicative of secondary reduction of bifaces and cores; the assemblage included 11 secondary and 10 non-cortical flakes, and 5 block/shatter fragments. The quartzite core was heavily reduced and

retained only 25 per cent of its original cortex. One of the sherds was sand-tempered Late Woodland period Potomac Creek ware; the exterior of the rim sherd exhibited Z-twisted cordage impressions with loosely woven vertical elements. Another sherd was an unidentified shell-tempered sherd; the exterior of this sherd was eroded. The third was a coarse sand-tempered Potomac Creek body sherd.

A large proportion of the artifacts from this small site were recovered from below the A or Ap horizon. Twenty-two of the artifacts were recovered from the second level, which had a maximum depth of 34 cmbs. Two shovel tests in the eastern portion of the site contained a layer of fill on top of intact soil horizons in most of the soil profiles. Site 18CH395 corresponded to the Beltsville silt loam mapped for the area. Four prehistoric artifacts were also recovered from a surface scatter in the area. Large sections of the site may have been destroyed by the radiology complex and erosion of the bluff. The remaining intact portion of the site may be too small to address significant research questions.

Area G

Area G encompassed 59.3 acres of mature mixed hardwood forest on a ridge overlooking Stump Neck and the marshy headwaters of Chicamuxen Creek (Figure 45). The area was bounded on the east by Marshall Road; on the north by Archer Avenue, the steep slopes of the ridge, and the septic field at the tip of the finger ridge; and on the west by Chicamuxen Creek and the fence line around Area 8. The southern boundary was the disassembly compound that formed the dividing line between Areas G and I. The area was relatively level with the exception of a low-lying drainage area running parallel to Archer Avenue at the bottom of the steep slope leading up to the tip of the ridge. The area currently forms a wooded buffer around the disassembly complex.

Vegetation in Area G consisted of beech, oak, large holly, some mature pines, mountain laurel, and greenbriar around the low wet areas. The trees generally were mature with trunks up to 70 cm in diameter. Around the periphery of Area G the trees were much smaller. Undergrowth was fairly light, although there were several areas with dense mountain laurel or with many saplings.

Soils of Area G belong to the Beltsville, Exum, Wickham soil association (Hall and Matthews 1974). The areas surveyed primarily were mapped as Beltsville silt loam with a narrow band of Matapeake silt loam running along the spine of the ridge. The soils on either side of this ridge were mapped as steep gravelly land. A typical soil profile for the Beltsville areas was : 0-8 cmbs grayish brown (2.5Y 5/2) silt loam; 8-30 cmbs light yellowish brown (2.5Y 6/4) silt; and 30-40 cmbs yellowish brown (10YR 5/6) clayey silt. The soils on the ridge did not correspond as closely with the mapped Matapeake silt loam, but are more like the Beltsville silt loam soils.

A single datum (N2000/E2000) was established for Areas G, I, and J, at the corner of Marshall Road and Archer Avenue. The baseline was laid in along the east side of Marshall Road at a bearing of 225° (magnetic north) and 21 transects were extended at a bearing of 315° on a 20 m grid. A total of 262 shovel tests were excavated in Area G, and 54 additional planned shovel tests were not dug because of slopes greater than 10°, standing water, or visible modern surface disturbances.

Area G was only moderately disturbed, primarily in the area around the munitions disassembly compound, which was graded and filled. Other areas of disturbance included the low wet area near Archer Avenue, and the steep slopes on the margins of the ridge. A septic leach field was located on a broad bench below the tip of the ridge in the extreme northern portion of the area. This bench was tested in 1995 by John Milner and Associates and no artifacts were recovered (Stevens et al. 1995:43).

Intensive Phase I survey of Area G identified two small prehistoric sites and recovered 25 artifacts from 18 isolated shovel tests. A road trace, purportedly from the Civil War, and a World War II pillbox was identified within the area. The road trace was visible as an eroded cut running south along the ridge from its tip. No historic artifacts were recovered from the vicinity of the cut. The WWII pillbox was located on the edge of the ridge overlooking Chicamuxen Creek. The pillbox was partially dug into the side of the ridge and was constructed of block cement with steel girders supporting the roof. It measured 1.3 x 4.5 m (4.3 x 14.8 ft), and was 2 m (6.56 ft) high. Shovel test N1900/E1420, located 5 m to the north, contained five bullet fragments. The only other historic

artifact from this area was a lead slug. The vast majority of the isolated finds were flakes, two of which were utilized. The two materials used for the 16 flakes were quartz and quartzite. The other isolated finds were 2 block/shatter fragments, 1 piece of silicified sandstone fire-cracked rock, and 1 possible burnt clay sample.

Site 18CH635. Site 18CH635 was located towards the end of the ridge in mature hardwood forest (Figure 45). The small site measured only 30 x 30 m (98.4 x 989.4 ft) and contained four artifacts: 3 pieces of debitage and 1 projectile point/knife. Two of the pieces of debitage were non-cortex quartzite flakes and the other was a quartz secondary flake. The quartzite point/knife (FS# 569) had a long blade, a deep side notch on one side, and a slightly convex base (Figure 47). The point is vaguely similar to the Meadowood type (Ritchie 1971). All four artifacts were recovered from the B horizon between 10-40 cmbs indicating the possibility of intact deposits. The recovered assemblage suggests that Site 18CH635 was probably a temporary hunting station possibly dating from the Early Woodland period (Ritchie 1971). The limited size of the site and range of artifacts in the assemblage indicates that Site 18CH635 is unlikely to contribute substantively to our current knowledge of prehistory.

Site 18CH636. Site 18CH636 was located at the edge of the wooded area near the intersection of Marshall Road and Sopchick Court (Figure 45). Like Site 18CH635, the site was small, represented by a single positive shovel test and five surface finds. The site covered an area approximately 30 x 40 m (98.4 x 131.2 ft) in size from which six artifacts were recovered. The positive shovel test contained a non-cortex quartz flake in the top 10 cm of soil. The surface finds were all quartzite and included 1 unmodified non-cortex flake, 1 unmodified biface thinning flake, 2 utilized non-cortex flakes, and the tip of a wide triangular bifacial projectile point/knife. The site almost certainly was disturbed by modern activities. Less than 5 m south of the lithic scatter there was a 1.5 m deep cut for Sopchick Court, the road leading to the Munitions Disassembly Compound. The soils in this area were mixed and graded, although the stratigraphy in the wooded area appeared to remain intact. Available evidence indicates that Site 18CH636 does not retain sufficient integrity to contribute to our current knowledge of prehistory.

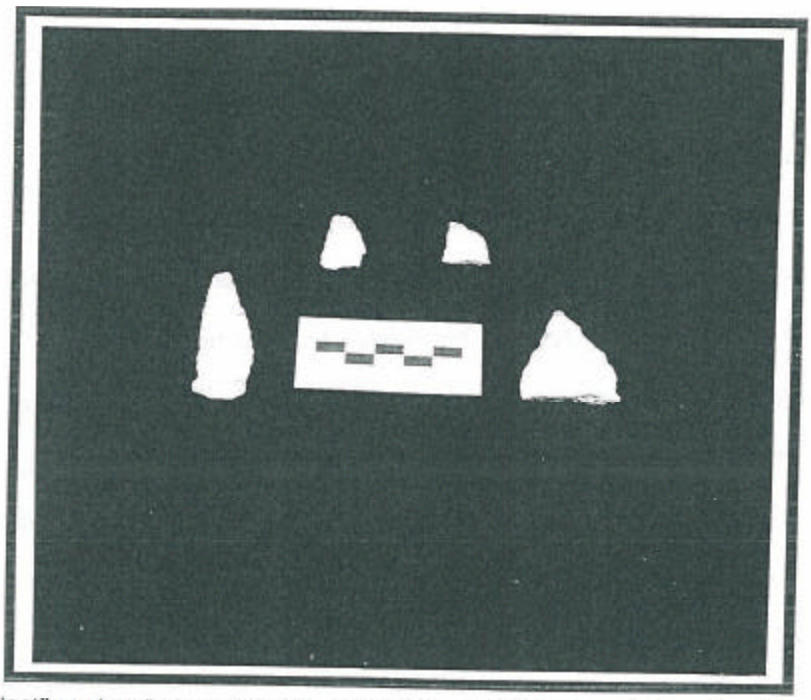

Figure 47. Projectile points/knives from Site 18CH635 and 18CH636, and Areas I and J, non-site. (Clockwise from upper left) [a] FS# 506; [b] FS# 538; [c] FS# 551; [d] FS# 569

Area H

Area H was located on the south side of Howard Road, adjacent to Areas I and 8, between the road and the property boundary (Figure 48). The southern and western boundaries were formed by the property fenceline, while Howard Road and the fence around the Area 8 training facility formed the eastern boundary. Chicamuxen Creek and a marsh formed the northern border of Area H. The center of Area H was occupied by a high terrace that extended west beyond the property line. The southern slope leading up to this high terrace was gradual, and only exceeded 10° in a few locations. The northern slope down to the floodplain was more steeper; the terrace formed a small finger ridge bounded by two drainages in this portion of Area H. The southern end of the area was cut by a meandering stream which flowed into the Chicamuxen.

Soils mapped for Area H consisted of Mattapeake silt loam on top and south of the terrace and Aura gravelly sandy loam on the north side (Hall and Matthews 1974). Gravelly sandy loam soils were encountered on the slope down to Chicamuxen Creek, although the soil colors did not precisely match the descriptions given by the soil survey (Hall and Matthews 1974). A typical soil profile from the high ground in the center of Area H consisted of: a 0-10 cmbs grayish brown (2.5Y 5/2) silt loam; a 10-23 cmbs light yellowish brown (2.5Y 6/4) silt loam; and, a 23-37 cmbs brownish yellow (10YR 6/6) silt clay. This profile corresponded generally to the Mattapeake silt loam mapped for most of the area.

Vegetation in Area H was very similar to that encountered in surrounding areas. The area was forested completely, primarily with mature mixed hardwoods and medium to low undergrowth. Dominant tree species were oak, maple, beech, hickory, cherry, sweet gum and holly, with saplings of these species as well as green briar and large paw paws forming the undergrowth. The slope down to Chicamuxen Creek and the floodplain were the most densely overgrown.

Disturbance in Area H was minimal and primarily natural in origin. At the southern end of the area the stream and several patches of standing water prevented testing, as did the slope in the drainages on either side of the finger ridge to the north. Slopes off the hilltop/finger ridge also prevented testing in certain areas. Many pushpiles and other signs of disturbance were observed

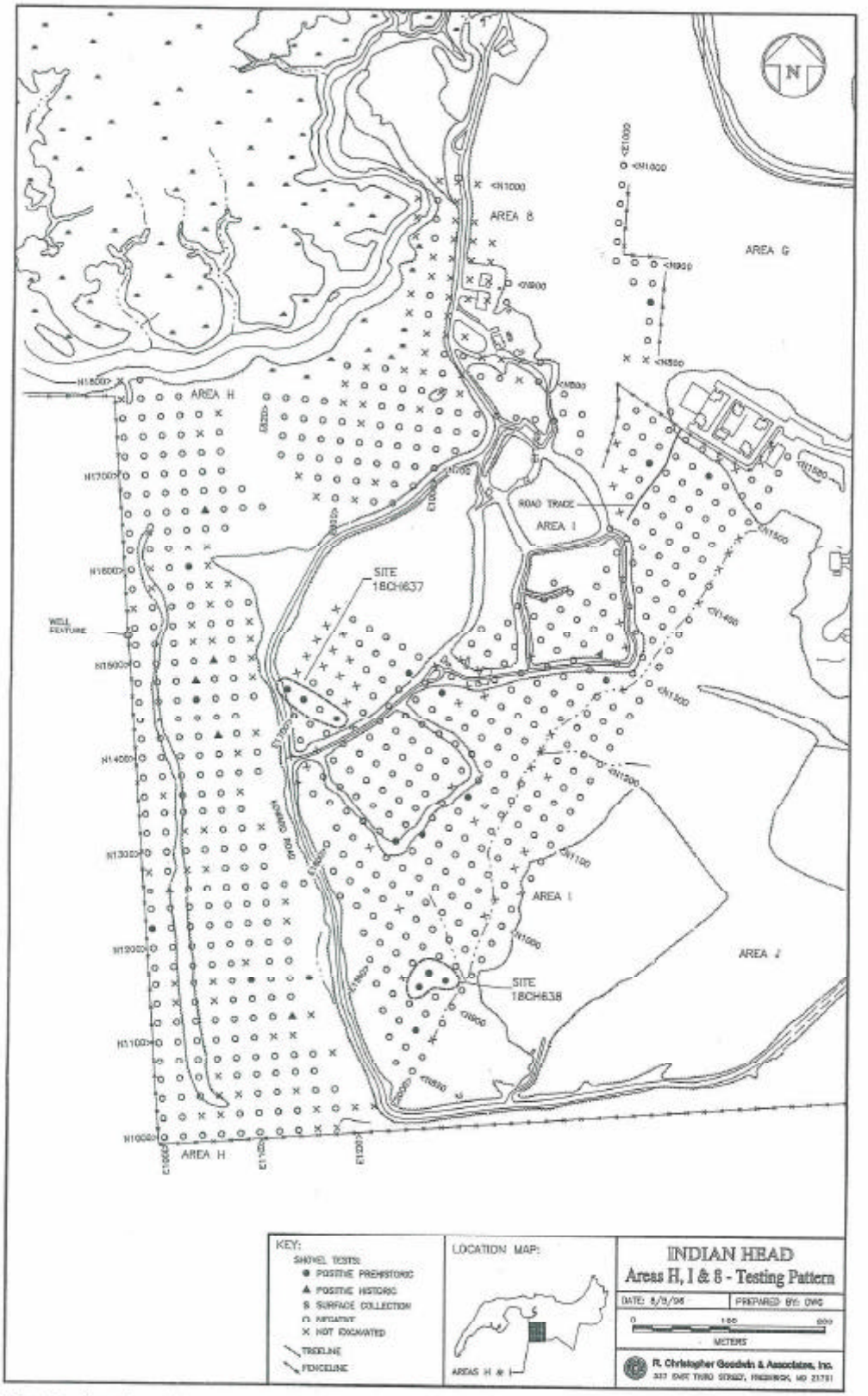

Figure 48. Map of Areas H, I, and B, showing shovel test pattern and site boundaries

along the edge of Howard Road, particularly in the area were the road curved sharply east towards the Area 8 training area. A large area was cleared and graded at the corner and large piles of gravel were left around the edges of the clearing. Construction debris also was dumped down the top of the small drainage nearest to the fence around Area 8.

The datum for Area H was located at the corner marker of the property, approximately 200 m west of Howard Road. The baseline followed the boundary fenceline north at a bearing of 3° to the edge of Chicamuxen Creek and marsh. A total of 41 transects were extended east off of the baseline on a bearing of 93°, and ended at Howard Road or the fence around Area 8. A total of 241 shovel tests were excavated in the survey area and an additional 54 planned tests were not dug because of slope, standing water or other disturbances.

No archeological sites were identified in Area H during the intensive Phase Ib survey. A total of 12 historic and 7 prehistoric artifacts were recovered, but none in sufficient concentrations to warrant a site designation. The prehistoric artifacts included: 2 silicified sandstone hammerstones; 2 primary flakes; 2 non-cortical flakes; and, 1 rhyolite fire-cracked rock fragment. Two of the historic artifacts were discarded after analysis because they were modern. The remaining artifacts included 2 dark green bottle glass fragments, one non-machine made and the other with a tooled lip; 2 aqua blown in mold glass fragments; 1 unidentified black or purple glass fragment; 1 unidentified nail; 3 brown glazed redware sherds; and, 1 green plate rim sherd of institutional or hotel porcelain. A possible historic well feature also was noted at the baseline near transect N1520. The circular hole had a diameter of 1.1 m (3.6 ft) and was flush with the ground surface. It was unmortared and constructed out of field stone. The well was open to a depth of 1.85 m (6.1 ft); no artifacts were recovered from the immediate vicinity to place it in a historic context. The historic artifacts may be a scatter associated with the well; however, without more architectural remains or a denser artifact concentration the association of this feature is tenuous.

Area I

Area I was located on two terraces cut by a small stream immediately south of Areas G and 8 and adjacent to Areas H and J (Figure 48). The area covered 59.6 acres of wooded land, bounded on the west by Howard Road and on the north by the same road and the boundary fence to Area 8. The eastern boundary was Area G and the munitions disassembly facility, and the southern boundary was the baseline shared by Areas G, I, and J. The topography within Area I was gently undulating with very little significant slope except along the northwestern edge where the land sloped steeply down towards Chicamuxen Creek. The area currently is used primarily as a buffer around the disassembly compound.

Most of Area I was wooded with mature hardwoods and occasional pines. The dominant tree species were red oak, white oak, beech, maple, sweetgum, poplar, and holly. In the center of the area there was a large patch of dense regrowth containing 5 year-old hardwood saplings and briars. With the exception of the regrowth area there was very little undergrowth. Daffodils were observed growing in one area on either side of the gravel driveway that led to Buildings 2124 and ROB92123; however, no historic structures or artifacts were noted in the vicinity.

The soils within Area I belong to the Beltsville-Exum-Wickham soil association. A representative soil profile for the area consisted of: a 0-12 cmbs grayish brown (10YR 5/2) silt loam; a 12-24 cmbs light yellowish brown (2.5Y 6/4) silt loam; and, a 24-38 cmbs yellowish brown (10YR 5/6) silt clay. The profile corresponded to the Beltsville silt loam soils mapped by the Soil Conservation Service for the majority of Area I (Hall and Matthews 1974).

Area I shared a baseline with Area G with testing for Area I beginning at Transect N1580/E2000. Thirty-nine transects were extended at a bearing of 315° from the baseline, and a total of 319 shovel tests were excavated. Modern surface disturbances and slope prevented the excavation of an additional 56 planned shovel tests.

As in Area G, the most significant disturbance in the area was the compound containing the munitions facility. Area I also was cut by several two-tracks, including the gravel drive leading to Buildings 2124 and ROB92123. Other disturbances observed included erosion along the stream that

flowed almost parallel to the baseline, and a 10 m wide ditch running parallel to the transects in the regrowth. A remnant of the possible Civil War corduroy road from Area G also was noted in the northern part of the area. The northern edge of Area I was disturbed by steep slopes down towards Chicamuxen Creek.

The Phase IB survey identified two small prehistoric sites and produced 11 artifacts from 10 isolated shovel tests and 1 surface find. Two of the non-site finds were historic artifacts: 1 fragment of a pontil from a dark green non machine made bottle, and 1 trailed slipware sherd with a tinted glaze. The prehistoric artifacts included 4 quartz/quartzite flakes, 2 cord marked sand-tempered Potomac Creek sherds (one of which was a rim sherd), 1 silicified sandstone fire-cracked rock fragment, the midsection from a quartzite point/knife, and a silicified sandstone hammerstone. Seven of the 11 isolated finds were recovered from the first stratigraphic level or the surface.

Site 18CH637. Site 18CH637 was located in the northeastern portion of Area I, in the mature growth forest north of the gravel driveway leading to Buildings 2124 and ROB92123. The site is small, measuring 10 x 60 m (32.8 x 196.8 ft), and probably dates to the Late Woodland period. The three artifacts were recovered from three shovel tests, and included a broken quartzite hammerstone, one silicified sandstone fire-cracked rock fragment, and a plain sand-tempered Potomac Creek body sherd. Only the hammerstone was recovered from below the plowzone. The limited nature of the assemblage recovered from the site suggests that it was a briefly occupied hunting or resource exploitation site. The small assemblage and questionable integrity of the site indicate that further investigation of Site 18CH637 is unlikely to produce important information on prehistoric behavior.

Site 18CH638. Site 18CH638 was a small lithic concentration located at the edge of the small stream in the southern portion of the survey area. The site measured approximately 30 x 30 m (98.4 x 98.4 ft) and contained only three prehistoric artifacts, none of which were diagnostic. The three positive shovel tests that comprise the site yielded 1 utilized quartz secondary flake, 1 unmodified secondary quartz flake, and 1 unmodified non-cortex silicified sandstone flake. None

of the artifacts were recovered from a depth greater than 17 cmbs, indicating that it is unlikely that any intact deposits remain below the plowzone.

Area J

Area J covered 84.1 acres of low and medium probability land around the Munitions Disassembly Complex (Figure 49). The area was located east of Areas G and I, and encompassed portions of two broad terraces. The upper terrace, at an elevation of 120 ft amsl, occupied the northern half of Area J, and sloped gently upwards from the baseline. The lower terrace had an elevation of 80 ft amsl, and included the entire southern half of Area J, south of the Disassembly Compound. The lower terrace landform sloped down to the southwest. The northern half of Area J was cut by several small drainages and a small unnamed stream that was located on the western boundary of the area. Area J was bounded on the west by Marshall Road and Areas G and I, and on the east by Howard Road and Areas L-2 and L-3. Archer Avenue formed the northern boundary of the survey area and Howard Road formed its southern limit.

Area J functioned primarily as a wooded buffer around the Munitions Disassembly Complex. The vegetation consisted of mixed hardwood forest with some areas of primary regrowth. Tree species were identical to those found in the surrounding survey areas and included beech, oak, maple, holly, as well as pine in the regrowth. Undergrowth in Area J generally was light except in the regrowth where dense patches of green briar, mountain laurel, and other low plants were encountered. Area J contained two grassy areas, one around the fenced compound and the second was the cleared and graded magnetic-free field at the southern end of the area.

The soils for Area J were mapped entirely as Beltsville silt loam (Hall and Matthews 1974). During the Phase I survey a general uniformity of soil color and texture was noted except in disturbed areas and where erosion had deflated the soils. A representative soil profile from Area J consisted of: a 0-14 cmbs dark grayish brown (10YR 4/2) silt loam; a 14-26 cmbs light yellowish brown (2.5Y 6/4) silt loam; and, a 26-37 cmbs brownish-yellow (10YR 6/6) heavy silt loam. This

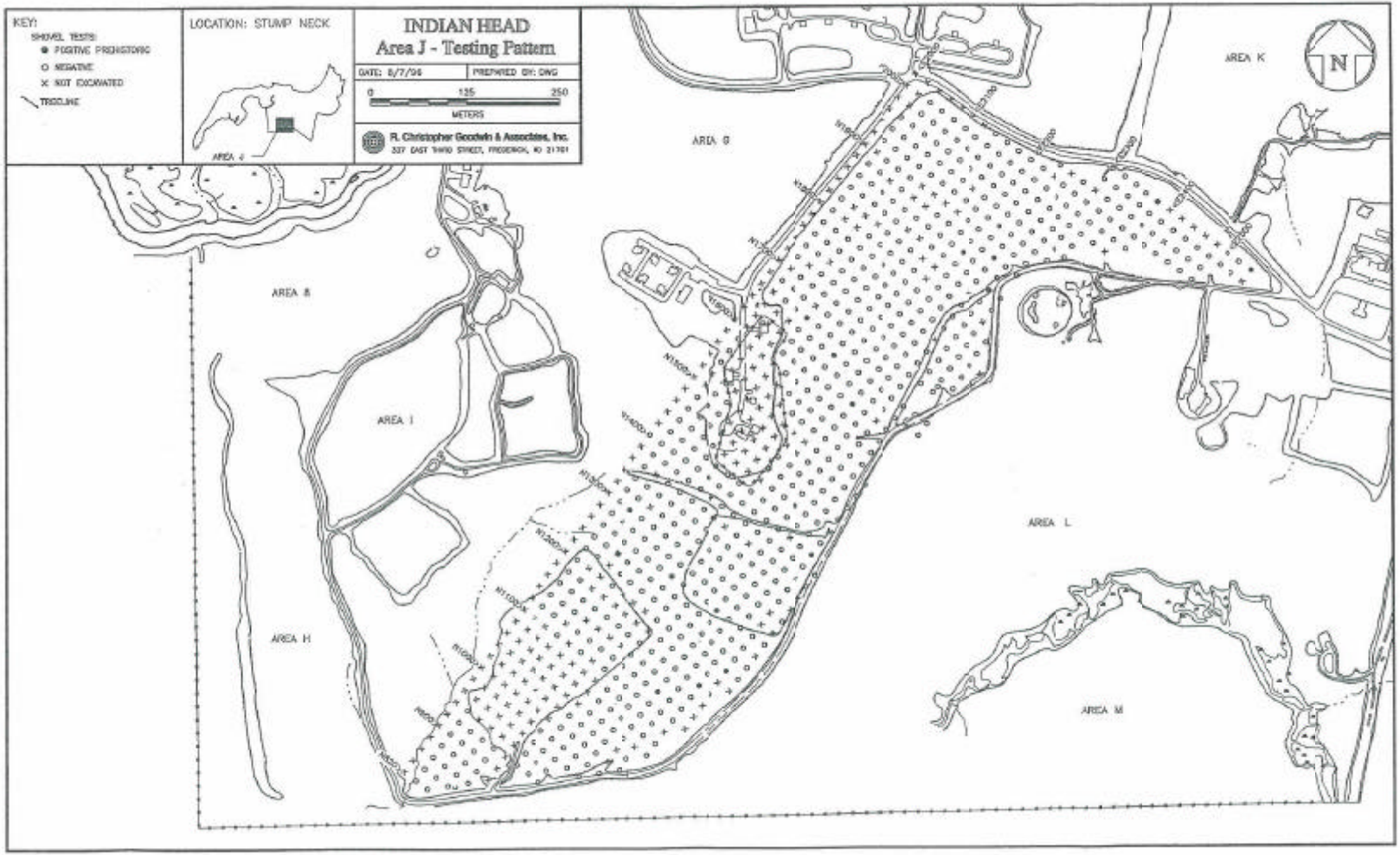

Figure 49. Map of Area J, showing shovel test pattern and site boundaries

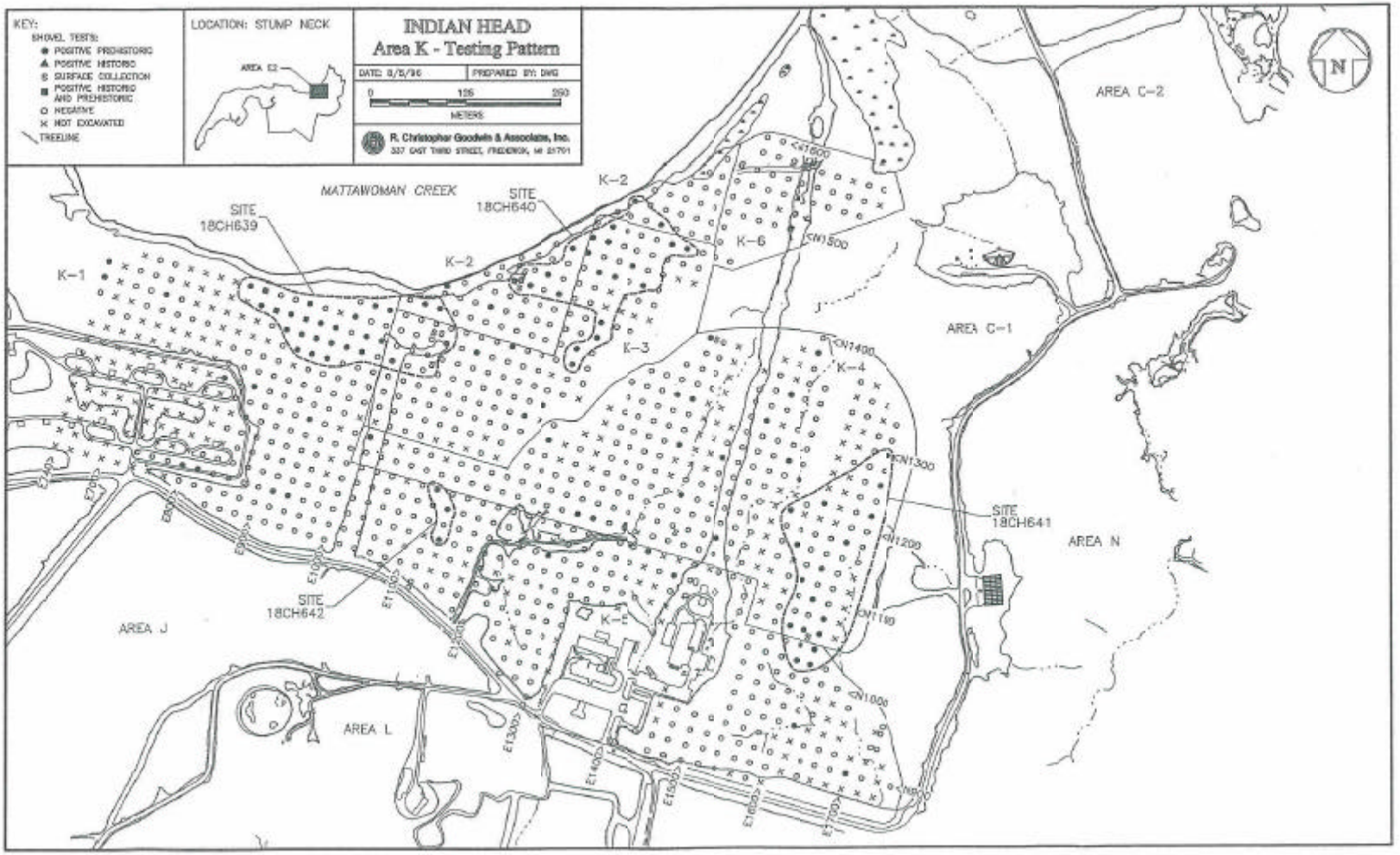

Figure 50. Map of Area K, showing shovel test pattern and site boundaries

profile corresponded generally to that of Beltsville silt loam mapped by the Soil Conservation Service for this area (Hall and Matthews 1974).

Disturbance in Area J was moderate and almost entirely a result of military activities. Human disturbances in Area J were concentrated principally in two areas. The first was the fenced bunker compound and surrounding cleared buffer zone associated with the Munitions Disassembly Complex. The second was a large open field that was graded for military use. Other disturbances observed were large pushpiles along Howard Road and around the edge of the cleared field and a series of abandoned logging roads in the central part of Area J.

The datum for Area J (N2000/E2000), the same as that for Areas G and I, was located southeast of the intersection of Archer Avenue and Marshall Road. The baseline was set on a bearing of 225° (magnetic north), and extended south to transect N820/E2000. The sixty-four transects were placed at 20 m (65.6 ft) intervals on a bearing of 135°. A total of 666 shovel tests were excavated within Area J. Another 197 planned shovel tests were not dug because of surface disturbance or slopes greater than 10°.

No sites were identified in the area and only 18 artifacts were recovered from 16 isolated shovel tests. The artifacts were all prehistoric and included 1 small quartz triangle point/knife (Figure 47; FS #506), 1 large square quartz basal blade fragment, 1 disc-shaped utilized primary quartzite flake, 2 utilized secondary flakes, 2 utilized non-cortical flakes, 1 tested cobble, 1 core fragment, 2 fire-cracked rock, 5 unmodified secondary flakes, and 1 each of unmodified non-cortical and primary flakes.

Area K

Area K encompassed 166.7 acres north of Archer Road surrounding the Quarterdeck (Figure 50). The area in the immediate vicinity of the Quarterdeck was not surveyed due to modern construction and asphalt parking lots. Area K was subdivided into Areas K-1 through K-6. The subdivisions within the area were based primarily on constraints imposed by the landform, but also

on human disturbance. The entire area was placed on the same 20 m grid based on a datum located in Area K-1.

The boundaries of Area K were defined as Archer Road and the property line on the south, Mattawoman Creek on the north, and a deep drainage forming the western boundary of Areas N and C-2 on the east. The western boundary was the steep drainage that formed the eastern boundary of Area F and the Main Magazine compound located just north of Archer Road. Shorelines along Mattawoman Creek form a high, steep escarpment exhibiting active erosion, but slope more gradually on the finger ridge at the far eastern end of Area K-6. Erosion was observed along the drainage on the eastern boundary of the area as well as along some of the smaller drainages in the northeastern part of the area. The topography of Area K was very similar to that of Area F but with more drainages and finger ridges.

Soils of Area K belong to the Beltsville-Exum-Wickam soil association. The areas surveyed were mapped predominantly as Beltsville silt loam with a small area of Exum silt loam in Areas K-4 and K-5 (Hall and Matthews 1974). The shoreline of the Mattawoman and all of the drainages were mapped as steep gravelly land. No other areas were mapped as extensively eroded.

The vegetation in Area K was fairly uniform with only a few variations. The majority of the area was open growth, mature forest with tree diameters up to 70 cm. Tree species included chestnut oak, white oak, beech, mature holly trees, maple, and sweetgum, with minimal undergrowth of small holly, mountain laurel, and green briar. An area of regrowth in Areas K-4 and K-5 contained dense patches of mountain laurel, green briar and blackberry, as well as large tree stumps and small saplings. Wildlife viewing areas were present in Areas K-1 and K-4; these areas consisted of plowed grass fields approximately 20 m wide and 240-300 m long.

Area K is currently maintained as a woodlot and hunting preserve, with the exception of the Quarterdeck and its associated buildings. A large water tower was located immediately north of Archer Road within Area K-5.

Phase I survey of Area K identified four prehistoric sites, one of which contained a small historic component. Testing did not relocate Site 18CH393, a prehistoric site located in the northern

portion of Area K-6 (Stevens et al. 1995). The site was identified on the basis of a single positive shovel test placed on a terrace approximately 40-50 ft asml. The location of Site 18CH149 also was not confirmed; it is likely that this site was under a beaver pond in the approximate location of the site as mapped at the Maryland Historical Trust.

Area K-1

Area K-1 was located at the western end of Area K. It was bounded on the north by Mattawoman Creek, on the south by Archer Road and on the west by Area F and the main magazine compound. The eastern boundary, which also formed the baseline, was one of the two wildlife viewing areas that extend from Archer Road north to Mattawoman Creek.

The datum (N1000/E1000) was established 10 m west of Telephone Pole 3183, just north of Archer Road. The baseline extended north up the center of the field at a bearing of 25° (magnetic north); 16 transects extended from the baseline at a bearing of 295°. A total of 158 shovel tests were placed in Area K-1 and an additional 37 shovel tests were not excavated because of modern surface disturbance, standing water, or slopes greater than 10 per cent.

Little disturbance was observed in Area K-1 except for erosion along the two steep drainages that bisect the northwestern portion of the area. A series of intersecting road traces or ditches, possibly dating from the Civil War, were located in the vicinity of Shovel Test N1240/E940.

With the exception of the grass wildlife field, Area K-1 was characterized by mature growth forest. The predominant species in the area included white oak, beech, maple, holly, and sweetgum, with occasional pines. Undergrowth generally was minimal and consisted of mountain laurel and green briar.

A representative soil profile from Area K-1 consisted of: a 0-13 cmbs dark grayish brown (10YR 4/2) silt loam; a 13-23 cmbs light yellowish brown (2.5Y 6/4) silt loam; and, a 23-35 cmbs light yellowish brown (10YR 6/4) silty clay. This profile is consistent with the Beltsville soils (Hall and Matthews 1974).

Phase I survey identified one prehistoric site with a small historic component and 10 isolated finds. Site 18CH639 extended into Areas K-2 and K-3. The isolated finds included 1 projectile point, 6 flakes, 1 core, 2 pieces of block shatter, and 2 pieces of fire-cracked rock. The quartz point had small shoulders, a wide stem, and a flat base (Figure 51 - top; FS #712). The morphology of this point is similar to the Early to Middle Woodland period Calvert type (Stephenson et al. 1963).

Site 18CH639. Site 18CH639 was a Late Woodland site measuring 80 x 260 m (262.5 x 853 ft) that was located on the high bluff above Mattawoman Creek (Figure 50). Prehistoric artifacts were recovered from 27 shovel tests, three of which contained mixed historic and prehistoric artifacts. Areas K-2 and K-3 each contained two of these positive shovel tests. Two surface finds also were made in Area K-3. A total of 70 prehistoric artifacts were recovered from the site, 57.97 per cent of which were unmodified flakes. In total, 63.77 per cent of the artifacts recovered were debitage. The remaining assemblage included 1 projectile point, 1 point tip, 2 biface fragments, 1 blade, 2 cores, 1 retouched flake, 3 sherds, and 16 pieces of fire-cracked rock. Three ceramic fragments were all Potomac Creek with sand temper. One of the sherds was cord marked. The side-notched quartz point was crudely flaked and mostly unifacial. Its overall morphology is similar to the Middle/Late Archaic Halifax type (Coe 1963; Hranicky 1991)(Figure 51 - top; FS #488). Artifacts were recovered, with only one exception, from the upper two stratigraphic levels. Slightly more (n=36) artifacts were recovered from 0-15 cmbs, than from the second level (n=29) from 15-30 cmbs. No artifacts were excavated from depths greater than 40 cmbs. While the artifacts were all recovered from relatively shallow depths, the area did not appear to have been disturbed recently, except in the wildlife area. Soils profiles were consistent across most of the site. Therefore, it is possible that the site contains intact, if shallow, deposits.

The four historic artifacts were concentrated at the end of a small finger ridge bounded by one of the two steep drainages in the western part of the area, and by Mattawoman Creek. The four artifacts were 1 English gunflint flake, 1 redware sherd with dark brown or black glaze, 1 undecorated whiteware handle sherd, and 1 unidentified nail. The only temporally diagnostic artifact indicates a date range from the second quarter of the nineteenth century through the twentieth. The

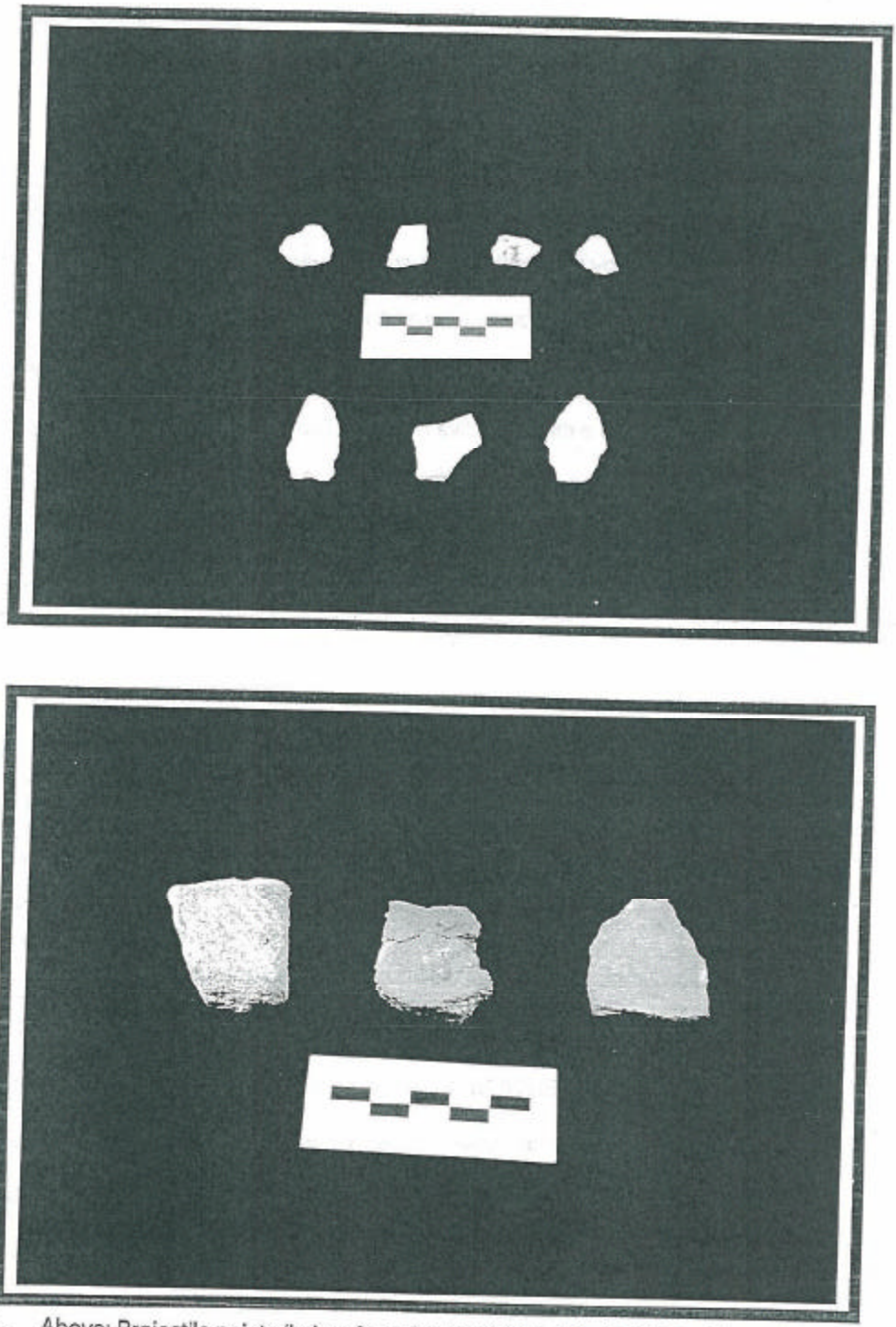

Figure 51. Above: Projectile points/knives from Site 18CH639, Site 18CH640, Site 18CH641, and non-site from Area K-1. (Clock-wise from upper left) [a] FS# 386; [b] FS# 433; [c] FS# 446; [d] FS# 480; [e] FS# 712; [f] FS# 498;[g] FS# 488
Bottom: Selected prehistoric ceramics from Site 18CH641. (L-R) [a] FS# 470; [b] FS# 437; [c] FS# 438

English flint was indicative of an earlier date. The historic component of Site 18CH639 may represent an isolated homestead or a more ephemeral event.

Area K-2

Area K-2 was located within mature growth forest along Mattawoman Creek. It was bounded to the north by the creek, to the south by Area K-3, to the west by Area K-1, and to the east by Area K-6. Area K-2 covered the shoreline side of a large relatively flat finger ridge that reached northeast towards Rum Point. The bluff overlooking Mattawoman Creek was approximately 18.29 m (60 ft) high and exhibited active erosion. The only other disturbance was a two-track that ran through the area parallel to the cliff.

Area K-2 was forested with mature growth trees and had minimal undergrowth as did most of Area K. Dominant species included beech, white oak, large holly, maple, and sweetgum. The occasional undergrowth consisted of mountain laurel and greenbriar, but most of the land was free of low ground cover.

A typical soil profile for Area K-2 consisted of: a 0-13 cmbs dark grayish brown (2.5Y 4/2) silt loam; a 13-35 cmbs pale yellow (2.5Y 7/4) silt loam; and, a 35-50 cmbs brownish yellow (10YR 6/6)clay loam. This profile corresponded to the Beltsville silt loam soils mapped for the landform (Hall and Matthews 1974).

To survey Area K-2, as well as K-3, a baseline was extended from Area K-1 Shovel Test N1300/E1000 east at a bearing of 295° (magnetic north) to Shovel Test N1300/E1220 where it extended north to N1480/E1220 at the edge of the bluff (Figure 50). The baseline then was extended east again as far as N1480/E1360 where it ended at the boundary with Area K-6. Transects were extended off the baseline at 25° on a 20 m grid. Area K-2 began 20 m north of the baseline because it was tested as part of Area K-3. A total of 68 shovel tests were excavated in Area K-2.

Portions of two sites and two isolated finds were identified during Phase IB survey of Area K-2. Area K-2 contained two positive prehistoric shovel tests from the northeast corner of Site

18CH639. The three artifacts recovered from these shovel tests, 2 flakes and 1 fire-cracked rock; were included in the discussion of Site 18CH639 in the Area K-1 description. Area K-2 also contained 6 prehistoric shovel tests, 1 mixed historic and prehistoric shovel test, and 3 surface finds from the western and northern edges of Site 18CH640. Site 18CH640 is discussed in detail below; the 16 artifacts from this site in Area K-2 included 11 flakes, 1 biface, 1 bipolar core fragment, 2 fire-cracked rock, and 1 machine cut nail. The two isolated positive shovel tests contained 1 fire-cracked rock, and 1 utilized flake. There was little evidence of any disturbance in the area except along the two-track at the edge of the cliff.

Area K-3

Area K-3 was located on the southern half of a long, relatively flat finger ridge bordering Mattawoman Creek and extending northeast towards Rum Point. The landform was categorized as moderate to high probability for the presence of cultural resources by Milner & Associates (1995). Area K-3 was bounded to the north by Area K-2, to the south by Area K-4 and a large drainage, to the east by Area K-6, and to the west by Area K-1. The drainage that formed the southern boundary began as a shallow swampy depression near the intersection of Areas K-1, K-3, and K-4, and gradually became, first, a small stream, and, then, a steep drainage emptying into the Mattawoman.

Vegetation in Area K-3 did not differ markedly from that of Area K-2. The forest consisted of mature growth with little ground cover except in isolated areas. Dominant tree species included white oak, beech, red maple, red oak, holly up to 20 cm (7.87 in) in diameter, and some pine. Undergrowth, when present, consisted of mountain laurel and green briar. The large hardwoods had diameters up to 60 cm (23.62 in) or greater.

The datum for Area K-3 was the same as that for Area K-2, and was situated at N1300/E1020, based on the grid set up for Area K-1. Transects extended off the baseline at a bearing of 205°, on a 20 m grid. The baseline itself and the northern control line were both tested as part of Area K-3. A total of 126 shovel tests were excavated, but 16 planned tests were not dug

due to slopes greater than 15 per cent or surface disturbance, primarily wet ground near the drainage (Figure 50).

The soils mapped for Area K-3 were Beltsville silt loam on the high ground and Exum silt loam around the drainage (Hall and Matthews 1974). Shovel testing revealed that a typical soil profile from near the drainage consisted of 9 cm of dark grayish brown (10YR 4/2) loam; 17 cm of yellowish brown (10YR 5/6) silt loam; and 14 cm of strong brown (7.5YR 5/6) clay loam. A typical profile on the finger ridge included 10 cm of dark grayish brown (2.5Y 4/2) silt loam; 8 cm of pale yellow (2.5Y 7/4) silt loam; and 14 cm of light yellowish brown (10YR 6/4) clay silt. These profiles generally correspond to a shallow Ap or A, B1, and B2 horizons of the Exum and Beltsville series.

Area K-3 contained portions of two large sites that overlap other portions of Area K. The majority of Site 18CH640 is located in Area K-3, as are two shovel tests and three surface finds from Site 18CH639. Area K-3 shovel tests also produced five isolated artifacts. The non-site artifacts included 2 quartz flakes, and 2 fire-cracked rock (Figure 51- top; FS #488).

Site 18CH639 artifacts from Area K-3 included 2 core fragments, 2 quartz flakes, 1 fire-cracked rock, and a quartz preform square base. These artifacts were included in the Site 18CH639 discussion above (Area K-1).

Site 18CH640. Site 18CH640 extended across the width of the finger ridge on which Areas K-2 and K-3 are located (Figure 50). The entire site measured approximately 100 x 140 m (328 x 459.3 ft). Only one historic artifact, a machine cut nail, was recovered during testing. The prehistoric assemblage was represented by 35 artifacts from 21 shovel tests and three surface finds. There were no ceramic sherds recovered from the site; this may indicate a pre-Woodland occupation. However, since no temporally diagnostic artifacts were identified, this can not be confirmed.

Debitage formed the largest artifact class with 54.29 per cent of the artifacts (n = 19), 15 of which were unmodified quartz and quartzite flakes. The remaining debitage included two utilized flakes, one quartz and one quartzite, and two quartzite block/shatter. The next largest artifact group was fire-cracked rock, of which there were 13 fragments (including 1 chert, 1 quartz, 8 quartzite, and

3 silicified sandstone). Other artifacts included the midsection of a quartzite point or knife, a silicified sand stone hammerstone, and a quartzite core fragment. The presence of fire-cracked rock, and the diversity and quantity of artifacts suggests that the site represents an encampment or series of encampments.

The A or Ap horizons produced 12 artifacts, the B1 horizon 16 artifacts, and the B2 horizon 3 artifacts. Since the majority of the artifacts originated below the plowzone, it appears that the site retains a high degree of integrity. In addition, despite the lack of diagnostic items, the density and diversity of artifacts suggest that the site has the potential to address research issues related to spatial distribution of activities and lithic reduction. As a result, Site 18CH640 warrants Phase II evaluation.

Area K-4

Area K-4 occupied a series of three finger ridges extending north into a large tributary of Mattawoman Creek that forms the southern boundary of Area K-3. Area K-4 also included a narrow section on the south side of the swampy ground near Area K-1. The topography was relatively level, with the ridges sloping gently down towards the north. The slope down into the deep drainage that forms the eastern boundary of the area was very steep and exhibited evidence of active erosion. The slopes at the northern end of the ridges were not as steep in most places. The southern boundary of the area was the shared baseline between Areas K-4 and K-5, and Area K-1 bordered Area K-4 on the west.

The vegetation in Area K-4 primarily comprised mature growth forest, as in the other areas. Area K-4 also contained a wildlife viewing field that stretched from the baseline almost as far as the end of the middle finger ridge. This grassy field was approximately 20 m wide. The other area of varied vegetation was a patch regrowth located between transects E1220 and E1460, and extending 20-40 m north of the baseline. The regrowth was composed of small beech and other hardwood saplings, dense mountain laurel, holly trees and bushes, greenbriar, blackberry, and devil's walkingstick.

There were three areas of disturbance in Area K-4. The first was the low wet ground between Areas K-3 and K-4; this zone was only partially tested due to standing water. The regrowth area contained a number of tree falls, push piles and disturbance from a small stream bed and a two-track. The wildlife viewing area had been plowed at one time and exhibited several large patches of fill.

The datum for Areas K-4 and K-5 was Shovel Test N1100/E1020 (based on the K-1 grid). The baseline extended at a bearing of 115° (magnetic north) to Transect E1540 where it turned 90° south down to Shovel Test N1040/E1540. From this point, it again extended east to shovel test N1040/E1640. Transects were placed on a 20 m grid at a bearing of 25°. The baseline and the jog to the south were tested as part of Area K-5; as a result, Area K-4 began 20 m north of the baseline. A total of 225 shovel tests were excavated in this area; 68 planned shovel tests were left unexcavated because of surface disturbance or slopes greater than 10° (Figure 50).

As with Area K-3, the soils in the western part of Area K-4 were mapped as Exum silt loam and those on the finger ridges as Beltsville silt loam (Hall and Matthews 1974). Much of the soil in the swampy area was severely waterlogged. Shovel tests indicated that a representative profile in the drier areas consisted of 14 cm of dark grayish brown (10YR 4/2) silt loam, 5 cm of brown (10YR 5/3) silt loam, and 11 cm of strong brown (7.5YR 5/6) clay loam. On the ridges, a typical soil profile exhibited 12 cm of grayish brown (2.5Y 5/2) silt loam, 9 cm of pale yellow (2.5Y 7/4) loamy silt, and 12 cm of light yellowish brown (2.5Y 6/4) clay silt. These profiles generally resemble the Ap, B1, and B2 horizons of the Exum and the Beltsville series, respectively.

One prehistoric site (18CH641) and 17 isolated finds were documented during the survey. These isolated shovel tests included 23 prehistoric artifacts, none of which were diagnostic. They included: 17 flakes, 3 of which were utilized; 2 fire-cracked rock and 2 core fragments; 1 block/shatter; and the midsection from an unidentified point/knife. The dominant material among these artifacts was quartzite.

Site 18CH641. Site 18CH641 was a Late Woodland site located on the eastern-most finger ridge in Area K-4, adjacent to the deep drainage that separates the area from Area N (Figure 50).

The site extends 40 m south into Area K-5, where an additional four positive shovel tests were encountered. The site measured approximately 60 x 280 m (196.8 x 918.2 ft), and was defined by 18 positive shovel tests and one surface find. A total of 33 artifacts were recovered, 20 of which were clustered at the southern end of the site. The remaining artifacts were scattered along the length of the ridge.

Ten of the artifacts were ceramic sherds. These sherds included 9 Potomac Creek coarse sand tempered body sherds, and 1 unidentified coarse sand tempered sherd (Figure 51- bottom). Seven of the Potomac Creek sherds were decorated; six were burnished and one had S-twist cord-marking. The non-diagnostic artifacts included 17 unmodified flakes, primarily quartz; 3 block/shatter; 1 fire-cracked rock; 1 quartz point/knife tip; and 1 quartz point/knife midsection (Figure 51 - top; FS #433, 480). The presence of fire-cracked rock and sherds suggests that the site represents an encampment.

A majority of the artifacts (n=24) were recovered from the Ao or Ap horizons, including most of the artifacts from the small concentration at the south end of the site. Of the remaining artifacts, four came from the surface, and five from the B1 horizon. The soils around the site exhibited evidence of natural deflation and erosion, especially near the edge of the ridge. Historic plowing and erosion appear to have negatively impacted a substantial portion of the site's integrity. However, the presence of some artifacts below the A horizon, and the quantity and diversity of artifacts suggest that enough integrity and research potential may persist to permit isolation of discrete activity areas. As a result, Phase II evaluation appears warranted.

Area K-5

Area K-5 was located immediately north of Archer Road and around the Quarterdeck. The landform sloped upward towards the road that ran west of the Quarterdeck, and it was cut by two small drainages leading into a larger ravine to the north (Figure 50). East of the Quarterdeck, the ground levelled out to form part of the same series of ridges as in Area K-4. Areas K-1 and K-4

formed boundaries to the west and north; Archer Road and the base property line were the southern boundary; and the deep drainage adjacent to Area N was the eastern limit of the area.

Area K-5 had very similar vegetation to that found in Area K-4. Mature growth forest covered most of the area, except for a large patch of regrowth west of the Quarterdeck. The regrowth extended from Transect E1200 to E1300, and from the baseline to Archer Road. It contained thickets of mountain laurel, holly, greenbriar, and brambles, as well as hardwood saplings and tree stumps.

There were several areas of modern surface disturbance in Area K-5; the largest of these was the Quarterdeck. A large cleared and graded area surrounded the Quarterdeck complex; this area was not tested. The open and cleared ground around the water tower north of Archer Road was not tested for the same reason. Large push piles and mixed soils in portions of regrowth also demonstrated significant disturbance.

In 1995 Louis Berger & Associates conducted a small Phase I survey on the proposed location of the new Indian Head Pass Office. The survey located a small prehistoric site (18CH486), which was identified by eight positive shovel tests containing nine artifacts, none of which were diagnostic. The site was not considered eligible for inclusion in the National Register of Historic Places, and no further work was recommended (Busby 1995). This site was mapped as lying within the boundaries of Area K-5.

The baseline for Area K-5 was shared with Area K-4. The datum for the two areas was Shovel Test N1100/E1020 on the Area K-1 grid. The baseline extended east to Transect E1540, where it was staggered south and then east again to ensure that all of the large finger ridge was included. Transects were extended off the baseline at a bearing of 205°, on a 20 m grid. A total of 213 shovel tests were excavated, but 50 planned tests were not excavated due to slopes greater than 15 per cent or visible surface disturbances.

Soils for Area K-5 were mapped as primarily Beltsville silt loam, with a very small area of Exum silt loam in the northwestern corner of the area (Hall and Matthews 1974). Shovel testing indicated that a representative soil profile from Area K-5 consisted of 15 cm of dark grayish brown

(10YR 4/2) silt loam, 22 cm of light yellowish brown (2.5Y 6/4) silt loam, and 10 cm of yellowish brown (10YR 5/6) silty clay. This profile corresponded generally with Beltsville Ap, B1, and B2 horizons.

Phase I survey indicated that Area A-5 encompassed one small prehistoric site (18CH642), and the southern end of Site 18CH641 (discussed above in Area K-4). In addition, there were five isolated positive shovel tests. During the current survey, the location of Site 18CH486 (Busby 1995) was tested again, but no further artifacts were recovered. The isolated positive shovel tests contained 3 fire-cracked rock, 3 flakes, and 1 quartzite biface.

Site 18CH642. Site 18CH642 was found to comprise a small concentration of prehistoric artifacts located on a gentle slope leading up to the ridgetop on which the Quarterdeck is situated. Site 18CH642 was defined by three positive prehistoric shovel tests in an area measuring 20 x 60 m (65.6 x 262.6 ft). The shovel tests contained 1 quartzite core fragment, 1 non-cortical quartzite flake, and 1 non-cortical quartz flake. The presence of only a core and two flakes suggests that the site may represent a brief episode of lithic reduction.

Two of the artifacts came from the Ap horizon and one from the surface. This context suggests that the site retains little integrity. In addition, the absence of diagnostic artifacts, and the low density and variety of cultural materials imply that the site has little potential to address significant research issues. As a result, no further work appears to be warranted.

Area K-6

Area K-6 was located at the northern tip of the same long finger ridge that lies within Areas K-2 and K-3 (Figure 50). The ridge was relatively level, but sloped steeply down to the Mattawoman Creek, and to a deep, unnamed drainage. At the northern tip of the ridge there was a small terrace 3-4.6 m (10-15 ft) below the ridge top. Mattawoman Creek formed the northern area boundary, and the unnamed drainage formed the southern and eastern boundaries. The western boundary of the area was the Transect E1360 line, at the eastern edge of Areas K-2 and K-3.

Vegetation in Area K-6 was identical to that of the surrounding areas. The finger ridge was forested with high canopy mixed hardwood forest; there was minimal undergrowth, except in slightly disturbed areas. Dominant tree species included oak, beech, holly, and maple. The undergrowth consisted of a concentration of maple saplings at the southern edge of the area, and green briar and other low plants scattered across the area.

There was very little disturbance in Area K-6, except for erosion along the steep side slopes to the drainages. An old two-track road ran along the edge of the ridge and created minor disturbance.

Two previously identified sites were situated within the K-6 survey area. One site (18CH149) was recorded in 1977 by Wilke and Thompson, and consisted of a small prehistoric site with no diagnostics located on a bench at 20 ft amsl (Stevens et al. 1995:6). During Phase I testing by Milner & Associates, three sherds of Popes Creek Net Impressed pottery and one possible Piscataway point/knife base were recovered, indicating a Middle Woodland association (Stevens et al. 1995:46). The other site (18CH393) was identified on the terrace below the ridgetop. This site consisted of two quartzite flakes from a single shovel test.

The baseline for Area K-6 was set as the E1360 line; this line had been tested as part of Areas K-2 and K-3. Seven transects extended east on a bearing of 115° from this transect, and an additional 2 transects were excavated north of the line. A total of 41 shovel tests were excavated; 3 planned tests were not excavated because of slope or surface disturbance.

The soils mapped for Area K-6 are the same as for Areas K-2 and K-3 and belong to the Beltsville silt loam soil association (Hall and Matthews 1974). Testing revealed that a typical soil profile from Area K-6 consisted of 8 cm of grayish brown (2.5Y 5/2) silt loam, 12 cm of light yellowish brown (10YR 6/4) silt loam, and 11 cm of brownish yellow (10YR 6/6) clay silt loam. This profile is consistent with the A or shallow Ap, B1, and B2 horizons of the Beltsville series.

Only one positive shovel test was encountered in Area K-6, and it contained a single historic sherd of trailed slipware with a clear glaze. During the current field work, the small terrace on which Site 18CH149 was situated was found to have been inundated by recent beaver activities. In

addition, no trace was found of Site 18CH393; perhaps this site, with its two flakes in one shovel test, reflected nothing more than a single, isolated episode of behavior.

Area L

Area L was located in the southeastern corner of the base on a series of finger ridges, cut by four drainages, sloping down in a semi-circle to the east, south, and west towards a large beaver pond and un-named stream. The area was bounded on the west and north by Howard Road, as well as Archer Avenue on the north. The eastern limit was the property boundary, and to the south, Area L ended at the beaver pond and stream around Area M. In order to test the landform completely, the area was subdivided into three separate survey units. Area L-1 occupied the eastern third of the area, and Area L-2 the western third. Area L-3 was located along the northern boundary, between L-1 and L-2. In total, Area L covered 112.1 acres of low, medium, and high probability land as defined by Milner & Associates in their 1995 study.

Most of Area L is currently used as a woodlot and wildlife viewing area, but there are several large sections of disturbance from military activities. Area L-1 contains the wildlife area and a long narrow strip of cleared and disturbed land that forms a buffer along the property boundary. Area L-2 is relatively undisturbed except for the fenced radio tower area in the northwest corner. Area L-3 is the most disturbed, and most of the eastern half of the area was not tested because of buildings, construction, and disturbed soils.

Phase I survey in Area L identified one small prehistoric site and one small early historic site, possibly from the Contact Period. These findings are discussed below.

Area L-1

Area L-1 covered a small finger ridge sloping south towards the beaver pond and the western gentle slope of another ridge that lay almost entirely outside of the base. Area L-1 also covered a narrow 360 m long strip of cleared land between the property fence and the stream. This strip was in a shallow depression between the ridge in Area M to the west and the ridges outside

the base to the east. The boundary between Areas L-1 and L-3 was a steep drainage that began just south of Archer Avenue and the Quarterdeck.

The vegetation in Area L-1 was varied. The small finger ridge in the northern half of the area was covered by dense regrowth of pine and hardwood saplings mixed with green briar, vines, and bushes. To the south, the forest consisted of open mature mixed hardwoods with little undergrowth. The trees included oak, beech, maple, with some holly and sweet gum. In the low land around the pond there were tall paw paw plants. Along the entire length of Area L-1, from the datum south to the property corner, there was a 20 m wide strip of cleared land covered by tall grasses and saplings.

Area L-1 had several areas of surface disturbance, primarily the result of military activities. The easement along the property boundary was disturbed severely by the clearing process and at the edge of the woods there were large push piles. Along the edge of the stream between Transects N1440 and N1360 there were push piles as well as many fallen logs from beaver activity. In the center of L-1, a picnic clearing associated with the wildlife viewing area also was highly disturbed by push piles, gravel, and other evidence for grading.

The datum (N2000/E1000) for Area L-1 was placed 6 m south of the telephone pole at the southeast corner of the intersection between the gravel access road to the wildlife viewing area and Archer Road, just outside the main gate to the base. The baseline extended for 900 m along the eastern edge of the easement, at a bearing of 200°. A total of 46 transects were laid at a 20 m (65.6 ft) interval, with shovel tests excavated at the same interval along a bearing of 290°. A total of 157 shovel tests were excavated. Several shovel tests were not excavated because of slope into the drainages (Figure 52).

The soils mapped for Area L-1 included Beltsville silt loam, Exum silt loam and Aura gravelly sandy loam (Hall and Matthews 1974). On higher ground, the shovel testing indicated that soils corresponded to the Beltsville series, but there was little evidence of the Exum soils. A representative soil profile from Area L-1 consisted of 18 cm of grayish brown (2.5Y 5/2) silt loam; 12 cm of light yellowish brown (10YR 6/4) silt loam; and 10 cm of yellowish brown (10YR 5/6)

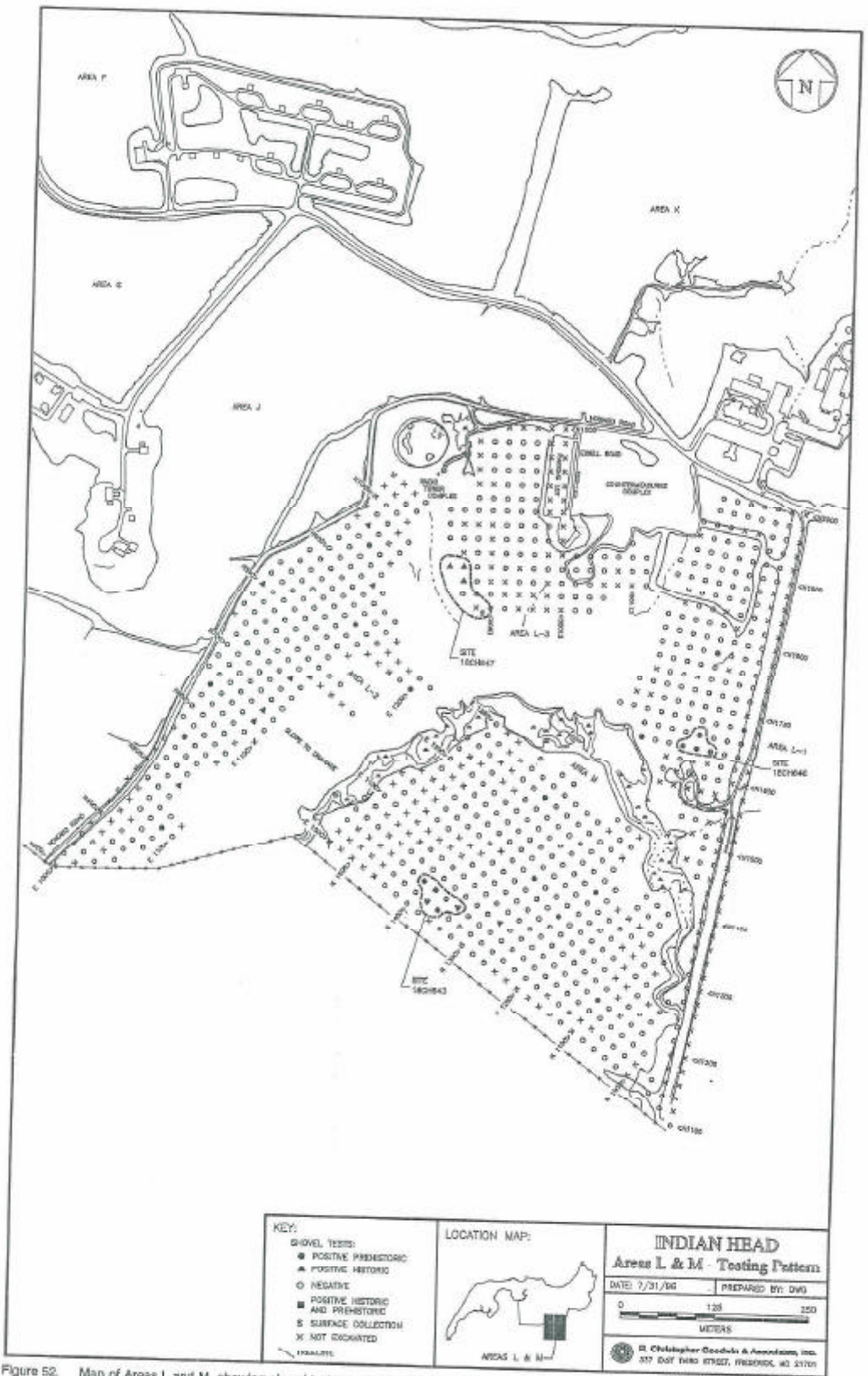

Figure 52. Map of Areas L and M, showing shovel test pattern and site boundaries

clayey silt. These strata probably correspond to Ap, B1, and B2 horizons. Shovel testing revealed that the soils south of Transect N1560 were disturbed, and those along the stream were waterlogged.

Shovel testing identified one small prehistoric site with no temporal affiliation, and three isolated positive shovel tests. These three shovel tests each contained 1 artifact, which included 2 unmodified quartzite secondary flakes and 1 unmodified quartzite non-cortical flake.

Site 18CH646 is a prehistoric site located near the center of Area L-1, in mature mixed hardwood forest on the gentle slope of the eastern finger ridge. The site measured 20 x 40 m (65.6 x 131.2 ft) and was identified through four positive shovel tests, yielding five prehistoric artifacts. No diagnostic artifacts were recovered so the site cannot be assigned to any specific period. The five artifacts included 1 silicified sandstone hammerstone, 1 quartzite disc core with a medial break, and 1 quartz and 2 quartzite unmodified secondary flakes. This artifact assemblage suggests that earlier stage lithic reduction activities occurred at the site.

All but one of the artifacts were recovered from the B1 horizon. This context suggests that the site may not have been disturbed extensively by plowing. The absence of fire-cracked rock suggests that the site may reflect a brief lithic reduction episode, and not even a short-term encampment. The absence of diagnostic artifacts is probably a factor of the earlier stage reduction prevalent at the site, and further testing probably will not reveal such items. As a result of these considerations, despite the possible integrity, the site appears lack to density and diversity of artifacts sufficient to address significant research issues. Therefore, no further work appears to be warranted.

Area L-2

Area L-2 covered the western third of Area L and occupied the southeastern half of the large level finger ridge that begins in Area J. The northern and western boundary of Area L-2 was Howard Road. The eastern limit was a shallow drainage between Areas L-2 and L-3. To the southeast, the area ended in a slope to the unnamed stream and beaver pond. The base property

line formed the southern boundary. Area L-2 was relatively flat, except at the southern end where the ridge formed a finger and sloped off to the south.

Area L-2 was completely forested with mixed hardwoods and occasional pines. There was little undergrowth, except along the edge near Howard Road and towards the bottom of the slope. Dominant tree species included beech, maple, oak, holly, and pine. Undergrowth consisted of green briar, hardwood saplings, and paw paw.

Area L-2 was the least disturbed of the three subdivisions. The largest disturbances came from the fenced radio towers and Howard Road. Because the road curved, several of the shovel tests fell in the middle of the road or in the push piles along the edge. At the southern end, a dirt two track road also caused some disturbance, as did several old road traces along the top of the ridge. Except for in four cases, testing stopped at the top of a steep slope to the east. Slope also prevented testing at the southern end of Area L-2, where the ridge narrowed to form a finger.

The datum (N1000/E1000) was established at the northwest corner of the fence around the radio towers, approximately 3 m from Howard Road. The baseline was set on a bearing of 227°, and the 38 transects were extended off the baseline at 313/137°. At total of 186 shovel tests were excavated and an additional 46 planned tests were not dug because of the various disturbances (Figure 52).

As in Area J, the soils of Area L-2 were mapped as Beltsville silt loam (Hall and Matthews 1974). The shovel tests confirmed the presence of Beltsville soils in L-2, although the stratigraphy was somewhat varied. Many of the shovel tests contained the expected profile of 10 cm of grayish brown (2.5Y 5/2) silt loam; 21 cm of light yellowish brown (10YR 6/4) silt loam; and 10 cm of yellowish brown (10YR 5/6) heavy silt loam. These strata probably correspond to Ap, B1, and B2 horizons. Another common profile contained only two strata, a grayish brown (2.5Y 5/2) A horizon from 0-14 cmbs, followed by a B or C horizon of a more reddish brown clayey silt loam. At the top of the slope down to the pond, erosion was evident.

The survey did not identify any sites; a total of 16 artifacts were recovered from 14 dispersed shovel tests. Nine of the artifacts were historic; these included 1 undecorated pearlware

sherd, 1 undecorated and 1 blue hand-painted whiteware sherds, 1 decayed slipware sherd with a clear glaze, 3 dark green non-machine made bottle fragments, 1 lamp glass fragment, and 1 solarized polished pressed glass lid fragment. The prehistoric artifacts included 1 plain possible Potomac Creek Plain coarse sand temper sherd, 1 silicified sandstone hammerstone, 1 quartzite multi-directional core fragment, 1 quartz block/shatter, 1 quartz primary flake, 1 quartz secondary flake, and 1 quartz non-cortical flake. These scattered artifacts probably represent casual historic discard, and isolated single episodes of prehistoric behavior.

Area L-3

Area L-3 was the smallest of the three sub-areas, and was located on the southern half of two small finger ridges or terraces, cut by a drainage, overlooking the beaver pond. The area was bounded by Howard Road on the north and the pond on the south. The western and eastern boundaries were the drainages that marked the edges of Areas L-2 and L-1, respectively.

Area L-3 was the most highly disturbed of the three areas; as a result, 38 per cent of the planned shovel tests were not excavated. Most of the eastern half of L-3 was not tested due to the presence of the Countermeasures building and active construction. Limited testing near the building indicated that the soils were mixed. To the west, the Countermeasures parking lot and the fenced radio tower complex, as well as push piles and deep tracks left by very heavy wheeled vehicles, prevented many shovel tests. Further south, natural disturbances from the three drainages and the slope also limited testing.

The vegetation west of the buildings was open mature hardwood forest with minimal undergrowth. The trees were the same as those in Areas L-1 and L-2, with oak predominating. The buildings were surrounded by mown grass clearings and there was one 30 x 40 m grass clearing south of Building 2006.

Area L-3 was surveyed using a N1000/E1000 datum set at the southwest corner of the intersection of Howard Road and Eigell Road. The baseline followed a bearing of 193°, and the transects were extended on a bearing of 347/103°, at a 20 m interval. A total of 83 shovel tests

were excavated, but 50 planned shovel tests were not dug because of the numerous disturbances (Figure 52).

The soils on the flat upper part of the ridges corresponded to the Beltsville silt loam soils mapped for the area (Hall and Matthews 1974). A representative soil profile consisted of 10 cm of grayish brown (2.5Y 5/2) silt loam, 12 cm of light yellowish brown (10YR 6/4) silt loam, and 15 cm of brownish yellow (10YR 6/6) silt loam. These strata probably correspond to Ap, B1, and B2 horizons. Closer to the slope, the soils changed somewhat, becoming more red, probably as a result of erosion.

Site 18CH647. Site 18CH647 was an early historic and possible Contact Period site located on the edge of the western terrace in Area L-3; at the edge of the slope. The site was identified by three positive shovel tests and one surface find; it measured 50 x 60 m (164 x 196.8 ft). The site assemblage consisted of 12 artifacts (Table 11). These items included: 1 Potomac Creek sand temper, burnished red and black prehistoric body sherd; 5 plain white Delft tin enamelled sherds from a single bowl base; 1 imported gray stoneware sherd; 1 redware sherd with a dark brown or black interior glaze and exterior incising; 2 possibly burned clear glazed plain slipware sherds with a thick body; and 2 clear glazed plain slipware spalls.

The Delft bowl base indicates a mid-seventeenth through late eighteenth century date range for the site. The redware and slipware sherds are not diagnostic, but appear to be very early. The absence of creamware and pearlware suggests that the site predates the mid-eighteenth century. Ten of the sherds were recovered from the Beltsville B1 horizon. This context suggests that the site retains a high degree of integrity. Although the assemblage is small and lacks architectural remains, the site represents one of the few early historic sites to be identified during the current survey. In addition, the Late Woodland sherd with burnished decoration may indicate a late date in the prehistoric sequence. As a result, the site may present an opportunity to study Native American and European interaction. Because of this apparent integrity and research potential, more testing should be conducted at Site 18CH647 in order to evaluate its National Register eligibility.

TABLE 11. SITE 18CH647 - SUMMARY OF DIAGNOSTIC HISTORIC ARTIFACTS

Artifact	Count
Earthenware, tin enamelled, plain white Delft, bowl base	5
Stoneware, imported gray, unidentified	1
Slipware, plain with clear glaze, thick body, possibly burned	2
Slipware, plain with clear glaze, spall	2
Redware, dark brown/black interior glaze, exterior incising	1

Area M

Area M was located on a ridgetop in the southeastern corner of the base. The area was bounded on the northwest and southeast by an unnamed drainage and to the northeast by a large beaver pond. The southwestern boundary was the property line for the base. Area M encompassed 45.4 acres of mature forest. Dominant tree species included beech, white oak, maple, yellow poplar, holly, sweetgum, and occasional pines. There was almost no undergrowth except along the baseline where there were smaller trees and some bushes.

Disturbance in Area M was limited almost entirely to slopes at the edges of the area and in a small drainage on the top of the ridge. The baseline was laid in along an overgrown hunting road where there was some disturbance from push piles and logging. Area M was criss-crossed by several formal nature trails, but these did not appear to have any impact on the natural stratigraphy.

The datum for Area M (N1000/E1000) was established at the intersection of the base property line and the southern branch of the drainage. From here, the baseline extended northwest at a bearing of 317°; 28 transects extended from the baseline at a bearing of 47° on a 20 m grid. A total of 251 shovel tests were placed in Area M and 80 planned shovel tests were not excavated because of modern surface disturbances or slopes greater than 10° (Figure 52).

Soils in Area M belong to the Beltsville-Exum-Wickham association. The majority of the area was mapped as Beltsville silt loam, with a smaller area of Exum silt loam (Hall and Matthews 1974). Shovel tests indicated that the typical soil profile generally corresponded to the Beltsville series; the profile consisted of 7 cm of grayish brown (2.5Y 5/2) silt loam, 13 cm of very pale brown (10YR 7/4) silt loam; and 20 cm of brownish yellow (10YR 6/6) loamy clay. These strata probably correspond to the A, B1, and B2 horizons. In some cases, the A horizon appears to be a shallow Ap layer.

Shovel testing identified one small mixed Late Woodland and nineteenth century site (Site 18CH643), as well as six isolated finds. The isolated finds were primarily prehistoric but included

2 manufactured brick fragments. The prehistoric finds consisted of 3 flakes, 1 core fragment, 1 fire-cracked rock, and a quartzite Halifax point/knife (Figure 53).

Site 18CH643. Site 18CH643 measured 20 x 60 m (65.6 x 196.8 ft). Artifact density at Site 18CH643 was very low. Three prehistoric artifacts were recovered: 1 unmodified primary quartz flake, 1 quartzite fire-cracked rock, and 1 possible Potomac Creek neck sherd with coarse sand temper and a black interior. The sherd indicates a Late Woodland date. The presence of fire-cracked rock suggests an encampment.

Four historic artifacts also were recovered from this site, indicating a probable mid to late nineteenth century occupation. These artifacts included: 1 transfer-printed whiteware sherd, 1 white undecorated ironstone hollowware sherd, 1 cream-colored earthenware whiteware sherd, and 1 unidentified clear bottle glass fragment. This small total of kitchen-related material may reflect nothing more than domestic discard in what was once an agricultural field.

All prehistoric and historic artifacts, except for the prehistoric sherd, came from Beltsville A or Ap horizon contexts. The sherd originated in the B1 horizon. The context of the majority of the artifacts suggests that site integrity has been impacted by plowing. In addition, the site appears to lack density and diversity of artifacts sufficient to address significant research issues. Therefore, no further work is warranted or recommended.

Area N

Area N was located at the southern end of Rum Point, on a large ridge between Area C-1 and the southeastern corner of the base; it encompassed approximately 43.42 acres. The area was bounded on the west by a large and deep drainage that flows into Mattawoman Creek; on the east and south, the boundary was the property line of the base. The ridge was cut by several smaller drainages running east and west into tributaries of the Mattawoman.

Area N contained large areas of disturbance, both human and natural; as a result, less than 50 per cent of the planned shovel tests were excavated. The primary sources of disturbance in Area N were an abandoned pistol range in the eastern half of the area, and a large graded area, currently

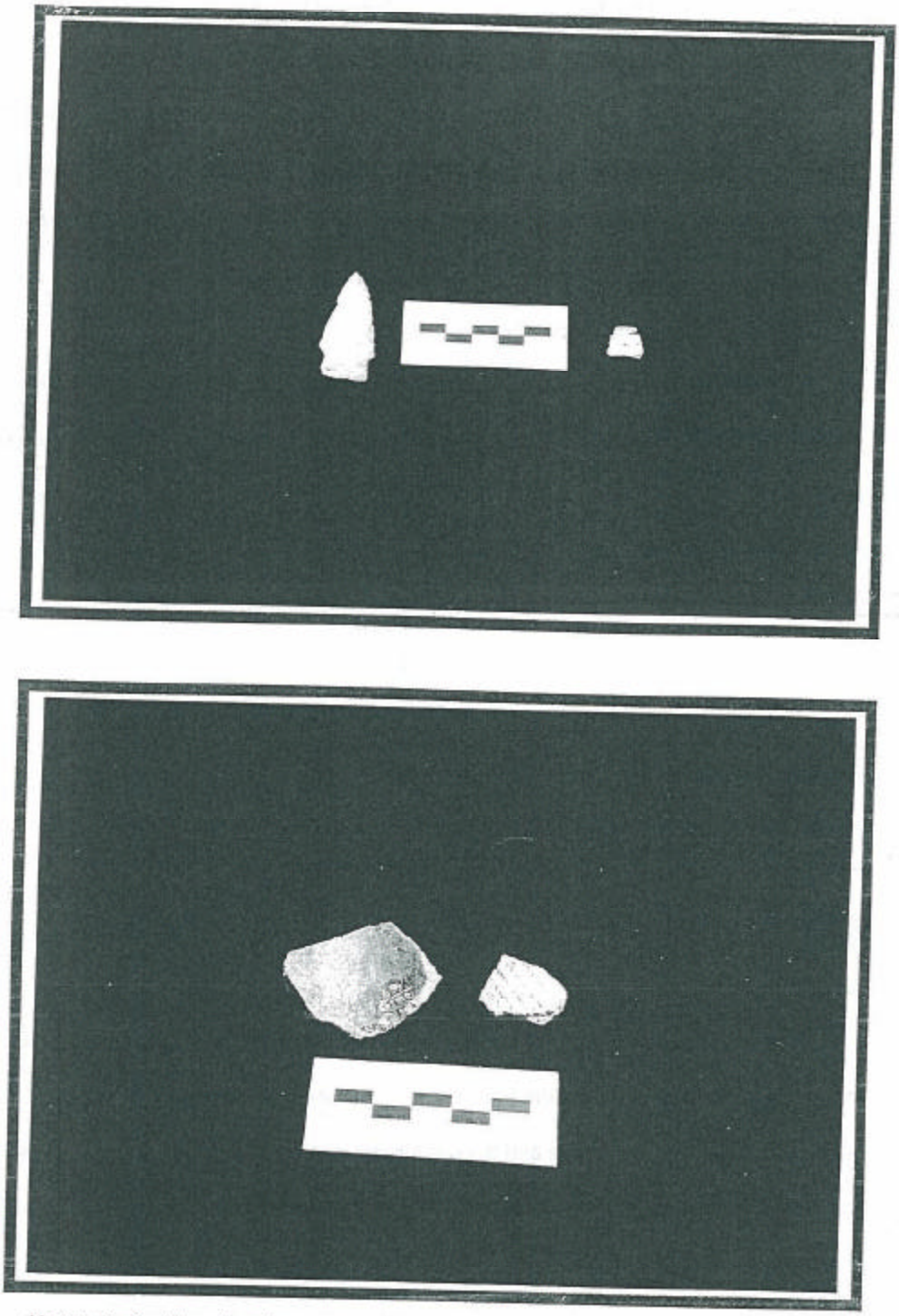

Figure 53. Above: Projectile points from Areas M and N non-site, and Site 18CH644. (L-R) [a] FS# 167; [b] FS# 180
Below: Selected prehistoric ceramics from Site 18CH643, and Site 18CH644. (L-R) [a] FS# 169; [b] FS# 184

used as a military dump, in the western half. Other human disturbances included small pushpiles scattered throughout the area. Natural disturbances consisted of erosion along the steep slopes that form the edges of the area, and small swales which cut across the ridgetop.

The vegetation in Area N was identical to that in the surrounding areas and consisted of mature hardwoods with little undergrowth. Dominant species were oak, beech, sweet gum, yellow poplar, and many holly trees. The disturbed area at the pistol range was covered in grass and small shrubs and the graded dump area was covered with saplings and shrubs.

The datum (N1000/E1000) for Area N was established just outside the Rum Point access gate, on the south side of the road. The baseline continued on a bearing of 325° (magnetic north) to N1200, where it doglegged 40 m to N1200/E1040 and then continued north to N1400, where the baseline jogged 20 m west and ended at N1480/E1020. A total of 25 transects were extended off of the baseline on a 20 m grid, at a bearing of 235/105°. A total of 93 shovel tests were excavated, but an additional 119 planned tests were not dug because of the extensive disturbance (Figure 54).

Much of the land in Area N was mapped as steep gravelly land or gravel and borrow pits (Hall and Matthews 1974). The intact soils included Beltsville silt loam along the crest of the ridge, and Aura gravelly sandy loam along the western edge. Shovel testing revealed that a typical soil profile from the undisturbed areas consisted of 14 cm of dark grayish brown (2.5Y 4/2) silt loam; 11 cm of pale brown (10YR 6/3) silt loam; and 9 cm of light yellowish brown (10YR 6/4) silt loam. This profile is consistent with Beltsville Ap, B1, and B2 horizons.

Shovel testing identified one small Late Woodland site (Site 18CH644), and five isolated positive shovel tests. The six non-site artifacts included 3 quartz or quartzite flakes, 1 quartz and 1 quartzite fire-cracked rock fragment, and an unidentified shell and coarse sand body sherd.

Site 18CH644. Site 18CH644 was located near the southern end of the ridge. Its five positive shovel tests contained eight artifacts. Artifacts included 1 Potomac Creek coarse sand tempered, cord marked body sherd, and 1 unidentified coarse sand tempered, possibly burnished body sherd (Figure 53 - bottom). The Late Woodland date suggested by the sherds was confirmed by the recovery of a small quartz Madison or Potomac projectile point with a missing tip (Figure 53

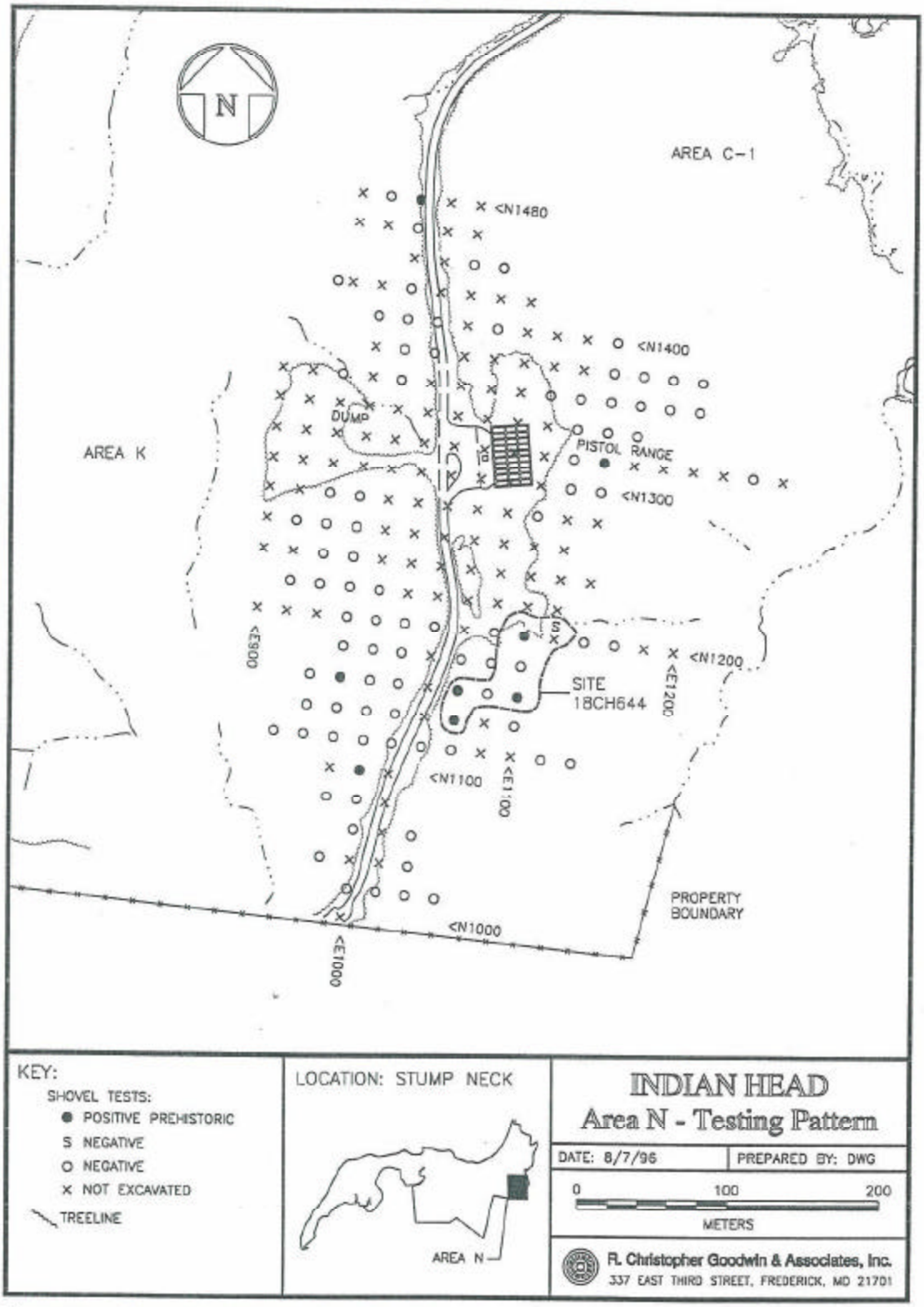

Figure 54. Map of Area N, showing shovel test pattern and site boundaries

- top; FS #180). This point is made on a flake, and has a slightly concave base. Also recovered were 2 secondary quartz flakes and 2 fragments of quartz block/shatter. The artifacts suggest that the site represents a small Late Woodland lithic resource procurement site. The presence of sherds implies that the site possibly was an encampment.

Two of the artifacts were surface finds, five came from the Ap horizon, and one from the B1 horizon. Although a majority of the artifacts were recovered from the Ap horizon, the presence of artifacts below this disturbance and fire-cracked rock on the site suggest that it may possess areas with integrity. The location of the site in the uplands contributes to its potential research value since few such sites have been investigated in the region. Therefore, Phase II evaluation is recommended at Site 18CH644.

Area 8

Area 8 was located at the eastern end of Chicamuxen Creek. The topography was divided between a low terrace sloping down to the edge of the creek, and the tips of a series of finger ridges above. The remainder of the ridge tops were surveyed as part of Areas G and I. Area 8 was bounded by Area H to the west, Areas G and I to the south and east, and Chicamuxen Creek to the northwest.

The vegetation in Area 8 varied with the topography. The upper ridges were forested with mature mixed hardwoods such as beech, oak, maple, and holly. There was minimal undergrowth on the ridges except for some green briar and hardwood saplings. On the terrace, the slightly higher dry ground was forested in much the same way, except with more sweet gum, yellow poplar and willow oak. There was more undergrowth in the form of mountain laurel, small holly trees and ferns. Closer to the water, in a swampy area, the trees were predominantly willow oak, and there was a lot of low ground cover such as ferns.

Area 8 was highly disturbed, not only from erosion along the natural slopes, but from extensive military use. Atop the ridge, there were bomb clearings, and a graded zone on the northernmost tip. The highest part of terrace, at the base of the slope, was occupied almost

completely by military buildings and a large pond. The remainder of the terrace was pock-marked by large pools of muddy water used for training purposes, and clearings containing various types of ordnance. Gravel two-track roads wound through the area, and there were deep ruts in the softer soil from heavy vehicles. Almost half (44 per cent) of the planned shovel tests on the terrace were not excavated because of these disturbances.

The datum for testing the lower half of Area 8 was established at the entrance gate on the west side of Roach Road. The baseline extended south on a bearing of 192° (magnetic north). Eighteen transects were tested on a bearing of 282/102°. A total of 70 shovel tests were excavated in this area; 55 additional planned tests were not dug because of the disturbance (Figure 48).

On the top of the ridge a separate baseline was used. The datum was established 5 m (16.4 ft) west and 10 m (32.8 ft) south of the boundary fence on the northernmost finger ridge. Eighteen additional tests were excavated on the ridge tips.

The soils on the finger ridges was mapped as Beltsville silt loam, while the terrace below was Aura gravelly sandy loam (Hall and Matthews 1974). The soils on the ridges corresponded to those of the Beltsville series. A representative profile included 8 cm of grayish brown (2.5Y 5/2) silt loam; 10 cm of light yellowish brown (10YR 6/4) silt loam; and 22 cm of brownish yellow (10YR 6/8) silt loam. These strata corresponded to Beltsville A, B1, and B2 horizons. The soils on the terrace did not correspond as closely to the Aura soils, and near the swampy ground many of the shovel tests contained gleyed soils.

A single isolated artifact was recovered from Area 8. This item was a fragment of quartz block/shatter recovered from Shovel Test N860/E1040. Such an isolated prehistoric artifact probably reflects nothing more than a single episode of tool curation or cobble testing.

Summary and Discussion of Prehistoric and Historic Activity

Phase I survey of the Stump Neck Annex identified 25 new sites and provided additional information on eight previously recorded sites. Three previously recorded prehistoric sites on Stump Neck Annex were not relocated during the survey; two of these sites apparently were sufficiently

small to evade detection when tested on a 20 m survey grid, another was underneath a beaver pond. The 33 sites examined included nine multi-component sites and 24 prehistoric sites; no sites were exclusively historic in nature. Historic components included 1 seventeenth century component, 1 eighteenth century component, and 7 nineteenth to twentieth century components. Prehistoric components included 7 Middle/Late Archaic components, 3 Early Woodland components, 6 Middle Woodland components, and 21 Late Woodland components (Table 12). The distribution of these components by landscape position provides insight into the patterns of landuse on Stump Neck and the Indian Head area in general; the distribution of sites was examined by topographic setting, proximity to fresh water, and soils.

The results of the intensive Phase IB survey provided an opportunity to evaluate and refine the sensitivity model for prehistoric resources developed by Milner and Associates in conjunction with the Phase IA reconnaissance survey of Stump Neck (Stevens et al. 1995). Stevens et al. (1995) highlighted four environmental factors important in structuring settlement in the area: (1) proximity to fresh water; (2) elevation; (3) proximity to diverse ecosystems; and, (4) soils. The results of the intensive survey of the Stump Neck Annex suggests that topographic setting and proximity to the Potomac River were the environmental factors most important in structuring prehistoric settlement in the area.

Evidence of Archaic period settlement within the confines of the Stump Neck Annex is scant. Only seven sites contain components that date from the Late Archaic and only one isolated find is suggestive of an earlier occupation; a possible late Middle Archaic period Morrow Mountain II projectile point/knife was recovered from the beach in Area E-2. The increased settlement during the Late Archaic period in the Stump Neck/Indian Head area appear to result from a combination of inundation of earlier sites and the increased carrying capacity of the estuarine areas in the lower Mattawoman and Chicamuxen Creek drainages. Large portions of the early Holocene floodplain along the Potomac River were drowned as sea level rose. Stabilization of shorelines at modern levels during the Mid-Holocene allowed the tidal marshes and associated biotic communities to become established. During the Early and Middle Archaic periods, much of the Stump Neck Annex

TABLE 12. DISTRIBUTION OF TEMPORAL COMPONENTS BY SITE

Area	Site	Prehistoric	Middle Archaic	Late Archaic	Early Woodland	Middle Woodland	Late Woodland	17th Century	18th Century	19th Century	20th Century
A	18CH390					X	X				
	18CH623					X	X				
	18CH624	X									
	18CH625			X			X				
B	18CH388					X	X			X	X
	18CH389			X	X	X				X	X
	18CH626	Woodland								X	X
C-1	18CH627	X									
C-2	18CH84						X			X	X
	18CH391			X	X	X	X		X	X	X
	18CH392						X		X		
	18CH628						X				
	18CH629	X									
	18CH630						X				
D	18CH645	X									
E-1	18CH631						X				
	18CH632			X			X				
E-2	18CH633						X			X*	X*
	18CH634			X			X			X*	X*
F-1	18CH150		X	X		X	X				
F-2	18CH394	(X)									
	18CH395						X				
G	18CH635										
	18CH636	X									
I	18CH637						X				
	18CH638	X									
K-1	18CH639		X	X			X				
K-3	18CH640	X									
K-4	18CH641						X				
K-5	18CH486	(X)									
	18CH642	X									
K-6	18CH149	(X)[@]									
	18CH393	(X)									
L-1	18CH648	X									
L-3	18CH647						X	X	X		
M	18CH643						X				
N	18CH644						X				
Total	37	14	2	7	2	6	21	1	3	5	5

x* = probably dumped refuse

(X) = not relocated

(X)[@] = not relocated-under water

would have been upland areas lying above the active floodplain of the Potomac River. Sites on the floodplain were inundated as the sea level rose during the early Holocene.

Settlement in the Indian Head area during the Early and Middle Woodland periods remained relatively scattered. Evidence for occupations dating from these periods was minimal and typically consisted only of one or two diagnostic sherds or projectile points from a site. In contrast, evidence for Late Woodland occupation of the area was ubiquitous. Nearly two-thirds (63.6 per cent) of the sites examined during the Phase IB survey contained Late Woodland components; this was nearly triple the component frequency of Late Archaic (21.2 per cent) and Middle Woodland (18.2 per cent) occupations. Nearly all Late Archaic, Early Woodland, and Middle Woodland sites were located on the floodplains and low terraces on Stump Neck and Rum Point. Late Woodland sites were identified in a greater number of settings including the high riverine terraces and upland areas of the Annex.

Historic settlement appears to have begun as early as the seventeenth century, with a small possible Contact Period site (18CH647) in the uplands. An eighteenth century occupation also is indicated on Rum Point (Site 18CH392). Neither occupation appears in the archival documents examined. Several nineteenth century components were identified, although some (18CH633 and 18CH634) appear to be the remains of dumped kitchen refuse. Architectural remains of a structure were encountered on Rum Point at Site 18CH84. Archival research suggests that this site may be related to the civil war use of Rum Point to land supplies for Hooker's encampment to the south. Later nineteenth century to early twentieth century occupations were indicated on sites in the vicinity of the hamlet twentieth century of Winthrop. Three Sites (18CH388, 18CH389, and 18CH626) in Area B and two (18CH633 and 18CH634) in Area E may be related to this settlement.

Topographic Setting

Floodplain/Low Terrace. Floodplains were areas of Holocene and late Pleistocene alluvium ranging in elevation between and 0 and 40 ft asml. All of the area on Stump Neck and Rum Point were classified as Floodplain/Low Terrace setting. The sediments within this area typically were

poorly sorted sand and gravel; silt loam also occurs within these areas, particularly in low lying areas. Soils on Stump Neck predominately were classified as moderately well-drained Keyport Silt Loam (Hall and Matthews 1974). The soils on Rum Point were more complex but contained large areas of the well-drained Sassafrass Sandy Loam (Hall and Matthews 1974).

Prehistoric settlement was ubiquitous in this setting. Sites on Stump Neck and Rum Point typically were larger and more tightly spaced than they were in other settings. Sites on Stump Neck were concentrated toward the Potomac River side of the peninsula; eight of the 11 sites identified on Stump Neck were on the Potomac side. Two of the three sites oriented toward Chicamuxen Creek date from the Late Archaic and Late Woodland periods. Settlement on Rum Point was nearly continuous, historic disturbance sharpened some of the boundaries between sites on this landform.

High Terraces. High riverine terraces were areas of nearly level land adjoining the Potomac River between 50 and 90 ft asml. The sediments on this landform generally are attributed to the Lower Cretaceous Potomac Group and range from silt loam to sandy soils. Gravels associated with this formation typically contain large amounts of quartz and quartzite cobbles suitable for lithic reduction. Also included in these gravels are chert and other cryptocrystalline materials (Glaser 1971). Soils on these terraces were characterized predominately as well-drained Beltsville silt loam (Hall and Matthews 1974).

Prehistoric settlement on the high terraces was focused toward the mouth of the Mattawoman Creek with the largest sites situated on the edges of the bluff above the creek. Only one of the seven sites identified in this setting was located in an interior setting. This site (18CH641) was situated approximately 450 m (1,500 ft) away from the creek on a sloping ridge on the margin of the uplands. The size and integrity of occupations at Site 18CH641 was atypical of sites in the interior high terrace and uplands. Late Woodland components are common as in other settings, although the spacing between them was greater. Early and Middle Woodland occupation was detected on only one site each. Late Archaic occupation was identified in two sites.

Uplands. The upland areas were areas above 90/100 ft asml, which were situated on Upper Pliocene age sandy to silty loam and clay sediments. Deeply incised drainages bisect these

areas forming finger ridges, ridges, and flat upland areas. Soils in these areas typically were the moderately well-drained Beltsville silt loam (Hall and Matthews 1974).

Prehistoric settlement in the upland areas was characterized by small, widely spaced sites with homogenous artifact assemblages. Most of the seven sites located within this setting were on the margins of deeply incised drainages. Four sites (18CH638, 18CH643, 18CH646, and 18CH647) were within the upper portion of a unnamed tributary to Chicamuxen Creek. Another two sites (18CH644 and 18CH627) were along a deeply incised drainage flowing into the Mattawoman Creek. Two others (18CH486 and 18CH642) were located on the interior portions of the upland area, within Area K. The five upland sites that produced diagnostic artifacts all date from the Woodland period. The remaining site produced only lithic artifacts. The sites appear to have been predominantly temporary resource procurement camps or wintering camps located in sheltered valleys away from the river. One site (18CH647) dates from the seventeenth century and possibly the contact period.

CHAPTER VI

SUMMARY AND RECOMMENDATIONS

Project Summary

This report presents the results of an historic resources survey to identify archeological sites on Stump Neck and to identify and evaluate historic properties applying the National Register of Historic Places (National Register) Criteria for Evaluation (36 CFR 60.4[a-d]). These investigations were undertaken at the Naval Surface Warfare Center (NSWC), Indian Head, Maryland on behalf of the Department of the Navy, Engineering Field Activity Chesapeake under Contract N62477-95D0044, Delivery Order No. 0003. These investigations were conducted in partial compliance with Section 110 of the National Historic Preservation Act (NHPA) of 1966, as amended. All work was undertaken in accordance with the Secretary of the Interior's *Standards and Guidelines for Archeology and Historic Preservation* (*Federal Register* 48, No. 190, 1983).

Archival investigations were conducted to identify appropriate historic contexts with which to assess historic resources using the frameworks established by the Maryland Historical Trust. Architectural investigations were undertaken to survey and assess buildings constructed at the activity between 1938 and 1950. Three previously proposed National Register Historic Districts were reviewed and management recommendations pertaining to National Register-eligible structures were prepared. Intensive Phase IB archeological survey of areas of moderate and high potential for archeological sites was conducted on approximately 1065 acres of the Stump Neck Annex, Naval Surface Warfare Center.

Architectural Results and Recommendations

The purpose of the current architectural investigations was threefold: (1) to survey and assess buildings constructed at the Naval Surface Warfare Center, Indian Head (NSWC) between 1938 and 1950; (2) to review the three previously proposed National Register Historic Districts; and,

(3) to prepare management recommendations pertaining to National Register-eligible structures at NSWC. These three objectives were fulfilled through a combination of archival investigations, field investigations, and data analyses.

The architectural evaluation completed in November 1995 by John Milner Associates identified three National-Register eligible historic districts at NSWC (Stevens et al. 1995). The three proposed historic districts are: (1) the Indian Head Residential Historic District; (2) the Naval Proving Ground Historic District; and, (3) the Naval Powder Factory Historic District. These district evaluations excluded all buildings built after 1938. A Multiple Property Documentation format was used to nominate the three proposed districts at Indian Head. This format is appropriate due to the thematic relationship among these three districts as distinctive features of a significant entity. The current investigations confirmed that the proposed boundary delineations, statements of significance, and periods of significance for the three districts are appropriate. The 1938-1950 resources located within the three districts were evaluated for inclusion within these districts.

Within the Indian Head Residential Historic District, the current investigations identified five additional contributing resources and five noncontributing resources. These additional resources raises the total number of resources in the district to: 64 contributing and 17 noncontributing.

Within the Naval Proving Ground Historic District, three resources were constructed between 1938 and 1950. All three were evaluated as noncontributing resources because they fall outside of the period of significance.

A total of 59 resources built between 1938 and 1950 are located within the Naval Powder Factory (NPF) Historic District. Investigations revealed that 17 are considered contributing resources and 42 as noncontributing resources. The high number of noncontributing resources within this district is due in large part to a general lack of integrity. These new data results in a revised tally of 124 contributing and 95 noncontributing resources within the NPF Historic District.

Current investigations identified one additional National Register-eligible historic district: the Extrusion Plant Historic District. The Extrusion Plant (EXP) Historic District encompasses both the Extrusion Plant and the Ballistic Laboratory (now the Small Motor Test area). The Extrusion Plant

was established in 1943 to produce rocket propellant; the Ballistic Laboratory was established the same year for the purpose of testing the rocket propellant produced at the Extrusion Plant. The current survey identified 126 buildings and structures located within the proposed EXP district boundaries. Of these 126 resources, 63 were assessed as contributing and 63 were assessed as noncontributing.

It is recommended that one area of the base, the Polaris facility, be researched further. This facility, although not yet 50 years old, may be eligible for the National Register as an *exceptionally* significant area. To be of exceptional significance a property must be: (1) associated directly with a major event or trend in our nation's history; (2) have played a primary role in the Navy's guided missile program; or, (3) represent a unique resource that was designed to accommodate an important mission or technological development. A windshield survey of this facility revealed that the complex retains its integrity of location, design, setting, association, and feeling; however, it is uncertain whether the facility possesses the qualities of *exceptional* significance necessary for properties under 50 years of age to be listed on the National Register. It is suggested that further archival work be undertaken to determine the significance of the facility, specifically the role the facility played in the nationwide development program for the Navy's first ballistic missile, the Polaris. The *Navy Cold War Guided Missile Context* (Best et al. 1995), designed to assist in the identification and evaluation of buildings, structures, sites, and districts associated with the Navy's Cold War guided missile program, should be consulted in the evaluation of Indian Head's Polaris facility.

Archeological Results and Recommendations

Recommendations for individual sites are based on the existing archeological integrity and the evidence for research potential. These recommendations are presented in Table 13. A total of 36 archeological sites were identified and investigated during the Phase I survey of the Naval Surface Warfare Center, Indian Head; 25 of these sites were previously unknown. A total of 11 of the sites were previously identified by collectors, a shoreline survey by Wilke and Thompson (1977),

TABLE 13. AREA AND SITE RECOMMENDATIONS

Survey Area	Archeological Resource	Type	Justification	Recommendation
Area A	Isolated Artifacts	Historic	limited material	No further work
Area A	Site 18CH390	Middle/Late Woodland	may have integrity	Phase II evaluation
Area A	Site 18CH623	Middle and Late Woodland	may have integrity	Phase II evaluation
Area A, D	Site 18CH624	Prehistoric	limited material	No further work
Area A	Site 18CH625	Late Archaic/Late Woodland	may have integrity	Phase II evaluation
Area B	Isolated Artifacts	Prehistoric/historic	isolated	No further work
Area B	Site 18CH388	Middle and Late Woodland/historic 19th and 20th century	may have integrity; northwest portion potentially stratified	Phase II evaluation
Area B	Site 18CH389	Late Archaic/Early-Middle Woodland/ Historic domestic: nineteenth century	does not retain integrity	No further work
Area B	Site 18CH626	Woodland/historic	limited assemblage/ partially disturbed	No further work
Area C-1	Isolated Artifacts	Prehistoric/historic	isolated	No further work
Area C-1	Site 18CH627	Prehistoric	limited assemblage/ questionable integrity	No further work
Area C-2	Isolated Artifacts	Prehistoric/historic	isolated	No further work

Survey Area	Archeological Resource	Type	Justification	Recommendation
Area C-2	Site 18CH34	Late Woodland/ nineteenth and twentieth century historic	diverse and large assemblage; may have integrity; historic foundation	Phase II evaluation
Area C-2	Site 18CH391	Late Archaic to Late Woodland/ eighteenth to twentieth century historic	diverse prehistoric assemblage; possible buried A horizon; possible integrity	Phase II evaluation
Area C-2	Site 18CH392	Eighteenth century historic domestic/ Late Woodland	unique assemblage	Phase II evaluation
Area C-2	Site 18CH628	Late Woodland	integrity; possible activity areas	Phase II evaluation
Area C-2	Site 18CH629	Prehistoric	integrity possible; diverse assemblage	Phase II evaluation
Area C-2	Site 18CH630	Woodland	may have integrity; small, diverse assemblage	Phase II evaluation
Area D	Isolated Artifacts	Prehistoric/historic	isolated	No further work
Area D	Site 18CH645	Prehistoric	limited material	No further work
Area E-1	Isolated Artifacts	Prehistoric/historic	isolated	No further work
Area E-1	Site 18CH631	Late Woodland	marginal integrity	No further work
Area E-1, D	Site 18CH632	Late Archaic/Late Woodland	very small area with integrity; limited material	No further work
Area E-2	Isolated Artifacts	Prehistoric/historic	isolated	No further work
Area E-2	Site 18CH633	Woodland	limited material; almost completely disturbed	No further work

Survey Area	Archeological Resource	Type	Justification	Recommendation
Area E-2	Site 18CH634	Late Archaic/Late Woodland/20th century dump	may have integrity; varied, albeit small assemblage in southern portion of site	Phase II evaluation
Area F	Isolated Artifacts	Prehistoric	isolated	No further work
Area F	Site 18CH150	Middle-Late Archaic/ Middle-Late Woodland	diverse assemblage; may have integrity; probable FCR feature	Phase II evaluation
Area F-2	Site 18CH394	Prehistoric	not relocated	No further work
Area F-2	Site 18CH395	Late Woodland	mostly destroyed; small portions may integrity	No further work
Area G	Isolated Artifacts	Prehistoric	isolated	No further work
Area G	Site 18CH635	Early Woodland	limited material; may have integrity	No further work
Area G	Site 18CH635	Prehistoric	limited material; no integrity	No further work
Area H	Isolated Artifacts	Historic/prehistoric	isolated	No further work
Area I	Isolated Artifacts	Prehistoric/historic	isolated	No further work
Area I	Site 18CH637	Late Woodland	limited material; very limited integrity	No further work
Area I	Site 18CH638	Prehistoric	limited material; no integrity	No further work
Area J	Isolated Artifacts	Prehistoric	isolated	No further work
Area K-1	Isolated Artifacts	Prehistoric	isolated	No further work

Survey Area	Archeological Resource	Type	Justification	Recommendation
Area K-1, K-2, K-3	Site 18CH639	Middle-Late Archaic/Late Woodland/historic domestic	may have integrity; varied assemblage, including fire-cracked rock	Phase II evaluation
Area K-2	Isolated Artifacts	Prehistoric	isolated	No further work
Area K-3	Isolated Artifacts	Prehistoric	isolated	No further work
Area K-2, K-3	Site 18CH640	Prehistoric	may have integrity; varied assemblage	Phase II evaluation
Area K-4	Isolated Artifacts	Prehistoric	isolated	No further work
Area K-4, K-5	Site 18CH641	Late Woodland	rare setting; may have integrity; diverse assemblage	Phase II evaluation
Area K-5	Isolated Artifacts	Prehistoric	isolated	No further work
Area K-5	Site 18CH642	Prehistoric	limited material	No further work
Area K-6	Isolated Artifacts	Historic	single artifact	No further work
Area K-6	Site 18CH149	early Middle Woodland	flooded	No further work
Area K-6	Site 18CH393	Prehistoric	not found - presumed isolated find during Phase IA	No further work
Area L-1	Isolated Artifacts	Prehistoric	isolated	No further work
Area L-1	Site 18CH646	Prehistoric	limited material; may have integrity	No further work
Area L-2	Isolated Artifacts	Historic/prehistoric	isolated	No further work
Area L-3	Site 18CH647	Historic domestic: sixteenth and seventeenth century	unique assemblage; may have integrity	Phase II evaluation

Survey Area	Archeological Resource	Type	Justification	Recommendation
Area M	Isolated Artifacts	Prehistoric/historic	isolated	No further work
Area M	Site 18CH643	Late Woodland/ nineteenth century domestic	limited material; mostly disturbed	No further work
Area N	Isolated Artifacts	Prehistoric	isolated	No further work
Area N	Site 18CH644	Late Woodland	may have integrity; varied assemblage; unique setting	Phase II evaluation
Area 8	Isolated Artifacts	Prehistoric	single artifact	No further work

* A previous survey identified this site and did not recommend further work (Busby 1995).

or during a Phase IA reconnaissance survey of Stump Neck Annex conducted in 1994 (Stevens et al. 1995). One previously recorded site located in Area K-6 was not investigated during the Phase IB survey. This site (18CH149) was inundated as a result of beaver activity in the area. Testing also failed to relocate two sites identified during the Phase Ia reconnaissance survey. Intensive survey of Area K-6 did not recover any cultural materials in the vicinity of the mapped location of Site 18CH393. The survey also did not recover materials from Site 18CH394, which appears to have been located in a disturbed area in Area F-2 on the eastern margin of the Radiology Laboratory.

Of the total 33 sites subject to this Phase I survey, 17 sites were recommended for Phase II evaluation.

Area A

The Phase I survey identified four previously unknown archeological sites in Area A. Cultural materials associated with a previously known site, Site 18CH390, also were identified. Located at the end of Stump Neck, Area A included an area on at the extreme southern tip of the neck that was used as a proving ground target and to test explosives; this portion of Area A was disturbed completely. Soil profiles to the north of this disturbed portion of Area A remained largely intact.

Site 18CH390 was identified in 1995 by Milner and Associates during a Phase IA reconnaissance survey of Stump Neck as a scatter of debitage on a high bluff overlooking the Potomac River. The current study relocated the site north of Archer Road, near the end or Stump Neck. The prehistoric assemblage from the site included 44 artifacts including ceramics, an adze, and fire-cracked rock fragments. Sherds of Mockley and Potomac Creek wares indicate that this base camp was occupied during the Middle and Late Woodland periods. Though no features were located, a large proportion of the artifacts were recovered from intact strata below the Ap horizon. **Phase II evaluation of Site 18CH390 is recommended.**

Site 18CH623 was a medium-sized Middle and Late Woodland camp site located on the edge of the disturbed area at the end of Stump Neck. Although military activities have disturbed

portions of this site, deeply stratified portions of the site on the ridge and southeastern slopes within the site indicate that it may retain a significant degree of integrity. **Phase II evaluation of Site 18CH623 is recommended.**

Site 18CH624 was a medium sized prehistoric resource procurement site, located north of Archer Avenue in the northwestern portion of Area A and adjoining a portion of Area D. Although two-thirds of the 22 prehistoric artifacts were from below the A horizon, the low density and limited variety of artifacts recovered from the site limit the research potential of the site. **No further work is recommended at Site 18CH624.**

Site 18CH625 was a small Late Archaic and Late Woodland period base camp, located on a gradual slope overlooking the mouth of Chicamuxen Creek. Disturbance from historic activities on Stump Neck was minimal. An unknown amount of the site has eroded into the creek. Among the 31 prehistoric artifacts from this site were two projectile points, ceramics, cores, flake tools, and fire-cracked rock. A majority of the prehistoric artifacts recovered in shovel tests were from below the A horizon and historic materials are restricted to within the A horizon. **Phase II evaluation of Site 18CH625 is recommended.**

Area B

Phase IB survey identified three sites within Area B; two of these sites were previously known. Archival research indicated that the early twentieth century hamlet of Winthrop was located within Survey Areas B and E. Architectural survey of Stump Neck (Chapter VI) did not locate any existing structures dating from the early twentieth century; therefore, the remains of Winthrop are entirely archeological. Portions of Area B were moderately to severely disturbed. Construction of a causeway and stabilization of the eastern margins of the survey area effectively destroyed all integrity in those areas. On the other hand, fill in the vicinity of the former skeet range appears to have preserved the Ap and B horizons intact.

Site 18CH388 was identified during Phase IA reconnaissance survey in 1995 as a multi-component site possibly corresponding to Indian Head Quad File #3, a Late Woodland Village

reported by Graham (Stevens et al. 1995:44). The current study expanded the boundaries of this site, located on the northeastern portion of Area B. The site is relatively large, complex, and rich in prehistoric and historic artifacts. The prehistoric component of Site 18CH388 was characterized as a base camp or village occupied during the Middle and Late Woodland periods. The diverse prehistoric assemblage included evidence of lithic tool production, flake tool use, and food preparation. Although no features were located, the shovel testing suggested the presence of intact soil horizons and artifact concentrations across the site. The historic component at the site was characterized by large amounts of domestic refuse and a limited amount of architectural debris. Although the site contains extensive later twentieth century debris, sufficient architectural and domestic materials remain to suggest that structures associated with Winthrop were located on the site. **Phase II evaluation of both the prehistoric and historic components of Site 18CH388 are recommended.**

Site 18CH389 was identified during Phase IA reconnaissance survey in 1995 as a multi-component early Middle Woodland and early twentieth century site (Stevens et al. 1995:44). The current study redefined the site boundaries and recovered artifacts dating from the Late Archaic and Middle Woodland periods. Military and other historic activities have impacted the site severely, mixing the prehistoric and historic components of the site with modern debris and destroying the integrity of the site. The prehistoric component at the site included a variety of artifact classes and types including four projectile points and fire-cracked rock. The prehistoric occupation was probably a base camp. The historic component was dominated by twentieth century artifacts most of which remain in use to this day. Although these artifact may relate to Winthrop, the evidence is not compelling. **No further work at this site is recommended.**

Site 18CH626 was located during Phase IB intensive survey in the southwestern portion of Area B. The small site produced debitage and untyped shell and sand-tempered ceramics that were either Middle or Late Woodland in age. The prehistoric assemblage is small and homogenous, perhaps indicative of a small campsite. The historic assemblage from the site was comprised of domestic debris dating from the late nineteenth to early twentieth centuries. Truncated soil profiles

and fill horizons on the site indicate that the area was graded; most of the site was disturbed. **No further work at this site is recommended.**

Area C-1

Phase Ib survey of Area C-1 identified one previously unknown site and several isolated finds. The area was located at the base of Rum Point between two deeply incised drainages. A gravel pit was located in the eastern portion of the area and disturbance from logging activities was visible.

Site 18CH627 was a small prehistoric lithic scatter. A majority of the artifacts in the very small assemblage from the site were recovered from within a plowzone. **No further work at Site 18CH627 is recommended.**

Area C-2

The Phase I survey identified six archeological sites within Area C-2; three of the sites were previously known. The area comprised most of Rum Point and included a skeet range at its southern end and an abandoned Boy Scout camp and pushpiles at its northern end. The very tip of the point was disturbed by a missile launching mechanism. A testing facility located in the central portion of the point disturbed a portion of Site 18CH391.

Site 18CH84 was relocated during the Phase IA reconnaissance survey and delineated during the current study. The large multi-component site was occupied during the Late Woodland period and the nineteenth to twentieth centuries. The prehistoric assemblage was diverse and included debitage, flake tools, a projectile point, ceramics, and fire-cracked rock fragments; a short-term camp was indicated. Although a sizable portion of the artifacts were recovered from within the plowzone, a small area of intact deposits below the Ap horizon was identified. The distribution of artifact types across the site suggests that activity areas and other intact deposits may remain. The historic component was characterized by a light scatter of nineteenth and twentieth century artifacts across the site and stone and brick foundation located in the northwestern portion of the site.

A test trench revealed a stone foundation with a section of a collapsed brick wall lying on top of a mortared stone floor. Although a large amount of modern debris was deposited on the feature, sufficient nineteenth century materials were associated with the feature to suggest that it might be related to the Civil War use of the point as a landing. **Phase II evaluation of the prehistoric and historic components of Site 18CH84 is recommended.**

Site 18CH391 was identified during Phase IA reconnaissance survey as an Early and Late Woodland period and twentieth century site (Stevens et al. 1995:44). Stevens suggested that the historic artifacts were related to the historic structure located on historic maps dating from between 1900 and 1945. The current study redefined the site boundaries and recovered artifacts dating from the Late Archaic through the Late Woodland periods. The size and nature of the prehistoric assemblage from the site suggest that it was a base camp or village. Although much of the prehistoric materials were from the Ap horizon, a possible intact Ab horizon in one portion of the site and artifact concentrations across the site suggest that it retains some degree of integrity. The historic component was characterized by a widely dispersed assemblage of eighteenth, nineteenth and twentieth century artifacts, all were mixed with modern debris. The eighteenth century artifacts may be associated with a contemporary occupation on Site 18CH392, located immediately to the south of the site. **Phase II evaluation of Site 18CH392 is recommended.**

Site 18CH392 was identified during Phase IA reconnaissance survey as an lithic scatter and a isolated sherd of Westerwald stoneware (Stevens et al. 1995:44). Intensive Phase IB testing of the site recovered a small assemblage dating from the Late Woodland and eighteenth century. The prehistoric assemblage was consistent with a small resource procurement or temporary campsite. The historic assemblage included a diverse assemblage of artifacts all dating from the early to mid-eighteenth century. Although many of these artifacts were recovered from the plowzone, over half of the historic artifacts were from a possible feature encountered in one shovel test. **Phase II evaluation of Site 18CH392 is recommended.**

Site 18CH628 was a small Late Woodland site located at the southern end of Area C-2. The small prehistoric assemblage included from the site included a variety of artifact classes including

debitage, flake tools, ceramics, and fire-cracked rock indicative of the use of the site as a resource procurement site or briefly occupied camp. Distinct prehistoric activity areas may be present on the site; cores and primary debitage were located in the southeastern portion of the site. The ceramics were located in the northwestern portion of the site. Historic artifacts recovered appear to be field scatter. The prehistoric artifacts were recovered in equal numbers from the A and B horizons, while historic artifacts were essentially restricted to the A horizon. The apparent integrity of the prehistoric component at the site and the possible activity areas indicate that the site may potentially yield insights into prehistory. **Phase II evaluation of Site 18CH628 is recommended.**

Site 18CH629 was a small and diffuse prehistoric site located in the northeastern portion of Area C-2. Most of the artifacts recovered were from within the B horizon within an area of mixed hardwood forest. The assemblage characterized by debitage, a hammerstone, a core fragment, and fire-cracked rock was characteristic of a resource procurement or hunting camp. It is possible that this site represents an upland occupation dating from the Archaic period. **Phase II evaluation of Site 18CH629 is recommended.**

Site 18CH630 is a small Late Woodland site located in the southwestern portion of Area C-2 on the western edge of Rum Point. A diverse assemblage of prehistoric artifacts including debitage, a flake tool, a core, ceramics, and fire-cracked rock fragments, was recovered from the unplowed A1 and A2 horizons in Sassafrass Silt Loam soils. The lack of a plowzone at the site and the quantity and diversity of artifacts recovered suggest that enough integrity and research potential may remain to permit isolation of activity areas. The presence of fire-cracked rock suggests that features may be present. Therefore, **Phase II evaluation of Site 18CH630 is recommended**.

Area D

Phase IB survey identified one archeological site within Area D; small portions of two other sites also were identified. A large portion of Area D was disturbed in the vicinity of the Explosives Testing Station and associated buildings and bunkers. Most of the western portion of the survey area was severely disturbed.

Site 18CH645 was a small lithic scatter located in the center of Area D, adjacent to a munitions bunker complex. The small, limited prehistoric assemblage from the site was characteristic of a brief reduction episode. Soil profiles across the site typically were truncated and indicate that the site does not retain sufficient integrity to be considered potentially eligible for listing on the National Register of Historic Places. **No further work at Site 18CH645 is recommended.**

Area E-1

Phase IB survey identified two previously unknown archeological sites within Area E-1. Located in the central portion of Stump Neck, Area E-1 was situated north of a large tidal marsh on Chicamuxen Creek. The degree of disturbance varied a great deal across the survey area. Most soil profiles within Area E-1 were truncated, disturbed, or buried by modern military activities. Sites typically were dispersed and disturbed.

Site 18CH631 was a medium-sized Late Woodland period site on the bluff above the Potomac River. The prehistoric assemblage principally consisted of debitage, although flake tools, ceramics, and fire-cracked rock also were recovered. The activities represented at the site were tool maintenance and food preparation activities. Although soil profiles within the site generally were intact, the disturbance from modern military activities appears to have compromised the integrity of the site severely. **No further archeological work is recommended for Site 18CH631.**

Site 18CH632 was a small probable Late Archaic and Late Woodland site which extends southwest into Area D. Artifact density at the site was low, but contained a rhyolite point/knife similar to the Late Archaic Macpherson type, and four coarse sand-tempered probable Potomac Creek sherds. The southern portion of the site appears to have been disturbed by the construction of Porter Road and a subterranean bunker complex. Despite the presence of diagnostic artifacts, the low artifact density and the modern disturbances suggest that the site retains only limited research potential. **No further work is recommended for Site 18CH632.**

Area E-2

Phase IB survey identified two previously unknown archeological sites within Area E-2. Located east of Area E-1, in the central portion of Stump Neck, Area E-2 was situated north of a large tidal marsh on Chicamuxen Creek. A large portion of Area E-2 was disturbed. Buildings at the western and southeastern portions of the area, a testing range, and smaller pushpiles were indicative of the extensive disturbance within the area.

Site 18CH633 was a Late Woodland site with evidence of twentieth century "field dumping" across the site. Modern disturbance to the site was extensive, and fill and disturbed soils were encountered across most of the area. Prehistoric artifacts were only recovered from below the modern disturbance in 4 shovel tests immediately adjacent to the Potomac River. The lack of diagnostic artifacts and the widespread disturbance suggest that Site 18CH633 has little to contribute to our understanding of prehistory. The historic component also appears to have little integrity. Only four architectural artifacts were recovered, and the ceramics and glass from the historic sub-assemblage date primarily to the twentieth century. The dearth of architectural remains suggests that the artifacts do not relate to the hamlet of Winthrop. **No further work is recommended at Site 18CH633.**

Site 18CH634 was a small Late Archaic and Late Woodland site with a twentieth century trash dump. The prehistoric artifacts all were recovered from the southern portion of the site, along the edge of Chicamuxen Creek. Half of the artifacts were recovered from the second stratigraphic level, in soils which did not appear to be disturbed. The apparent integrity of the site combined with the presence of diagnostic artifacts suggests that the prehistoric component of the site may possess research potential. The historic component, characterized by a twentieth century dump lacks such potential. **Phase II evaluation of the prehistoric component at Site 18CH634 is recommended.**

Area F

Phase Ib survey relocated and defined the boundaries of the previously identified Site 18CH150. Diagnostic artifacts recovered from this site range from the Late Archaic to the Late

Woodland. Over 60 per cent of the artifacts were recovered from the second stratigraphic level (A2 horizon). Transect N1475 which ran along the edge of the cliff overlooking Mattawoman Creek, contained the largest concentration of artifacts; these data may indicate that a significant part of the site has been lost to erosion. A shovel test on this transect also contained a possible fire-cracked rock feature of 14 fragments. Despite erosion of the bluff, the uniformity of the soils across the site suggests that intact cultural remains are present, particularly along the bluff. **Phase II evaluation of Site 18CH150 is recommended.**

Area F-2

Area F-2 was defined as the level terrace and slope down to the water in the far northwestern corner of Area F. Only one of the two previously identified sites located there were relocated during the survey. No evidence of Site 18CH394 was recovered in the mapped location of the site; the recorded location is on a very small terrace or bench at an elevation of approximately 40 ft amsl. This site apparently is of a very limited horizontal aspect; thus **no further work at the site is recommended.**

Site 18CH395 was located along the edge of the terrace and appears to have been at least partially disturbed by the construction of the radiology complex. The site dates to the Late Woodland period and contained three prehistoric ceramics, one of which was a Potomac Creek sand-tempered sherd. A majority of the artifacts were recovered from below the A or Ap horizon. Despite the presence of diagnostic artifacts and the apparent integrity of the soils, disturbance from the radiology complex may have rendered the intact portion of the site too small to address significant research questions. **No further work at Site 18CH395 is recommended.**

Area G

Two small prehistoric sites, a WWII pillbox, and a road trace that purportedly dates from the Civil War, were identified in Area G. The WWII pillbox was located on the edge of the ridge

limited number of artifacts and the lack of archeological integrity indicate that the site does not possess research potential. **No further work is recommended within Site 18CH642.**

Area K-6

Neither of the two previously identified sites in Area K-6 were relocated during the current Phase Ib survey. Site 18CH149 was reported to be located on a small terrace at approximately 20 ft amsl. During the current fieldwork the low bench on which the site was situated was found to have been flooded by recent beaver activity, making testing impossible. **No further work is recommended within Site 18CH149.**

Site 18CH393 was previously identified by a single shovel test on a middle terrace above Site 18CH149. No artifacts were recovered from this terrace during the survey, and the site may reflect an isolated event. **No further work is recommended within Site 18CH393.**

Area L-1

Site 18CH646 is a small prehistoric site with no temporal affiliation. The artifact assemblage suggests that the site may reflect a brief lithic reduction episode without an encampment. All but one of the artifacts were recovered from the B1 horizon. Despite the possible integrity, the site appears to lack a density and diversity of artifacts sufficient to address significant research issues. **No further work is recommended within Site 18CH646.**

Area L-2

No archeological sites were identified during the intensive survey of Area L-2. Historic and prehistoric artifacts were recovered from 14 isolated shovel tests. The small number and the isolated character of these finds limits further analysis. Consequently, these materials do not appear to posses the quality of significance that would make them eligible for listing on the National Register of Historic Places under Criterion D. **No further archeological work is recommended for Area L-2.**

Area L-3

Site 18CH647 is an early historic and possible Contact Period site, containing a Potomac Creek sherd as well as Delft and early redware sherds. Ten of the 12 artifacts were recovered from the B1 horizon, suggesting that the site retains a high degree of integrity. Although the site lacks architectural remains, it is one of the few early historic sites to be identified during the current survey. The prehistoric ceramic may indicate a date very late in the prehistoric sequence. As a result, the site may present an opportunity to study Native American and European interaction. **Phase II evaluation of Site 18CH647 is recommended.**

Area M

Site 18CH643 was a small multi-component site containing Late Woodland and nineteenth century artifacts. All of the artifacts, with the exception of the possible Potomac Creek sherd, were recovered from the A or Ap horizon, suggesting that the site has been impacted by plowing. The low artifact density and apparent lack of integrity indicate that the site does not possess research potential. **No further work is recommended.**

Area N

Site 18CH644 is a small Late Woodland site. Although a majority of the artifacts were recovered from the Ap horizon, the presence of artifacts below this disturbance and fire-cracked rock on the site suggest that it may possess areas with integrity. The location of the site in the uplands contributes to its potential research value since few such sites have been investigated in the region. Therefore, **Phase II evaluation of Site 18CH644 is recommended.**

Area 8

Area 8 was highly disturbed by both natural erosion and swampy land, as well as by extensive military use. Only one isolated prehistoric artifact was recovered from the area. **No further archeological work is recommended for Area 8.**

PHASE I CULTURAL RESOURCES SURVEY OF STUMP NECK ANNEX AND SUPPLEMENTAL ARCHITECTURAL INVESTIGATIONS, INDIAN HEAD NAVAL SURFACE WARFARE CENTER, CHARLES COUNTY, MARYLAND

DRAFT REPORT

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ABSTRACT

This document presents the results of an intensive-level, Phase I archeological and architectural survey of Stump Neck Annex and Supplemental Architectural investigations, for the Indian Head Division, Naval Surface Warfare Center, Charles County, Maryland. The project was conducted on behalf of the Department of the Navy, Engineering Field Activity Chesapeake (EFA Chesapeake) under Contract N62477-95-D-0044, Delivery Order No. 003. These investigations were conducted January through July, 1996 by R. Christopher Goodwin & Associates, Inc. This study was designed to address the Department of Defense's responsibilities under Sections 106 and 110 of the National Historic Preservation Act (NHPA) of 1966, as amended, and its implementing regulation (36 CFR 800).

Research objectives included: (1) the location and identification of archeological and architectural resources; (2) the identification and evaluation of potential significance of all buildings constructed between 1938 and 1950; (3) a review of the three proposed National Register Historic Districts at NSWC; and (4) preparation of management recommendations pertaining to National Register-eligible structures at NSWC. Additional research objectives included an assessment of landuse patterns on the base and on the Potomac River in general. Methods used to achieve these goals included archival research, interpretation of the prehistoric and historic contexts, discrimination between disturbed and intact areas of the installation, pedestrian reconnaissance of the disturbed areas, and systematic subsurface testing of the undisturbed areas.

The architectural survey of the entire activity identified 198 structures dating from 1938 to 1950 within four National Register eligible Historic Districts. Three of the historic districts were previously proposed and are supplemented by these architectural investigations. A total of 10 additional resources (five contributing and five noncontributing) were identified within the Indian Head Residential Historic District. Three additional resources were located within the Naval Proving Ground Historic District; all were outside the period of significance and were deemed noncontributing resources. A total of 59 resources were built during this period within the Naval

Powder Factory (NPF) Historic District; 17 were considered contributing resources and 42 as noncontributing resources. A fourth National Register-eligible historic district also was identified: the Extrusion Plant Historic District. The current survey identified 126 buildings and structures located within the proposed district boundaries. Of these 126 resources, 63 were assessed as contributing and 63 were assessed as noncontributing.

A total of 1,065 acres out of the approximately 1,170 acre Stump Neck Annex were surveyed through pedestrian reconnaissance and intensive subsurface testing. This area comprised all of the area on the Annex available for testing. The archeological survey identified 25 sites and investigated 8 previously identified sites within the boundaries of the Stump Neck Annex. These 33 sites included 25 prehistoric sites, and 8 multi-component sites. Historic components represented the seventeenth through the early twentieth centuries; prehistoric components included representations from the Late Archaic through Late Woodland periods. Twelve of these sites were recommended for Phase II evaluation, in order to determine their potential for eligibility for listing on the National Register of Historic Places.

TABLE OF CONTENTS

ABSTRACT ii

LIST OF FIGURES viii

LIST OF TABLES xii

I. INTRODUCTION 1
Project Location and Description 1
Research Objectives and Design 1
Overview of the Project Area 5
Organization of the Report 5

II. NATURAL AND CULTURAL SETTING 6
Natural Setting 6
Prehistoric Setting 9
Previous Investigations 9
Prehistoric Cultural Sequence 18
The Paleo-Indian/Early Archaic Period 18
The Archaic Period 21
The Woodland Period 22
Historic Setting 26
Previous Investigations 26
Historic Cultural Sequence 28
Contact and Settlement Period (1634 - 1680) 28
Establishment of Charles County 28
Social Stratification 29
Rural Agrarian Intensification (1680 - 1815) 30
Social Structure 30
Tobacco Plantation Economy 30
Transportation Systems 31
American Revolution 33
African-American Population in Charles County 33
War of 1812 33
Agricultural-Industrial Transition (1815 - 1870) 34
Economic and Social Stability 34
Social Structure 35
Agriculture 35
The Civil War 35
Abolition of Slavery 39
Industrial/Urban Dominance (1870 - 1930) 39
Population Trends 39
Economic Diversification 39
Improved Communication and Transportation Systems 40
Modern Period (1930 - present) 41
Economic Stabilization 41
Present Day Charles County 43
Historic Overview of Indian Head 44
Naval Proving Grounds (1890 - 1921) 45

Naval Powder Factory (1900 - 1938) 48
World War II Expansion of Indian Head (1938 - 1945) 52
Explosives Investigation Laboratory (EIL) 54
New Explosive D Plant 55
Jet Propulsion Laboratory (JPL) 56
Extrusion Plant 56
Ballistic Laboratory 57
Post-War Period (1945 - 1950) 58
Research and Development Laboratory 58
The Patterson Pilot Plant 59
Continued Development of Indian Head (1950 - Present) 59

III. RESEARCH DESIGN AND METHODOLOGY 62
Archival Investigations 62
Archeological Investigations 62
Field Survey 63
Laboratory Analysis and Curation 65
Lithic Artifacts 65
Prehistoric Ceramics 66
Historic Materials 67
Records and Curation 67
Architectural Investigations 67
Expected Results 69

IV. RESULTS OF ARCHITECTURAL INVESTIGATIONS 70
Introduction 70
Multiple Property Documentation 70
Analysis of Proposed National Register Historic Districts 71
Indian Head Residential Historic District 71
Resources Constructed between 1938 - 1950 72
Naval Proving Ground Historic District 77
Newly Evaluated Resources 79
Naval Powder Factory Historic District 79
Newly Evaluated Resources within the Historic District Boundary . . 83
Additional Proposed National Register Historic District 98
Extrusion Plant Historic District 98
Narrative Description 98
Narrative Statement of Significance 117
Verbal Boundary Description 120
Boundary Justification 120
Inventory of Resources within the EXP Historic District 121
Contributing Resources 121
Noncontributing Resources 122
Polaris Plant Historic District 124

V. RESULTS OF ARCHEOLOGICAL INVESTIGATIONS 127
Archival Results 127
Archeological Results 129
Area A 130
Site 18CH390 133
Site 18CH623 136
Site 18CH624 138
Site 18CH625 139

Area B 141
Site 18CH388 145
Site 18CH389 152
Site 18CH626 154
Area C 155
Area C-1 156
Site 18CH627 158
Area C-2 158
Site 18CH84 162
Site 18CH391 168
Site 18CH392 172
Site 18CH628 174
Site 18CH629 176
Site 18CH630 176
Area D 177
Site 18CH645 180
Area E 182
Area E-1 183
Site 18CH631 185
Site 18CH632 187
Area E-2 188
Site 18CH633 190
Site 18CH634 191
Area F 193
Site 18CH150 196
Area F-2 200
Site 18CH395 200
Area G 201
Site 18CH635 203
Site 18CH636 203
Area H 205
Area I 208
Site 18CH637 209
Site 18CH638 209
Area J 210
Area K 212
Area K-1 215
Site 18CH639 216
Area K-2 218
Area K-3 219
Site 18CH640 220
Area K-4 221
Site 18CH641 222
Area K-5 223
Site 18CH642 225
Area K-6 225
Area L 227
Area L-1 227
Area L-2 230
Area L-3 232
Site 18CH647 233
Area M 235
Site 18CH643 236

Area N 236
Site 18CH644 238
Area 8 240
Summary and Discussion of Prehistoric and Historic Activity 241
Topographic Setting 244
Floodplain/Low Terrace 244
High Terraces 245
Uplands 245

VI. SUMMARY AND RECOMMENDATIONS 247
Project Summary 247
Architectural Results and Recommendations 247
Archeological Results and Recommendations 249
Area A 255
Area B 256
Area C-1 258
Area C-2 258
Area D 260
Area E-1 261
Area E-2 262
Area F 262
Area F-2 263
Area G 263
Area H 264
Area I 265
Area J 265
Area K-1 265
Area K-2 266
Area K-3 266
Area K-4 266
Area K-5 266
Area K-6 267
Area L-1 267
Area L-2 267
Area L-3 268
Area M 268
Area N 268
Area 8 268

REFERENCES 269
ACKNOWLEDGEMENTS 280

APPENDIX I - LIST OF BUILDINGS AND DESCRIPTIONS

APPENDIX II - NATIONAL REGISTER FORMS

APPENDIX III - ARTIFACT INVENTORY

APPENDIX IV - MARYLAND ARCHEOLOGICAL SITE SURVEY FORMS

APPENDIX V - RESUMES OF KEY PROJECT PERSONNEL

APPENDIX VI - NADB - REPORTS RECORDING FORM

LIST OF FIGURES

Figure 1. Location of Project Area in Charles County, Maryland 2

Figure 2. Excerpt from the 1966 (Photorevised 1978) Indian Head, Maryland/Virginia 7.5' USGS Quadrangle, Showing the Location of the Project Area 3

Figure 3. Excerpt from the 1966 (Photorevised 1978) Indian Head, Maryland/Virginia 7.5' USGS Quadrangle, Showing the Location of Previously Known Archeological Sites within the Project Area 17

Figure 4. Portion of Griffith's *Map of the State of Maryland* (1794) showing the project area 32

Figure 5. Portion of Martenet's *Map of Maryland* (1885) showing project area 37

Figure 6. Williamson's *Surveys and Reconnaissances in the Vicinity of Budd's Ferry, Charles County, Maryland* (1861-1862), showing the project area 42

Figure 7. Map showing World War I era development at the Naval Powder Factory, Indian Head (ca. 1920) 51

Figure 8. Map showing boundaries of the Indian Head Residential Historic District 64

Figure 9. Above: Garage (No. D22A), view southeast; Below: D322, view south 76

Figure 10. Map showing boundaries of the Naval Proving Ground Historic District 78

Figure 11. Above: No. 45A; Below: Magazine (No. 523) 81

Figure 12. Map showing boundaries of the Naval Powder Factory Historic District 84

Figure 13. Ether Vault (No. 496), view northwest 89

Figure 14. Building 481, view southeast 91

Figure 15. Above: Front of Solvent Recovery House (No. 453); Below: Rear of No. 453 92

Figure 16. Above: World War II-era Dryhouse (No. 507); Below: World War II-era smokeless powder magazine (No. 513) 94

Figure 17. Above: No. 556, view northeast; Below: Research and Development Laboratory (No. 600), view southeast 96

Figure 18. Surveillance Magazine (No. 555), view southeast 97

Figure 19. Schematic map showing the Extrusion Plant in 1944 based on map entitled Extrusion Plant and Ballistic Laboratory 99

Figure 20. Map showing boundaries of the proposed Extrusion Plant Historic District and the contributing and noncontributing structures within the District 100

Figure 21. Flowchart of extrusion process at Indian Head 102

Figure 22. Above: Ready service magazine (No. 583), view north; Below: Charge rolling building (No. 577), view south 103

Figure 23. Above: Electronic heating building (No. 576), view north; Below: Preheating oven (No. 570), view west 105

Figure 24. Above: Press house (No. 529), view west; Below: Press House (No. 562), view north 107

Figure 25. Above: View west of press houses arranged in a semicircular configuration along East Schoeffel Road; Below: Front elevation of the Annealing oven (No. 579) 109

Figure 26. Machining Building (No. 571), view southwest 111

Figure 27. Above: Change House (No. 601), view west; Below: Attendant shed (No. 1235) shown next to Preheating oven (No. 570) 113

Figure 28. Above: Ballistic Laboratory (No. 558); Below: Magazine (No. 589) 115

Figure 29. Powder Distribution Building (No. 591) 116

Figure 30. Map indicating location of the Polaris facility 125

Figure 31. Map of the Stump Neck Annex showing the Location of Survey Areas 131

Figure 32. Map of Area A, showing shovel test pattern and site boundaries 134

Figure 33. Adze/celt from Site 18CH390 (FS# 3) 135

Figure 34. Above: Projectile points/knives from Site 18CH623 and Site 18CH625 (Clock-wise from upper left) [a] FS# 46; [b] FS# 46; [c] FS# 72; [d] FS# 46; [e] FS# 81; [f] FS# 44)
Below: Selected prehistoric ceramics from Sites 18CH390, 18CH623, and 18CH625
(L-R) [a] FS# 4; [b] FS# 67; [c] FS# 100; [d] FS# 4 137

Figure 35. Map of Area B, showing shovel test pattern and site boundaries 142

Figure 36. Above: Projectile points/knifes from Site 18CH388 and Site 18CH389 (Clock-wise from upper left) [a] FS# 12; [b] FS# 79; [c] FS# 32; [d] FS# 30; [e] FS# 41)
Below: Selected prehistoric ceramics from Site 18CH388. (L-R) [a] FS# 41; [b] FS# 61 147

Figure 37. Map of Area C-1, showing shovel test pattern and site boundaries 157

Figure 38. Projectile points/knives from Areas C-1 and C-2, non-site, and Sites 18CH84 and 18CH391. (Clock-wise from upper left) [a] FS# 15; [b] FS# 11; [c] FS# 60; [d] FS# 70; [e] FS# 57) 159

Figure 39. Map of Area C-2, showing shovel test pattern and site boundaries 160

Figure 40. Area C-2: Planview of Historic Stone foundation in Trench 1 165

Figure 41. Map of Area D, showing shovel test pattern and site boundaries 178

Figure 42. Projectile points/knives from Area D non-site, and Area E-2 non-site, and Sites 18CH632, 18CH631, and 18CH634. (Clock-wise from upper left) [a] FS# 241; [b] FS# 227; [c] FS# 303; [d] FS# 251; [e] FS# 655; [f] FS# 658; [g] FS# 661 181

Figure 43. Map of Area E-1, showing shovel test pattern and site boundaries 184

Figure 44. Map of Area E-2, showing shovel test pattern and site boundaries 189

Figure 45. Map of Areas F and G, showing shovel test pattern and site boundaries 194

Figure 46. Projectile points/knives from Site 18CH150. (Clock-wise from upper left) [a] FS# 59; [b] FS# 19; [c] FS# 12; [d] FS# 62; [e] FS# 58 198

Figure 47. Projectile points/knives from Site 18CH635 and 18CH636, and Areas I and J, non-site. (Clock-wise from upper left) [a] FS# 506; [b] FS# 538; [c] FS# 551; [d] FS# 569 204

Figure 48. Map of Areas H, I, and 8, showing shovel test pattern and site boundaries 206

Figure 49. Map of Area J, showing shovel test pattern and site boundaries 211

Figure 50. Map of Area K, showing shovel test pattern and site boundaries 213

Figure 51. Above: Projectile points/knives from Site 18CH639, Site 18CH640, Site 18CH641, and non-site from Area K-1. (Clock-wise from upper left) [a] FS# 386; [b] FS# 433; [c] FS# 446; [d] FS# 480; [e] FS# 712; [f] FS# 498;[g] FS# 488
Bottom: Selected prehistoric ceramics from Site 18CH641. (L-R) [a] FS# 470; [b] FS# 437; [c] FS# 438 217

Figure 52. Map of Areas L and M, showing shovel test pattern and site boundaries 229

Figure 53. Above: Projectile points from Areas M and N non-site, and Site 18CH644. (L-R) [a] FS# 167; [b] FS# 180
Below: Selected prehistoric ceramics from Site 18CH643, and Site 18CH644. (L-R) [a] FS# 169; [b] FS# 184 237

Figure 54. Map of Area N, showing shovel test pattern and site boundaries 239

LIST OF TABLES

Table 1. Previously Identified Prehistoric Archeological Sites Located Within 3.2 km (2.0 mi) of the Project Area 10

Table 2. Previously Identified Historic Archeological Sites Located Within 3.2 km (2.0 mi) of the Project Area 27

Table 3. Indian Head Residential Historic District Buildings and Structures Constructed Between 1938 and 1950 73

Table 4. Naval Proving Ground Historic District Buildings and Structures Constructed Between 1938 and 1950 80

Table 5. Naval Powder Factory Historic District Buildings and Structures Constructed Between 1938 and 1950 85

Table 6. Site 18CH388 - Summary of Prehistoric Ceramics 148

Table 7. Site 18CH388 - Functional and Typological Breakdown of Historic Assemblage 150

Table 8. Site 18CH84 - Functional and Typological Breakdown of Historic Artifacts from Stone and Brick Foundation 167

Table 9. Site 18CH391 - Summary of Prehistoric Ceramics 170

Table 10. Site 18CH392 - Summary of Diagnostic Historic Artifacts 173

Table 11. Site 18CH647 - Summary of Diagnostic Historic Artifacts 234

Table 12. Distribution of Temporal Components by Site 243

Table 13. Area and Site Recommendations 250

CHAPTER I

INTRODUCTION

Project Location and Description

This report presents the results of archival, archeological, and architectural investigations at Naval Surface Warfare Center, Indian Head, Maryland (Figures 1 and 2). Indian Head is located on Cornwallis and Stump Necks at the mouth of Mattawoman Creek on the east bank of the Potomac River. These investigations were conducted by staff from R. Christopher Goodwin & Associates, Inc. who meet the Secretary of the Interior's professional qualifications standards (36 CFR 61). The project was undertaken on behalf of the Department of the Navy, Engineering Field Activity Chesapeake (EFA Chesapeake) for Indian Head Division, Naval Surface Warfare Center (IHNSWC), Charles County, Maryland under Contract N62477-95-D-0044, Delivery Order No. 0003.

The current investigation was undertaken in compliance with Sections 106 and 110 of the National Historic Preservation Act (NHPA) of 1966, as amended, which charges Federal agencies with identification and evaluation of historic resources under their stewardship and the nomination of eligible properties to the National Register of Historic Places (National Register). The Department of the Navy also has established standards and procedures for executing its stewardship responsibilities for cultural resources in OPNAVINST 5090.1B, Chapter 23, "Historic and Archeological Resources Protection." The work also was undertaken in accordance with the guidelines set forth in the *Secretary of the Interior's Guidelines for Historic Preservation* and those established by the Maryland Historical Trust (Shaffer and Cole 1994).

Research Objectives and Design

The research objectives for the current investigations were to conduct a detailed investigation of the history of the property, an examination of previous cultural resources studies within the project area, and a systematic survey and assessment of both archeological and

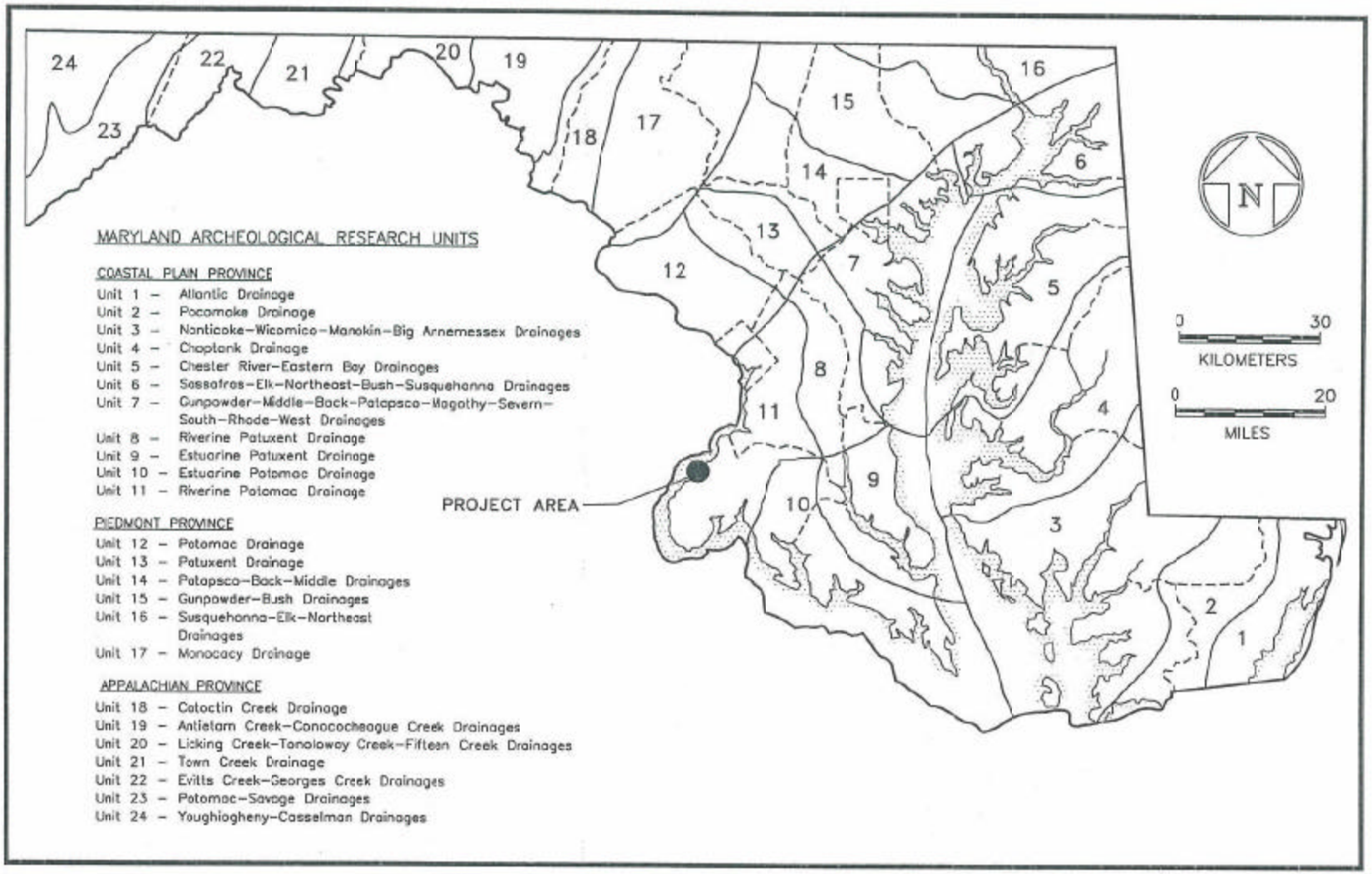


Figure 1. Location of Project Area in Charles County, Maryland

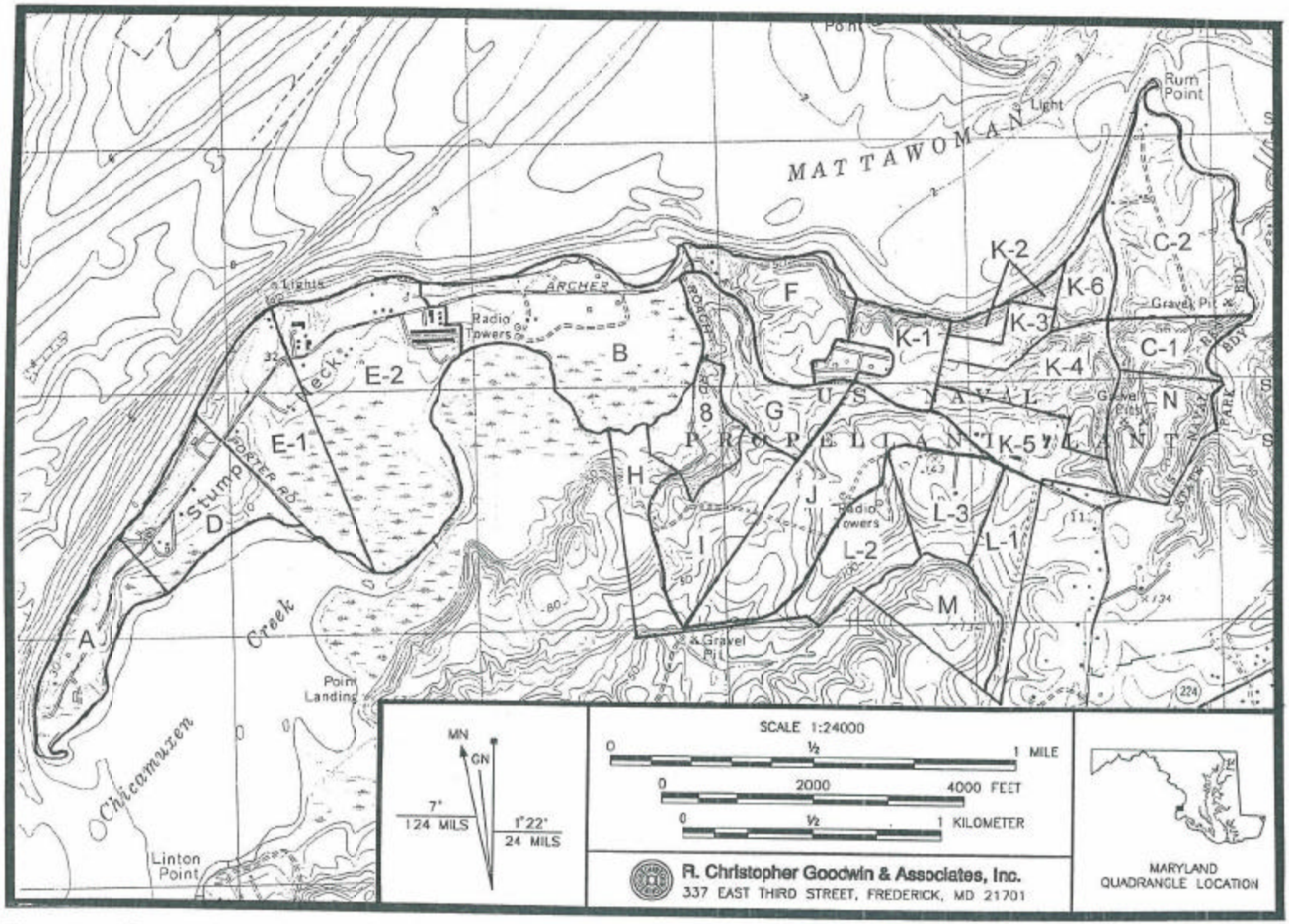


Figure 2. Excerpt from the 1966 (Photorevised 1978) Indian Head, Maryland/Virginia 7.5' USGS Quadrangle, Showing the Location of the Project Area

architectural resources on the activity. Phase Ib intensive-level archeological survey was conducted over approximately 1,065 acres on the Stump Neck Annex. The architectural investigations were to identify, document, and evaluate all structures erected between 1938 and 1950. The proposed National Register Historic Districts also were reviewed.

The archeological research design included the following objectives: (1) to locate, identify, and delineate all prehistoric and historic cultural features within the Stump Neck Annex, IHNSWC; (2) to evaluate, as possible, the eligibility of cultural resources within the project area for listing in the National Register of Historic Places, applying National Register Criteria of Evaluation (36 CFR 60.4 [a-d]); (3) to provide cultural resource management recommendations for these resources; (4) to provide data on prehistoric and historic landuse patterns in the region. The intensive Phase Ib archeological survey built upon the results of a Phase Ia archival and archeological reconnaissance survey conducted by John Milner and Associates (Stevens et al. 1995).

The objective of the architectural investigations was to follow up the previous architectural survey work conducted at Indian Head during the 1980s that involved an examination of all buildings and structures erected prior to 1938. The current investigations were designed to identify, document, and evaluate the potential significance of all buildings constructed between 1938 and 1950. The previous Indian Head architectural evaluation, completed in November 1995 by John Milner Associates, identified three National-Register eligible historic districts at NSWC. The three proposed historic districts are: (1) the Indian Head Residential Historic District; (2) the Naval Proving Ground Historic District; and, (3) the Naval Powder Factory Historic District. These district evaluations excluded all buildings built after 1938. The current architectural investigations consisted of three primary tasks: (1) survey and assessment of buildings constructed between 1938 and 1950; (2) review of the three proposed National Register Historic Districts; and, (3) preparation of management recommendations pertaining to National Register-eligible structures at NSWC.

Overview of the Project Area

The Indian Head Naval Surface Warfare Center consists of property situated on both the north and south sides of Mattawoman and Chicamuxen Creeks, which are tributaries of the Potomac River. The activity is composed of two principal areas: (1) the northern Indian Head area, located on Cornwallis Neck, which includes approximately 1,970 acres; and (2) the southern Stump Neck Annex, containing approximately 1,170 acres. The main Indian Head area includes approximately 1970 acres and is a relatively densely developed area for the production of explosive materials. The Stump Neck Annex is less developed and serves as an explosive training and testing area. Other properties associated with the activity include: March Island, 25 acres; Thoroughfare Island, 10 acres; Bullitt's Neck, 47 acres; and White Plains Railroad, 161 acres.

Organization of the Report

Chapter I presents a description of the project and research objectives. Chapter II provides a description of the project area, an overview of the natural setting, and an historic context for the installation. Archival research emphasized the post-1938 period of development at Indian Head. The research methodology is presented in Chapter III. The results of architectural investigations are presented in Chapter IV; results of the archeological investigations are presented in Chapter V. Chapter VI provides management recommendations. Appendix I contains a list of buildings and architectural descriptions of the buildings and structures included in the current survey. Appendix II consists of the National Register nomination form for the proposed Extrusion Plant Historic District and the amended forms for the three previously proposed National Register Historic Districts. Appendix III includes the inventory of results for the archeological investigations. Appendix IV contains the site forms. Appendix V includes the resumes of key project personnel. The architectural field forms, computer-generated database, and photographic documentation are contained in a separate data compendium, which will be submitted upon review and approval of the final technical synthesis report.

CHAPTER II

NATURAL AND CULTURAL SETTING

Natural Setting

Indian Head Division, Naval Surface Warfare Center (IHNSWC) is situated in western Charles County Maryland, on the Potomac River (Figure 2). The activity consists of property situated on both the northern and southern sides of Mattawoman and Chicamuxen Creeks, which are tributaries of the Potomac River. The approximately 1,369.1 ha (3,383 ac) activity is composed of two principal areas: (1) the northern Indian Head area, including approximately 797.3 ha (1,970 ac); and (2) the southern Stump Neck Annex, containing approximately 473.5 ha (1,170 ac). The Indian Head area is a relatively densely developed area located on Cornwallis Neck; its primary mission is the production of explosive materials. The Stump Neck Annex is less developed and serves as an explosive training and testing area. Other properties associated with the activity include: March Island, 10.1 ha (25 ac); Thoroughfare Island, 4.0 ha (10 ac); Bullitt's Neck, 19.0 ha (47 ac); and White Plains Railroad, 65.2 ha (161 ac).

Indian Head Division, Naval Surface Warfare Center is located in the Atlantic Coastal Plain Province (Maryland Archeological Research Unit 11, the Riverine Potomac Drainage). The Stump Neck Annex is dissected by second, third, and fourth order tributaries of Mattawoman Creek, Chicamuxen Creek, and the Potomac River. Associated terrace fringes are divided into a series of finger ridges by steep, "V-profile" drainages. Slopes within the area were observed ranging from nearly flat to nearly vertical, which provide dynamic relief. Elevations range from less than 3 to 43.5 m (10 to 143 ft.) above mean sea level (amsl). Lowest elevations are located on the floodplains of the Potomac River. Highest elevations occur on the upland plateau located immediately southwest of the Quarterdeck.

Indian Head is situated on riverine terraces of the Coastal Plain. Beneath the Coastal Plain, a Piedmont basement slopes from the Fall Line to the southeast. The overlying coastal plain strata

simultaneously slopes and thickens in this same direction, forming a wedge-shaped deposit that extends along the entire eastern seaboard of North America, and off-shore towards the continental shelf of Canada. The parent material of all soils in Charles County is composed of unconsolidated deposits of the Coastal Plain. These deposits, or geologic formations, are composed of nearly horizontal beds of loose sediment consisting of silt, clay, sand, gravel, and limestone of both continental and marine origins. The geology of the Coastal Plain deposits is usually stratiform, with finer-grained deposits characterizing the easternmost portions of the formation.

Two soil associations are mapped for the project area within the Stump Neck Annex of Indian Head; Beltsville-Exum-Wickham Association and Bibb-Tidal Marsh-Swamp Association (Hall and Matthews 1974). Within these associations, two soil series have been mapped for the project area. Beltsville silt loam has a typical stratigraphic profile including a 2.5Y 5/2 grayish brown silt loam from the surface to a depth of 5 cm. Below this is a pale yellow 2.5Y 7/4 silt loam to 30 cm. A light yellowish brown 10YR 6/4 heavy silt loam follows to a depth of 40 cm. No testing extended below this depth. Gravelly land is a mix of soils and gravels representing extensive erosion. No specific color or texture information applies. This series was mapped and clearly observed for the western portion of the testing area.

The Stump Neck Annex includes a diverse assemblage of both floral and faunal species. Late prehistoric and historic modification of the land have dramatically altered both the floral and the faunal species present in this region.

Typical forest morphology for southern Maryland includes three subsets of vegetation resultant from recent human activity. Old growth forests typically exist along the slopes of the major, more deeply incised drainages. These are typical of the Oak-Hickory group defined by Kricher (1988). Species of this group include: a variety of oak and hickory including White Oak, Northern Red Oak, Chestnut Oak, Black Oak, Pignut Hickory, Butternut Hickory, Shellbark Hickory; in mesic environments Tulip tree, Sweetgum, and Red Maple; and areas of recent human activity Black Locust, Red Cedar, and Pitch Pine; and although not indicator species, American Beech, American Holly, Princess Tree, Flowering Dogwood, and Ironwood.

In areas of disturbance, the high canopy species are less numerous and there is an increase in primary regrowth vegetation, including thorned species of wild berries, common greenbriar, poison ivy, devils walking stick, and virginia creeper. These areas typically include abandoned activity areas or areas of clear-cut deforestation. Other areas have been completely cleared of all trees. These include maintained lawns, building sites, firing ranges, and wildlife management areas.

A variety of faunal species is supported by the ecosystem present in and surrounding the Indian Head facilities. The proximity to the Potomac River and the high bluffs overlooking the Mattawoman Creek provide a basis for a divers faunal population. Faunal species include: bald eagle, wild turkey, red tail hawk, and a variety of songbirds as well as scavengers; a variety of rodent species including mice, chipmunk, gray squirrel, and beaver; and other mammals including red fox, skunk, opossum, raccoon, and white tailed deer.

Charles County has a continental climate with well defined seasons (Hall and Matthews 1974:91). The project area is situated within the average path of low-pressure systems that move across the continent, causing frequent changes in local weather patterns. Prevailing winds are from northwest to west-northwest, except during summer, when southerly winds are more common. Wind velocity averages 14 km (9 mi) per hour. Climatic conditions within Charles County are significantly influenced by the modifying effects of the Chesapeake Bay and Atlantic Ocean. The warmest period of the year for the project area falls in late July, when maximum temperatures average 89° F. The coldest temperatures occur during the last part of January and the beginning of February, when daily minimum temperatures average 21° F. The annual growing season for the region averages 187 days, with the first winter frosts occurring in mid-October. Annual precipitation for central Charles County measures 119 cm (47 in) per anum on average, with rainfall being fairly evenly distributed throughout the year. The highest levels of precipitation are measured during the months of July and August. Annual snowfall averages 46 cm (18 in). Relative humidities are consistently high throughout all months of the year due to the proximity of the area to large bodies of water. Drought may occur at any time of the year, but is more prevalent during the summer months.

Prehistoric Setting

Previous Investigations

An examination of the Maryland Inventory of Historic Sites identified 65 prehistoric archeological sites within a 3.2 km (2 mi) radius of the project area (Table 1). Most of these sites were recorded during six previous cultural resource studies undertaken in the vicinity of the project area.

The first of these studies was undertaken by Steve Wilke and Gail Thompson as part of a statewide study of the archeological resources within Maryland's coastal zone. This report, *Prehistoric Archeological Resources in the Maryland Coastal Zone: a Management Overview*, was completed in 1977. The Wilke/Thompson study examined the southern shoreline of the Mattawoman Creek, south of the Indian Head Area. A total of nine prehistoric archeological sites were located in the vicinity of the project area; two sites (18CH149 and 18CH150) were located within the boundaries of the Stump Neck Annex.

The second study, *A Preliminary Reconnaissance of the Naval Ordnance Station, Indian Head, MD*, was undertaken by William Barse in 1985 under contract with the Maryland Historical Trust and included the project area. The Barse investigation consisted of a Phase I investigation at the Indian Head Naval Ordnance Station. The results of this survey included the identification of 45 archeological sites, all but four of which were prehistoric. Of the datable prehistoric components, 1 was classified as the Early Archaic; 1 as Middle Archaic; 5 as Late Archaic; 4 as Early Woodland; 5 as Middle Woodland; and 19 as Late Woodland. The ceramics found in the Early Woodland components included Marcey Creek and Accokeek ware; in the Middle Woodland occupations, Popes Creek and Mockley dominated; the Late Woodland sites contained Potomac Creek ceramics. Most of these sites were located along ridges, knolls, upland flats, bluffs, or benches that overlook Mattawoman Creek, one of its tributary drainages, or the Potomac River. One site (18CH281) consisted of a Late Woodland/Contact Period village, and two (18CH270 and 18CH283) may have reflected Late Woodland hamlets. Where characterization was possible, the remaining sites were considered short-term or transient encampments, or resource procurement areas.

TABLE 1. PREVIOUSLY IDENTIFIED PREHISTORIC ARCHEOLOGICAL SITES WITHIN 3.2 KM (2 MI) OF THE PROJECT AREA

Site No./Name	Reported By	Diagnostic Artifacts	Site Type	Cultural Period
18CH23	MacNamara	No data	Camp	Period unknown
18CH71	Barse 1985	No data	Unknown	Period unknown
18CH82	Dowling and Graham 1891	No data	Unknown	Archaic/Woodland
18CH84/Rum Point	Graham 1950; J. Milner & Assoc.	Potomac Creek Pottery	Unknown	Archaic/Woodland
18CH142/CH-C #14	Wilke and Thompson 1977	No data	Unknown	Period unknown
18CH143/CH-C #14	Wilke and Thompson 1977	No data	Unknown	Period unknown
18CH144/CH-C #12	Wilke and Thompson 1977; Barse 1985	No data	Unknown	Period unknown
18CH145/CH-C #11	Wilke and Thompson 1977; Barse 1985	No data	Unknown	Period unknown
18CH146	Wilke and Thompson 1977; Barse 1985	No data	Unknown	Period unknown
18CH147	Wilke and Thompson 1977; Barse 1985	No data	Unknown	Period unknown
18CH148/CH-C #4	McNamara 1978	Prehistoric	Unknown	Period unknown
18CH149/10-1	Wilke and Thompson 1977; Stevens et al. 1995	Pope Creek sherds; bifaces	Short-term Camp	Middle Woodland
18CH150	Wilke and Thompson 1977; Stevens et al. 1995	Decorated ceramics; primary and secondary flakes of quartz, quartzite, and rhyolite; fire-cracked rock	Possible seasonal camp	Period unknown

Site No./Name	Reported By	Diagnostic Artifacts	Site Type	Cultural Period
18CH151	Wilke and Thompson 1977	Prehistoric ceramics	Unknown	Woodland
18CH206/Sweden Point	McNamara 1978	Grit-tempered pottery	Unknown	Period unknown
18CH251	Barse 1985	Piscataway	Unknown	Early Woodland
18CH252	Barse 1985	Kirk Variant, Popes Creek, Mockley, Triangular Points	Unknown	Early Archaic to Late Woodland
18CH253	Barse 1985	Potomac Creek	Camp	Late Woodland
18CH254	Barse 1985	Marcey Creek, Mockley and Potomac Creek ceramics	Unknown	Early to Late Woodland
18CH255	Barse 1985	Mockley, Potomac Creek	Unknown	Middle Woodland/ Late Woodland
18CH256	Barse 1985	Potomac Creek	Unknown	Late Woodland
18CH257	Barse 1985	Potomac Creek	Extractive camp	Late Woodland
18CH258	Barse 1985	Contracting stem point	Unknown	Middle Archaic
18CH260	Barse 1985	No data	Unknown	Middle Archaic
18CH261	Barse 1985	Mockley, Potomac Creek	Unknown	Middle Woodland/ Late Woodland
18CH262	Barse 1985	No data	Camp	Period unknown
18CH263	Barse 1985	Popes Creek, Potomac Creek	Unknown	Middle Woodland/ Late Woodland
18CH264	Barse 1985	Marcey Creek	Camp	Early Woodland
19CH265	Barse 1985	Accokeek	Short-term camp and limited quarry	Period unknown
18CH266	Barse 1985	None	Short-term camp	Period unknown
18CH267	Barse 1985	None	Unknown	Period unknown

Site No./Name	Reported By	Diagnostic Artifacts	Site Type	Cultural Period
18CH268	Barse 1985	Accokeek	Camp	Early Woodland
18CH269	Barse 1985	Steatite bowl fragment, Accokeek	Unknown	Late Archaic/ Early Woodland
18CH270	Barse 1985	Potomac Creek	Unknown	Late Woodland
18CH273	Barse 1985	Contracting Stem Point	Camp with quarry activity	Late Archaic
18CH274	Barse 1985	Steatite	Camp	Late Archaic
18CH275	Barse 1985	Guilford point, Brewerton? point	Unknown	Early Woodland/ Late Archaic
18CH276	Barse 1985	None	Camp	Period unknown
18CH277	Barse 1985	None	Camp/quarry	Period unknown
18CH278	Barse 1985	Potomac Creek	Camp	Late Woodland
18CH279	Barse 1985	Potomac Creek	Camp	Late Woodland
18CH280	Barse 1985	Potomac Creek	Camp	Period unknown
18CH281	Barse 1985	Potomac Creek	Village or base camp	Late Woodland/ Contact
18CH282	Barse 1985	Potomac Creek	Unknown	Late Woodland
18CH283	Barse 1985	Potomac Creek	Hamlet	Late Woodland
18CH284	Barse 1985	Potomac Creek	Transient camp	Late Woodland
18CH285	Barse 1985	Potomac Creek	Transient camp	Late Woodland
18CH286	Barse 1985	Potomac Creek	Transient camp	Late Woodland
18CH287	Barse 1985	Triangular points	Camp	Early Woodland/ Late Woodland
18CH288	Barse 1985	None	Unknown	Period unknown

Site No./Name	Reported By	Diagnostic Artifacts	Site Type	Cultural Period
18CH289	Barse 1985	None	Unknown	Period unknown
18CH290	Barse 1985	None	Transient camp	Period unknown
18CH291	Barse 1985	Popes Creek, Potomac Creek	Unknown	Middle Woodland/ Late Woodland
18CH386	Stevens et al. 1995	Potomac Creek	Short-term resource procurement	Late Woodland
18CH388	Stevens et al. 1995	Bifaces, Flaked Cobble	Unknown	Period unknown
18CH389	Stevens et al. 1995	Popes Creek	Unknown	Middle Woodland
18CH390	Stevens et al. 1995	2 decortication flakes; 2 secondary flakes	Unknown	Period unknown
18CH391	Stevens et al. 1995	Accokeek	Base camp	Early Woodland/ Late Woodland
18CH392	Stevens et al. 1995	None	Unknown	Period unknown
18CH393	Stevens et al. 1995	None	Unknown	Period unknown
18CH394	Stevens et al. 1995	None	Unknown	Period unknown
18CH395	Stevens et al. 1995	None	Unknown	Period unknown
18CH422	L. Berger & Assoc. 1994	None	Unknown	Period unknown
18CH423	L. Berger & Assoc. 1994	None	Unknown	Period unknown
18CH486	Busby 1995	None	Unknown	Period unknown

The third study was undertaken by John Milner & Assoc. in 1994 (Stevens et al. 1995). This study involved a reconnaissance level archeological investigation of the Stump Neck Annex, NAVEODTECHDIV and intensive Phase Ib testing of three areas on Cornwallis Neck. Researchers conducting the reconnaissance survey examined three of the previously recorded sites (18CH84, 18CH149 and 18CH150), and identified eight previously unrecorded prehistoric sites; these sites date from the Early to Late Woodland periods. Due to the nature of this investigation, the boundaries of these sites were not delineated. Intensive survey examined three previously identified Late Woodland sites (18CH278, 18CH279, and 18CH280). Two unrecorded sites (18CH386 and 18CH387) also were identified. Site 18CH386 was a Late Woodland Site containing Potomac Creek ceramics. Site 18CH387 was a nineteenth century site

In 1994, an archeological survey of approximately 14 acres on Cornwallis Neck was conducted at three alternate sites for the Explosive Test Facility at NSWC Indian Head. Two archeological sites (18CH422 and 18CH423) were identified. The sites contained non-diagnostic prehistoric materials and late eighteenth through nineteenth century historic materials. No further work was recommended at either site.

Phase I investigations for the proposed Denitration/Acid Mix Facility (MilCon P-121) were undertaken by R. Christopher Goodwin & Associates, Inc. in April 1995 on behalf of ECG, Inc. for Indian Head Division, Naval Surface Warfare Center. The archeological survey area consisted of a 0.88 acre parcel. The majority of the project area had been disturbed. A dispersed artifact scatter was revealed in the undisturbed portion of the project area. Four pieces of window glass and a triangular metal hinge reflected historic disposal; prehistoric material consisted of two quartz secondary flakes. The prehistoric and historic artifact scatter identified in the project area was considered too ephemeral to be considered a site. No further archeological investigation was recommended.

Phase I investigations preceding the construction of a new pass office at the Naval Explosive Ordnance Disposal Technology Division (Stump Neck Annex) identified a small prehistoric site (18CH486)(Busby 1995). The small lithic scatter was of unknown temporal or cultural affiliation.

Areas of moderate to extensive disturbance were observed across the site. Due to the non-descript nature of the assemblage and the disturbance present, no further archeological work was recommended.

An Archaeological Resource Management Plan for the Southern Maryland Region, published in 1985, provides a useful background document for the study area (Pogue and Smolek 1985). The Mattawoman Creek vicinity was defined as "exhibiting high probability for containing significant archeological remains" (Pogue and Smolek 1985:134). In addition to a thorough review of the natural and cultural setting, the plan discussed factors that can bias archeological survey. One biasing factor that may be relevant to the study area was "field dumping," the eighteenth and nineteenth century practice of spreading household garbage, including artifacts, across active fields. This practice creates the illusion of an historic site.

A review of settlement patterns on the Mattawoman Creek identified 209 prehistoric sites within the drainage; 66 per cent of the sites contained no diagnostic materials (Child 1995). The data indicate that an overwhelming number of the sites within the drainage contain components dating to the Late Woodland period. The 236 temporal components on these sites included: 2 Early Archaic period components; 3 Middle Archaic; 10 Late Archaic; 10 Early Woodland; 13 Middle Woodland; and 34 Late Woodland.

A large proportion of the previously identified sites in the vicinity of the Indian Head Naval Surface Warfare Center date from the Woodland period. Woodland components were considerably more common than were those dating from the Archaic period. Of the 65 identified sites in the vicinity of the project area, 1 contained a component dating from the Early Archaic period, 3 dated from the Middle Archaic, 5 from the Late Archaic, 8 from the Early Woodland, 7 from the Middle Woodland, and 19 from the Late Woodland. A contact period site also was represented. This pattern is probably related to both the greater ability to date sites that contain ceramics, and to changes in the landscape of the lower Potomac River Valley. Sea level rise has inundated many Archaic period sites, leaving only the upland sites above the modern sea level.

The prevalence of sites on the low Pleistocene terraces on the margins of the Mattawoman and Chicamuxen Creeks as well as the Potomac River is at least partially due to a survey bias towards those areas in previous surveys. Upland sites were recorded by Barse on Cornwallis Neck (Barse 1985) as well as at Chapmans Landing immediately north of the project area (Davis et al. 1995).

The 12 sites on Stump Neck Annex known prior to the current survey were predominately of unknown temporal or cultural affiliation (Figure 3). Seven of the sites produced no diagnostic artifacts and therefore could not be assigned to a cultural period. The remaining five sites contained cultural components from the Archaic (18CH84), and the Woodland periods (18CH84, 18CH149, 18CH150, 18CH389, and 18CH391). Most of the sites were located in lowland portions of the Stump Neck Annex, particularly along the bluff above Mattawoman Creek. Only one site (18CH486) was located in an upland area. The pattern appears to be largely a result of survey bias; sites eroding out of the bluff are considerably more visible and more likely to be identified during reconnaissance surveys.

Three of the sites (18CH84, 18CH391, and 18CH392) were located on Rum Point, perhaps reflecting the intensive prehistoric use of the landform. Site 18CH84 was recorded by Graham in 1950. Diagnostic artifacts from the site were Potomac Creek sherds; the site also has an Archaic/Woodland cultural affiliation. Sites 18CH391 and 18CH392 were both identified by Milner & Associates (Stevens et al. 1995) on the inland central portion of the Rum Point peninsula. Site 18CH391 contained Accokeek sherds and was characterized as an Early and Late Woodland base camp. No temporally diagnostic artifacts were recovered from Site 18CH392, and its function is unknown. Site 18CH393 was located on an intermediate terrace at the confluence of a small stream and Mattawoman Creek. No diagnostic artifacts were recovered from these site.

Four sites (18CH149, 18CH150, 18CH394, and 18CH395) were located on the high bluff overlooking Mattawoman Creek, between Rum Point and Stump Neck. Site 18CH149 first was identified by Wilke and Thompson (1977) and was relocated by Milner & Associates (Stevens et al. 1995); the site was situated on a low terrace below Site 18CH393 at the confluence of a small

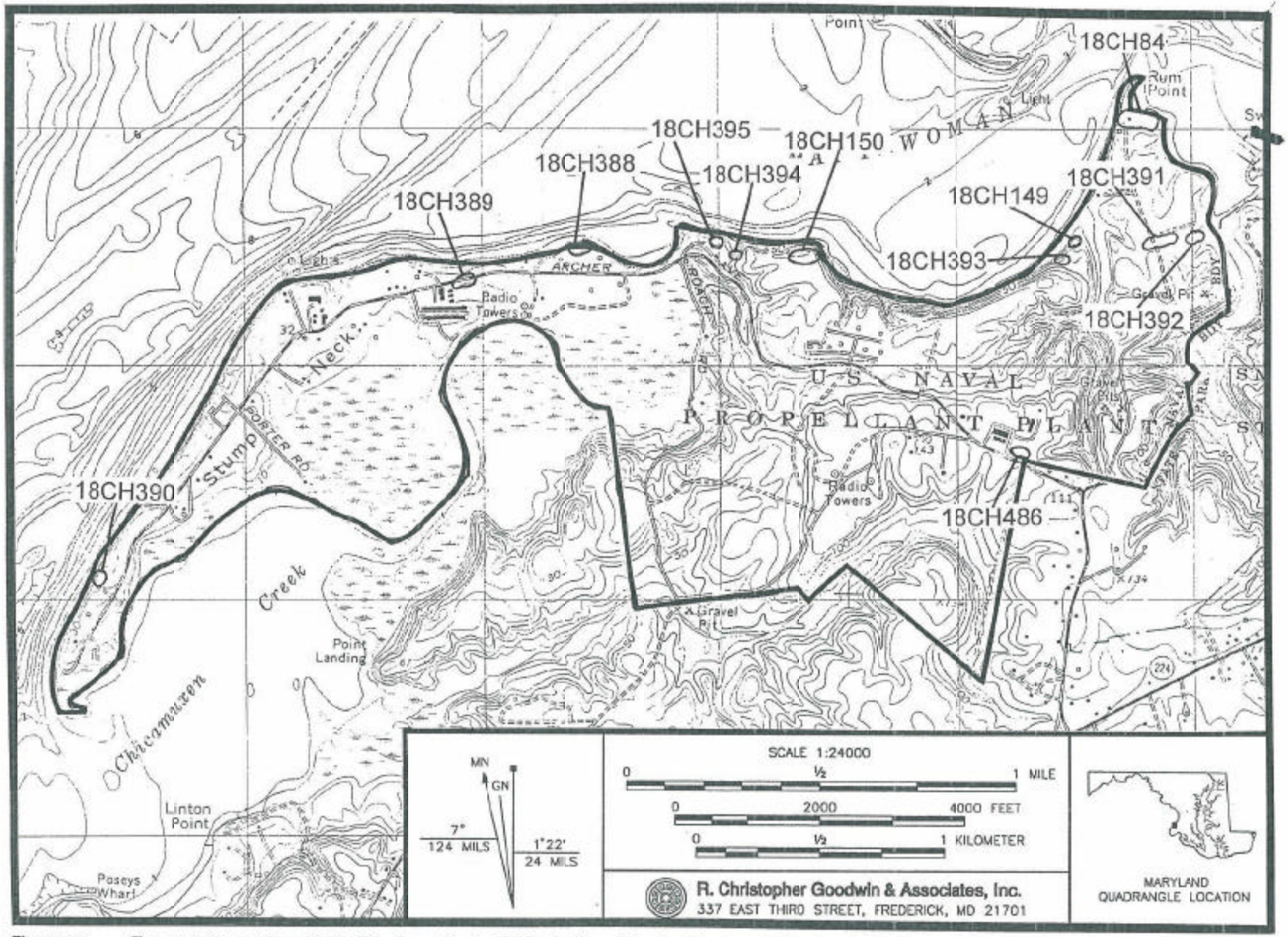


Figure 3. Excerpt from the 1966 (Photorevised 1978) Indian Head, Maryland/Virginia 7.5' USGS Quadrangle, Showing the Location of Previously Known Archeological Sites within the Project Area

stream and Mattawoman Creek. The site was characterized as a Middle Woodland site; several Popes Creek sherds and bifaces were recovered.

Site 18CH150 also was recorded by Wilke and Thompson (1977) and relocated during the recent Phase Ia survey (Stevens et al. 1995). The site overlooks the mouth of Mattawoman Creek and contained a number of artifacts, including unidentified decorated ceramics, debitage, and fire-cracked rock, and appears to have been a seasonal camp.

Further west, along the bluff overlooking the Mattawoman, Sites 18CH394 and 18CH395 were identified in 1994 (Stevens et al. 1995). The artifact assemblage from both sites contained primary and secondary flakes of quartz, quartzite and rhyolite.

Three sites were previously identified (18CH388, 18CH389, and 18CH390) on Stump Neck. Site 18CH388 was located in a grassy field along the shoreline of Mattawoman Creek under several layers of historic and modern fill. Several bifaces and a flaked cobble were recovered, but the lack of temporally diagnostic artifacts precluded temporal placement of the site (Stevens et al. 1995). This site may correspond to Indian Head Quad File #4.

Site 18CH389 was characterized as an early Middle Woodland site on the basis of the Popes Creek ceramics recovered from the site (Stevens et al. 1995). The artifacts were recovered from the surface collection of a plowed field on high level ground near the center of the peninsula.

Site 18CH390 was located near the tip of Stump Neck on a low bluff overlooking the Potomac River. No diagnostic artifacts were recovered from the lithic scatter that identified the site.

The only upland site previously recorded at Stump Neck was Site 18CH486, which was characterized as a small lithic scatter of an unknown function and occupation period (Busby 1995).

Prehistoric Cultural Sequence

The Paleo-Indian/Early Archaic Period. The Paleo-Indian/Early Archaic period ranged from about 12,000 to 6,500 B.C. The continuity of adaptive pattern throughout these periods (Gardner 1979, 1983) found in archeological investigations at the Flint Run Paleo-Indian Complex in the Shenandoah Valley, Virginia suggests that grouping them together is warranted. Diagnostic artifacts

villages in Prince George's County (Klapthor and Brown 1958:7). One of these palisaded villages, Moyaone, was excavated by Ferguson during the 1930s (Stephenson et al. 1963). In an ossuary, Ferguson found large quantities of Potomac Creek ceramics in context with seventeenth century European trade goods (Ferguson and Stewart 1940). The Susquehannock Wars of 1675 - 1676 dealt a severe blow to Indian-white relationships in the Potomac region. Several Charles County residents served in the militia during this struggle, and some were killed (Klapthor and Brown 1958:30)

The Late Woodland/Contact period at the installation is represented by 21 known sites (Barse 1985). Site 18CH281 is interpreted as a small village site, from the Contact period. The high number of known Late Woodland sites at the installation makes a Late Woodland component the most probable prehistoric manifestation within the project area.

Historic Setting

Previous Investigations

An examination of the Maryland Inventory of Historic Sites identified four historic archeological sites within a 3.2 km (2 mi) radius of the project area (Table 2). These are all domestic sites that were recorded on Cornwallis Neck during an archeological survey conducted by Barse (1985). Two of the sites (18CH271 and 18CH272) date from the early to mid-nineteenth century. One site (18CH270) dates from the mid to late nineteenth century and the fourth site (18CH259) from the mid nineteenth to early twentieth centuries. Small, ill-defined, historic components were identified on two other sites (18CH15 and 18CHX17) on Cornwallis Neck and three sites (18CH389, 18CHX391, and 18CH392) on Stump Neck. Little information is available concerning the nature of the sites on Cornwallis Neck.

The content and character of the sites on Stump Neck is documented more fully. Site 18CH389 produced a scatter of early twentieth-century domestic artifacts associated with a poured concrete house foundation. Occupation of the site probably relates to the early twentieth century hamlet of Winthrop. Site 18CH391 contained five late nineteenth to early twentieth century ceramics

TABLE 2. PREVIOUSLY IDENTIFIED HISTORIC ARCHEOLOGICAL SITES WITHIN 3.2 KM (2 MI) OF THE PROJECT AREA

Site No./Name	Reported By	Diagnostic Artifacts	Site Type	Cultural Period
18CH259	Barse 1985	No data	Domestic Site	19th C
18CH270	Barse 1985	No data	Domestic Site	19th C
18CH271	Barse 1985	No data	Domestic Site	18th-19th C
18CH272	Barse 1985	No data	Domestic Site	19th C

which may represent field dumping or a scatter related to a nearby historic site. A single sherd of purple decorated Westerwald stoneware was recovered from Site 18CH392.

Historic Cultural Sequence

Contact and Settlement Period (1634 - 1680)

Establishment of Charles County. The colony of Maryland was established in 1634, when approximately 150 colonist settled at St. Mary's City, located at a natural deep water port on the lower Potomac River. Cecilius Calvert, second Lord Baltimore, was proprietor of the colony. He inherited the charter for the region in 1632, from his father George Calvert, who had secured the Maryland grant from King Charles I (Wilstach 1931:35). This colony became Maryland, named for Henrietta Maria, wife of Charles I. St. Mary's City served as the seat of Maryland's colonial government until 1695, when Annapolis became the capitol. The success of tobacco cultivation in the neighboring colony of Virginia encouraged early Maryland colonist to adopt tobacco as the primary cash crop. Tobacco cultivation required large tracts of land and a large labor force. Small plantations dominated Maryland's tobacco economy. For almost a century settlement in the region was concentrated along major water routes with access to the Chesapeake Bay (Menard et al. 1988:185).

Charles County was established in 1658. The same year, a ferry began operation over the Wicomico River, in Charles County. The county courthouse was situated in the town of Popes Creek along the Potomac River. The county originally included all the land between the Wicomico River and the Potomac River. Prince George's County was later founded 1695, from the northern portions of Charles County (Walsh 1977:2-3). The original boundaries for Prince George's County included some land north of Mattawoman Creek. In 1748 the Maryland Assembly voted to return this land to Charles County, at the request of the residents (Van Horn 1976:85).

Charles County's early population grew steadily; the European population increased from 900 in 1660 to 1,884 in 1675, but the area remained sparsely settled (Pogue and Smolek 1985:52, 57). The colonial legislature attempted to encourage the economic growth of towns through the

Potomac River, as well as to prevent smuggling goods to the enemy, recruitment into the rebel army, and any other secessionist activity (Newmann 1976:213). Maryland had been a slave state before the war and constantly gave Washington worries as a border state with questionable loyalties (Herbert 1944:55-56).

In early October of 1861, Union General Joseph Hooker and his division established their headquarters in and around the Stump Neck and Rum Point area. He erected earthworks on the Indian Head peninsula and constructed supply depots at Rum Point and ten miles south at Liverpool Point. To defend against confederate raids, Hooker stationed troops near Budd's Ferry, approximately 1.5 miles southeast of the tip of Stump Neck; Sandy Point, approximately eight miles southeast of Rum Point; and a landing on Mattawoman Creek, possibly Rum Point. To improve communications, Hooker moved his headquarters from six miles above Budd's Ferry to two miles southeast of Rum Point. The headquarters, which also housed a Union regiment, was called Camp Baker (Herbert 1944:57-60).

The establishment of the encampment at Rum Point was described in the memoirs of Private Alfred Bellard:

> On the afternoon of the 5th we were again on the move, and marching about 4 miles we entered a beautiful pine grove interspersed with holly, hemlock and cedar trees, which was to be our future home for the winter. After stacking arms, the tents were brought out and pitched and we were at home once more. The rebels were on the other side of the river at Cockpit Point where they had a battery for the purposed of blockading the Potomac River but the day that we arrived, some 40 shells had been thrown at an oyster boat without doing any further damage than sprinkling them with water. One full company took charge of Rum Point Landing, about 4 miles from camp, to protect the government stores and other property that were landed at that place, previous to being transported to camp. There was also a detail of 108 men taken from the brigade for picket duty along the shore. It was rather risky bussines to sail on the river as the Johny's had 3 batterys on the oppisite side of the river, manned with heavy guns. One at Cockpit directly oppisite our camp with 5 guns, one at Shipping Point, lower down the river with 3 guns, and still another, and the most formidable at Aquia Creek (Donald 1975:35-36).

According to Captain R. S. Williamson's 1862 map of Budd's Ferry, Charles County, there were structures along the northern coast of Stump Neck. A Civil War era road is depicted on the map, as well as other roads that ran through the area. Also depicted on the map was the divisional headquarters of General Joseph Hooker, located approximately two miles southeast of Rum Point (Figure 5).

The building is surrounded by noncontributing buildings and is not visually related to the district. Therefore, Building 1343 was classified as a noncontributing element.

Building D323 (Farragut Hall), originally constructed as a Marine barracks, also has lost its integrity. Although the building retains its original footprint and massing, the windows and doors on the building have been replaced with historically inappropriate units.

The Mix House (No. D324) originally was constructed as a Bachelor Officers' Quarters. This building was assessed as noncontributing due to additions and alterations to the building. A one-story metal and plexiglass canopy was added to the front elevation. Along the rear elevation, a flat-roofed, one-story addition, wood deck, and bar were added.

Naval Proving Ground Historic District

Data generated under the current investigations confirmed the proposed district boundaries, statement of significance, and period of significance previously defined for the Naval Proving Ground Historic District. The district consists of approximately 23 acres flanking Torrense Road in the northern section of the installation, along the Potomac River (Figure 10).

The area is significant under Criterion A, as the original location of the proof work for the Washington Navy Yard and for its later role in testing smokeless powder manufactured at the nearby Single Base Line. The area also is significant under Criterion C for its distinctive design. The landscape and the buildings in the proving ground were designed specifically for testing weaponry. The earliest buildings were crude bunkers for sheltering personnel. The landscape of the district also was important to the proofing activities. A dock was built along the Potomac where barges from the Washington gun factory could unload weapons for testing. The terrain of the valley was important to early gun testing; guns generally were mounted on the south side of the valley and fired at a steel plate on the opposite side of the valley.

The period of significance for the Naval Proving Ground Historic District is 1890 to 1921. This period extends from the establishment of the proving ground in 1890 to 1921, when proofing activities were transferred to Dahlgren, Virginia.

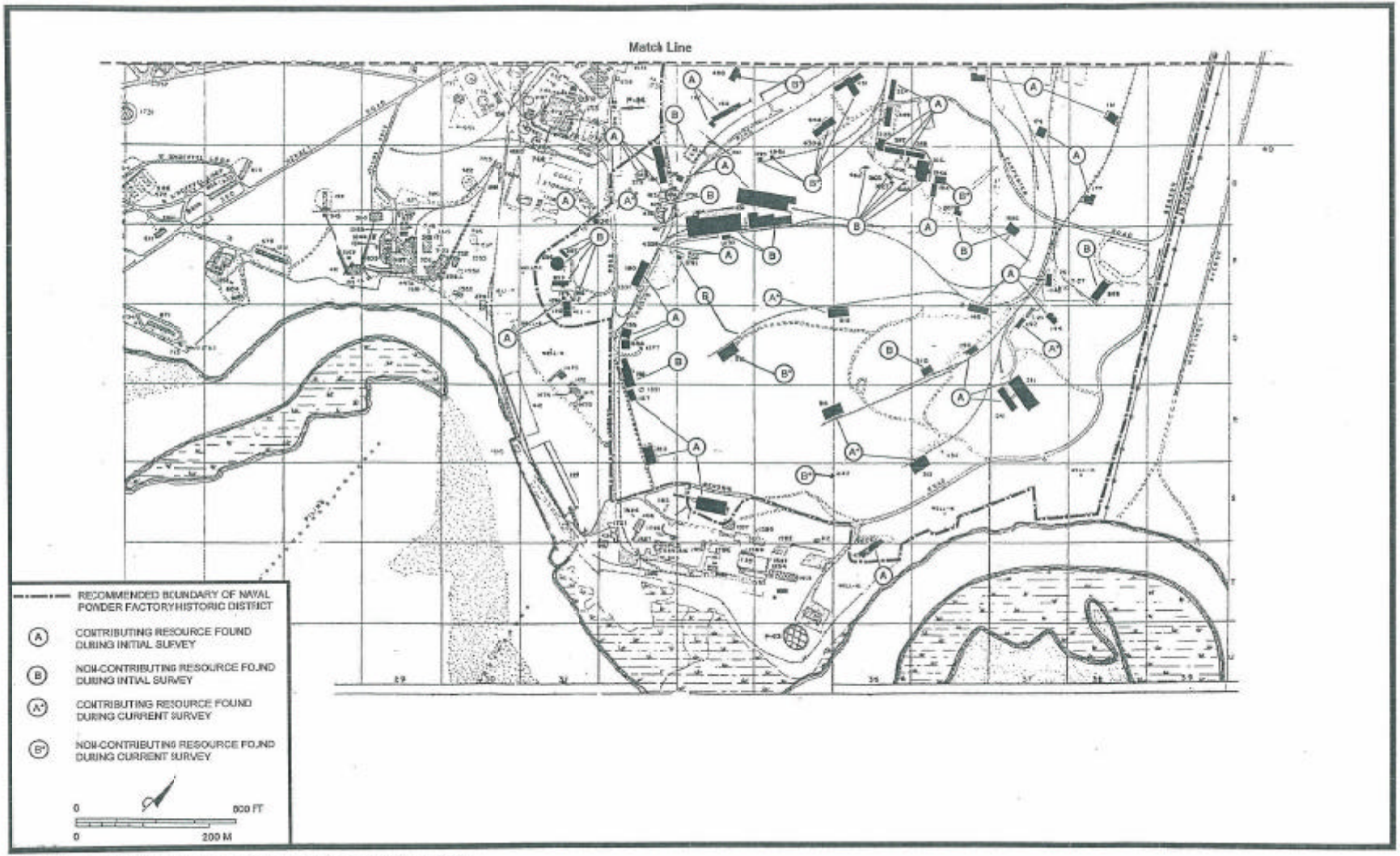
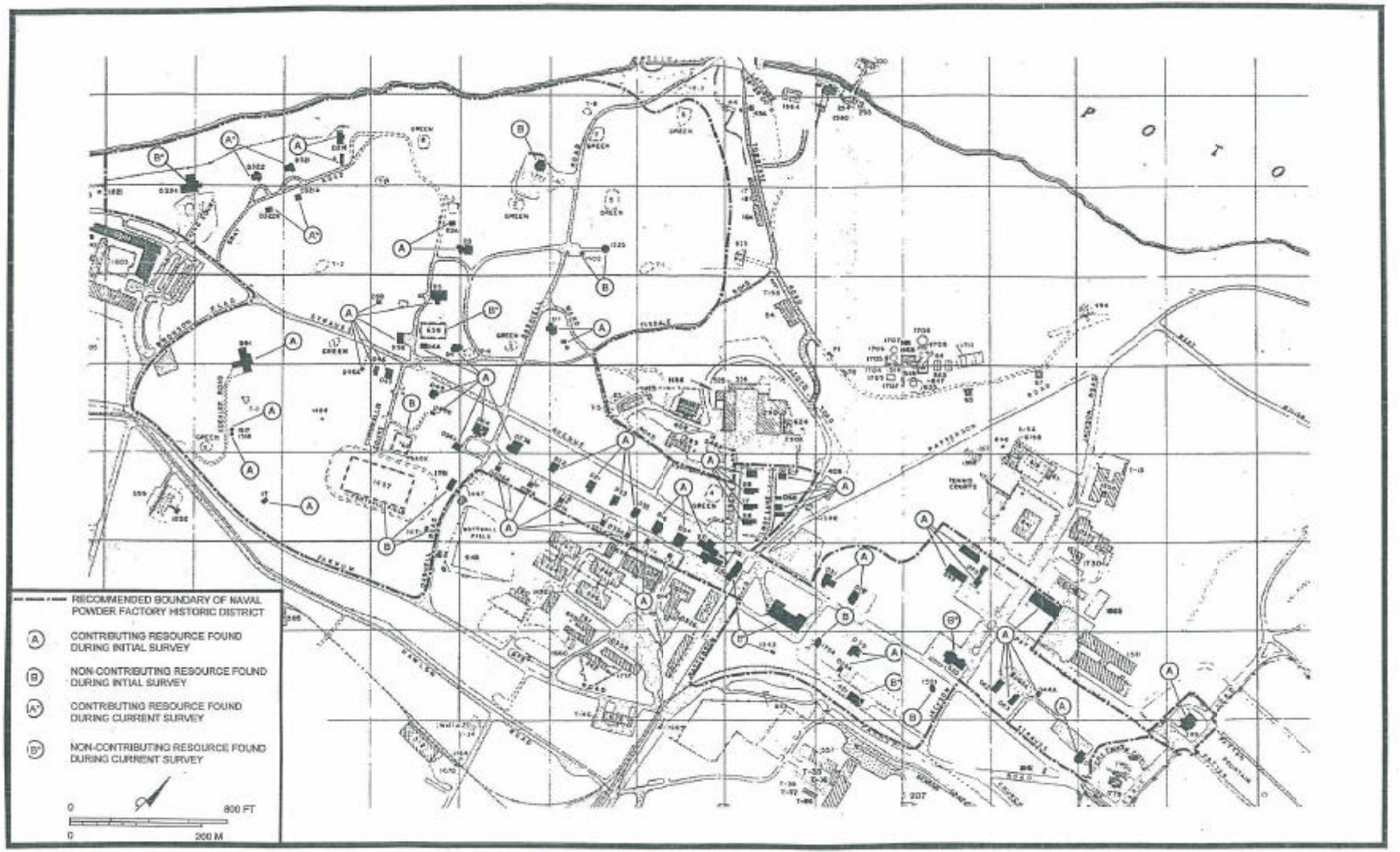


Figure 10. Map showing boundaries of the Naval Proving Ground Historic District


RECOMMENDED BOUNDARY OF NAVAL POWDER FACTORY HISTORIC DISTRICT
A CONTRIBUTING RESOURCE FOUND DURING INITIAL SURVEY
B NON-CONTRIBUTING RESOURCE FOUND DURING INTIAL SURVEY
A* CONTRIBUTING RESOURCE FOUND DURING CURRENT SURVEY
B* NON-CONTRIBUTING RESOURCE FOUND DURING CURRENT SURVEY
0
800 FT
0
200 M

The original documentation for the district comprised 10 contributing resources, 1 noncontributing resources, and 3 unevaluated resources. The resources that were unevaluated during the initial survey were erected after 1938. These resources were assessed as part of the current investigations. Discussions of these resources are provided below.

Newly Evaluated Resources. The three resources located within the district boundaries that were built after 1938 are the Marina Safety Building (No. 45A) and two magazines (Nos. 494 and 523). These three structures were constructed during the 1940s while the Jet Propulsion Lab (JPL) occupied the "Valley." All three resources were assessed as noncontributing because they do not fall within the district's period of significance (Table 4).

Building 45A is located along Torrense Road near the Potomac River. The building was constructed in 1942 as a powder cutting room (Figure 11). It is a one-story, rectangular brick structure with a flat roof. Two single metal doors are located on the front elevation. The gable end windows are covered with metal shutters.

Buildings 494 and 523 are identical structures built in 1941 as high explosives magazines. Building 523 is located at the intersection of Tisdale and Torrense roads; Building 494 is situated on a dirt road in the northeast portion of the district. These magazines are one-story structures built of concrete with concrete retaining walls. The side walls and roof are covered with earth. A double metal door with strap hinges is located along the front elevation. A concrete loading dock extends from the door.

Naval Powder Factory Historic District

During the current investigations, the area of the installation delineated as the Naval Powder Factory (NPF) Historic District also was reexamined. Investigations confirmed the proposed district boundaries, statement of significance, and period of significance as defined in the 1995 Milner survey are appropriate for the NPF Historic District.

The district consists of approximately 370 acres in the easternmost section of the installation. The district boundaries encompass all areas associated with the production of

TABLE 4. NAVAL PROVING GROUND HISTORIC DISTRICT BUILDINGS AND STRUCTURES CONSTRUCTED BETWEEN 1938 AND 1950

Bldg. #	Date	Current Use	Historic Use	Recommendation
45A	1942	Marina Safety Building	Powder Cutting Room	NPG NC
494	1941	Magazine	High Explosives Magazine	NPG NC
523	1941	Magazine	High Explosives Magazine	NPG NC

C = Resource contributes to historic district
NC = Resource does not contribute to the historic district
NPG = Resource is located within the Naval Proving Ground Historic District boundary
Res. = Resource is located within the Residential Historic District boundary
NPF = Resource is located within the Naval Powder Factory Historic District boundary
EXP = Resource is located within the Extrusion Plant Historic District boundary
NE = Not Eligible; Resource is not within historic district boundary and is not individually eligible

smokeless powder through World War II. The spine of the district is formed by the manufacturing corridor, known as the Single Base Line. This Single Base Line was established in an S-curved valley that drained into the Mattawoman Creek. The facility was designed so that raw materials entered the line at Mattawoman Creek and advanced through the manufacturing process by rail. The support services, such as power plant, water distribution, storage, and offices were built along the sides of the main production corridor.

The NPF district is significant under Criterion A as the first major chemical factory operated by the Navy and an important supplier of smokeless powder during World Wars I and II. The district also was the location of an important research and development facility that contributed significantly to the development of more efficient manufacturing processes and new armament technology.

The NPF district also is significant under Criterion C for its design as an important industrial facility. The industrial buildings were designed to house specific machinery and processes. The late nineteenth century and earliest twentieth century buildings in the district incorporate ornamentation, while the design of the World War I and World War II buildings emphasize advances in building technology and the more functional aesthetic of the modern era. World War I-era buildings emphasize building structure, volume, and minimal ornamentation. Reinforced concrete and steel structural systems replaced the massive load-bearing masonry walls that had characterized nineteenth century factories (Cannan et al. 1996). Buildings constructed at the powder factory during the World War II industrial mobilization exemplify the typical developments in wartime industrial architecture (Cannan et al. 1996). During the earliest phase of World War II mobilization, permanent materials were used. By 1942, permanent building material shortages became acute, and industrial construction undertaken late in the emergency construction program utilized temporary materials. Wood-frame buildings clad with asbestos siding were erected, and construction of masonry buildings was limited (Cannan et al. 1996).

The period of significance for the NPF Historic District is 1900 to 1945. This period covers the initial phase of production and extends through World Wars I and II.

Newly Evaluated Resources within the Historic District Boundary. A total of 59 resources built between 1938 and 1950 and located within the NPF Historic District were evaluated for inclusion in the district (Figure 12; Table 5). Investigations revealed that three of the previously unevaluated resources were demolished since the last architectural survey was completed: Buildings 483, 617, and 618, all associated with the water filtration plant. New construction in the location of these buildings is underway.

The buildings added to the powder factory after 1938 were located within previously established functional areas of the factory: the cotton area; the powder area; and, the solvent and recovery area, which contain the solvent recovery houses and dry houses. Whereas the earlier buildings constructed at the powder factory exhibit permanent construction, many buildings erected during the World War II period reflect the efforts to economize.

The evaluation of these 59 resources resulted in the classification of 17 contributing resources and 42 noncontributing resources (Table 5). The contributing resources meet the National Register criteria for inclusion in the district. The noncontributing resources are those that were constructed after the period of significance (post-1945) or that lacked sufficient integrity to convey their historic importance.

Among the **contributing** resources are a solvent recovery house and its associated condenser houses; a powder picking house; an ether vault; smokeless powder magazines; and, research laboratories. These facilities are associated with the powder production process expanded during the World War II and the construction methods used. The following discussion of contributing resources is arranged in order of process; buildings constructed for use in the early stages of the powder production process are discussed first.

Building 496, Ether Vault No.4, was built in 1941 along the Single Base Line (Figure 13). The building is constructed of reinforced concrete and built into a hillside. The front exposed elevation of the structure is concrete with two metal double doors separated by a flat concrete pilaster. The wall features two recessed panels that are engraved with "ETHER VAULT." The vault is situated adjacent to Ether Vaults 1 and 2, which were built in 1899 and 1900, respectively.

CHAPTER V

RESULTS OF ARCHEOLOGICAL INVESTIGATIONS

Archival Results

An examination of the Maryland Inventory of Historic Sites identified numerous previously recorded prehistoric and historic archeological sites within a 3.2 km (2 mi) radius of the project area. Eleven of the sites were located within the boundaries of NAVEODTECHDIV, Stump Neck. A majority of these sites were of unknown age. Of the 11 sites previously identified on Stump Neck, all contained Woodland period components; only one contained an Archaic component. This pattern is consistent with the predominance of Woodland, particularly Late Woodland sites, observed by Barse (1985) on Cornwallis Neck.

John Smith recorded several villages in the vicinity of Stump Neck on his 1612 map. Barse (1985) argued that Smith's commoner village of *Cinquateck* was located south of Mattawoman Creek, on Stump Neck. According to Clark and Roundtree (1993:114, Figure 5.2) the early seventeenth century village was a Mattawoman Indian commoner village. Cornwallis and Stump Necks were occupied by during the 1670s by several Pamunkey and Mattawoman villages (Clark and Rountree 1993:115, Figure 5.3).

European settlement in the area did not occur until around 1654 when Thomas Cornwallis patented a 5,000 acres tract called Mattawoman Neck, located north of Stump Neck (Charles County Land Records, Liber AB&H, Folio 401; Busby 1995). References to "Stump Neck Town" in colonial documents between 1649 and 1670 document the failed efforts of the colonial government to develop a trading port in the vicinity of "Chingamixen" (Archives of Maryland VII:548, 609; X:503; Busby 1995). Busby (1995:12) suggests that the southern side of the Stump Neck peninsula, along Chicamuxen Creek, was the intended location for this port. By the mid-eighteenth century, most of the arable land near the Potomac was cultivated in tobacco; no occupation of Stump Neck is documented during this time. With the onset of the Civil War, activity on Stump Neck increased

dramatically. Arms and other supplies were probably smuggled across the river to Confederates on the Virginia shore from Stump Neck (Wills 1975:49). Union troops occupied the area in the vicinity of Stump Neck between October 1861 and March 1862 in an effort to reduce smuggling and to thwart any potential Confederate advances. The landing at Rum Point was one of several critical supply routes to General Hooker's headquarters south of Stump Neck. A full company of Union soldiers were stationed at the landing to guard the stores and other property landed there, prior to their transport to Camp Baker two miles to the south (Donald 1975:35-36).

Residential occupation of Stump Neck did not occur until the early twentieth century when the hamlet of Winthrop appears on historic maps (Figures 7 and 8)(Stevens et al. 1995: Figures 9-15). These maps indicate the presence of a small town comprised of five structures, a wharf on the Potomac side of Stump Neck, and two structures associated with the wharf. Two structures also were identified on Rum Point. Although little is known about this hamlet it appears to have lasted only about 50 years, when the land became part of the Indian Head U.S. Naval Proving Grounds.

The Explosives Investigation Laboratory (EIL) was established in July 1942 on 1,500 acres at Stump Neck in order to examine captured enemy ordnance. Functions of EIL included: (1) the stripping and disassembly of recovered enemy ordnance, including mines, torpedoes, and bombs; (2) developing methods of locating, identifying, and disposing of enemy and ally ordnance; and (3) demonstrating ordnance disposal techniques. Ordnance devices examined at EIL typically were opened, disassembled, and inventoried. The chemical materials were sent to another laboratory to determine the composition of the device.

By 1944, EIL had expanded into the investigation of non-ordnance items, including recording devices, tools, parachutes, pistols and machine guns, and other auxiliary equipment. Among the more famous items examined at EIL were the German V-1 "Buzz bomb" and the solid rocket propellant grain from the Japanese "BAKA," a rocket-driven kamikaze plane flown in early 1945 (Carlisle 1990:114-7). The EIL facility was equipped with a variety of laboratories, magazines, storehouses, and other secondary structures.

During the post-war years, EIL was transformed into the Naval Explosive Ordnance Disposal Technical Division (NAVEODTECHDIV), which operated the Ordnance Disposal School. The primary function of EODTC was to serve as an operational unit; secondarily, it operated as a school. The mission of the Unit was "to have available at any hour of the day or night, a Unit equipped with technical ordnance specialists and the latest equipment, ready to cope with any explosive ordnance disposal problem anywhere in the world." The School was established to train officers and enlisted men of the Armed Forces "to identify, analyze, render safe, and dispose of any known form of explosive ordnance" (Smokeless Flashes January 21, 1949:2). Training in underwater ordnance disposal also was an important component of ODU. To accommodate the school, the old WAVEs' quarters was converted from a barracks to a school (Smokeless Flashes October 18, 1946).

Archeological Results

In order to facilitate testing of the Annex, the property was subdivided into 14 distinct survey areas lettered A through N. Area 8 was surveyed separately due to issues regarding access to the area. Phase I survey of the area for a proposed Jogging Trail along Archer Road was completed as a separate task of this project and a separate report was completed for this project (Child et al. 1996). The boundaries of the survey areas generally corresponded to topographic features and landscape elements such as roads, fences, and field margins. In only a few circumstances were testing boundaries oriented where no previously established or obvious boundaries existed. The results of the archeological survey are presented by survey area below. Each survey area and the archeological sites relocated or newly identified within it are discussed. Recommendations regarding each of the sites on Stump Neck are presented in Chapter VI, *Summary and Recommendations*.

Previous Phase IA reconnaissance level investigations divided Stump Neck Annex into areas of low, moderate, and high probability for archeological resources (Stevens et al. 1994). The Phase IA study identified approximately 456.2 acres of high probability and 206.4 acres of moderate probability. The remaining approximately 507 acres of the Stump Neck Annex was classified as low

probability due to wetlands or slopes greater than 20 per cent. Phase IB field investigations examined all of the high and moderate probability areas as well as portions of the low probability areas that possessed slopes less than 10 per cent. Although most of the sites identified on Stump Neck Annex were located within the high and moderate probability areas, several small sites were identified within areas classified as low probability.

Area A

Area A was located at the extreme southern end of Stump Neck and encompassed 34.12 acres (197 and 32.8 ft) of high probability land (Figure 31). The peninsula is bounded by the Potomac River on the north and west and Chicamuxen Creek on the south and east. The northeastern boundary of the area was set as the gate marking the restricted zone around the Range 3 testing area (Area D). Archer Avenue bisected the area northeast to southwest. The landform consisted of a high bluff along the Potomac River with a gradual slope south and east toward Chicamuxen Creek. The bluff rose between 6 and 10 m above the river and exhibited evidence of active erosion; a narrow gravel beach lay at the base. The high bluff extended east across Archer Avenue in the center of the area then sloped down to Chicamuxen Creek. An abandoned testing facility was located on this slope. One shallow drainage running to the Potomac cut across the high ground near the middle of the area. A low terrace in the southeastern corner of Area A was situated approximately 1 m above Chicamuxen Creek; a small sandy beach bounded that portion of the area. Further north, the low terrace gave way to steep slope, disturbance and swampy, wet land that was not tested.

The soils in Area A were mapped as Matawan loamy sand, Elkton silt loam, and Keyport silt loam (Hall and Matthews 1974). In the northwest corner of the area around Sites 18CH390 and 18CH624, a typical soil profile consisted of 0 - 11 cmbs dark grayish brown (2.5Y 4/2) silt loam; 11 - 37 cmbs light yellowish brown (2.5Y 6/4) sticky silt loam; and 37 - 50 cmbs yellowish brown (10YR 5/8) silty clay. This profile corresponded to that of the Keyport soils mapped for the area. The loamy sand soils associated with Matawan loamy sand were encountered at the southern end of

Area A, primarily on the high ground to the west at Site 18CH623; however, the colors recorded did not precisely match those described in the soil survey for Charles County.

Vegetation in Area A primarily was mixed hardwood forest. The dominant species was willow oak, with smaller numbers of maple, sweet gum, holly, poplar and beech. The shallow drainage and the disturbed areas at the edge of the woods were thick with green briar and other thorned primary regrowth species. Along Archer Avenue there was a grass easement approximately 20 m wide on either side of the road. The southern end of the area, west of Archer Avenue around Building 2000, was also grass.

Disturbance from military activities in Area A was moderate. The tip of Stump Neck was once a proving ground target and is now used to test explosives; therefore, no testing took place in that area. The low terrace in the southeast was marked by several large depressions filled with water, possibly the result of old bombing tests. Area A contained several buildings and bunkers as well as a landing ramp on Chicamuxen Creek in the center of the area. Disturbance was particularly extensive in the east-central part of Area A, surrounding Bunker 53SN and Buildings 2054 and 2055. This area appeared to be a former loading and exploding facility. Numerous pushpiles were observed along the treelines adjacent to the road easement as well as scattered elsewhere across the area. Natural disturbances were confined largely to the erosion of the cliff along the Potomac.

The datum for Area A was placed on the west side of Archer Avenue across from the intersection with Sgt. Bird Road, the road leading to the fenced bunker complex. A total of 28 transects were set along the baseline bearing of 37° (magnetic north) at 20 m intervals from the area datum (N1000/E1000). Transects extended east and west from this baseline and terminated at the Chicamuxen Creek and the Potomac River. Only the west side of the baseline was tested north of Transect N1160 because of disturbance, slope, and the swampy ground to the east. The area extended to transect N1540 at the gate to Range 3 (Area D). A total of 151 shovel tests were excavated in Area A, and 42 planned tests were not dug because of surface disturbance, standing water, or a slope greater than 10°.

A total of four archeological sites were identified within Area A. One site, Site 18CH390, was identified in 1994 by Milner & Associates (Stevens et al. 1995); testing delineated the boundaries of this site. The remaining three sites were located in the southern and northeastern portions of the survey area. Three isolated fragments of military hardware also were recovered from within Area A. All of the sites within this area lie within the mapped location of Indian Head quad file #5, a "village" site identified by Graham in the nineteenth century.

Site 18CH390. Site 18CH390 is a Middle and Late Woodland site that was identified first by Milner & Associates in 1994 during the Phase IA study of Stump Neck (Stevens et al. 1995). The site was located through pedestrian survey along the bluff overlooking the Potomac River, where five pieces of debitage were recovered. Shovel testing for the current project relocated the site in the north central portion of Area A overlooking the Potomac River. Site 18CH390 measured approximately 80 x 100 m (262.5 x 328 ft) but probably was larger (Figure 32). The site was eroding out of the bluff on the west and extended east as far as Archer Avenue where it may have been disturbed by construction of the road. A total of 14 shovel tests were excavated within Site 18CH390. A total of 44 artifacts were recovered from eight shovel tests and a surface collection from the eroding cliff face. The assemblage contained seven prehistoric ceramics including: 3 cord marked Mockley sherds; 3 Potomac Creek sherds, 1 cord marked, 1 burnished, and the other eroded; and 1 unidentified eroded shell, grog, and quartz tempered sherd. The Mockley sherds as well as a complete adze or celt, fire-cracked rock, and several flakes were recovered from the bluff.

The lithic artifacts recovered from Site 18CH390 included 22 pieces of debitage (1 primary, 5 secondary, and 12 non-cortex flakes, and 3 pieces of block/shatter), 2 cores, a pieces *esquillee* (wedge), an adze or celt, and 11 fragments of fire-cracked rock (Figure 33). The artifact assemblage generally is characteristic of base camps in which some tool manufacture/maintenance and food preparation activities occurred. Diagnostic artifacts recovered from the site place this occupation during the Middle and Late Woodland periods.

The highest concentration of artifacts within Site 18CH390 was located in the shovel tests adjacent to the surface collection on the N1360 and N1380 transects. Twenty-four artifacts were

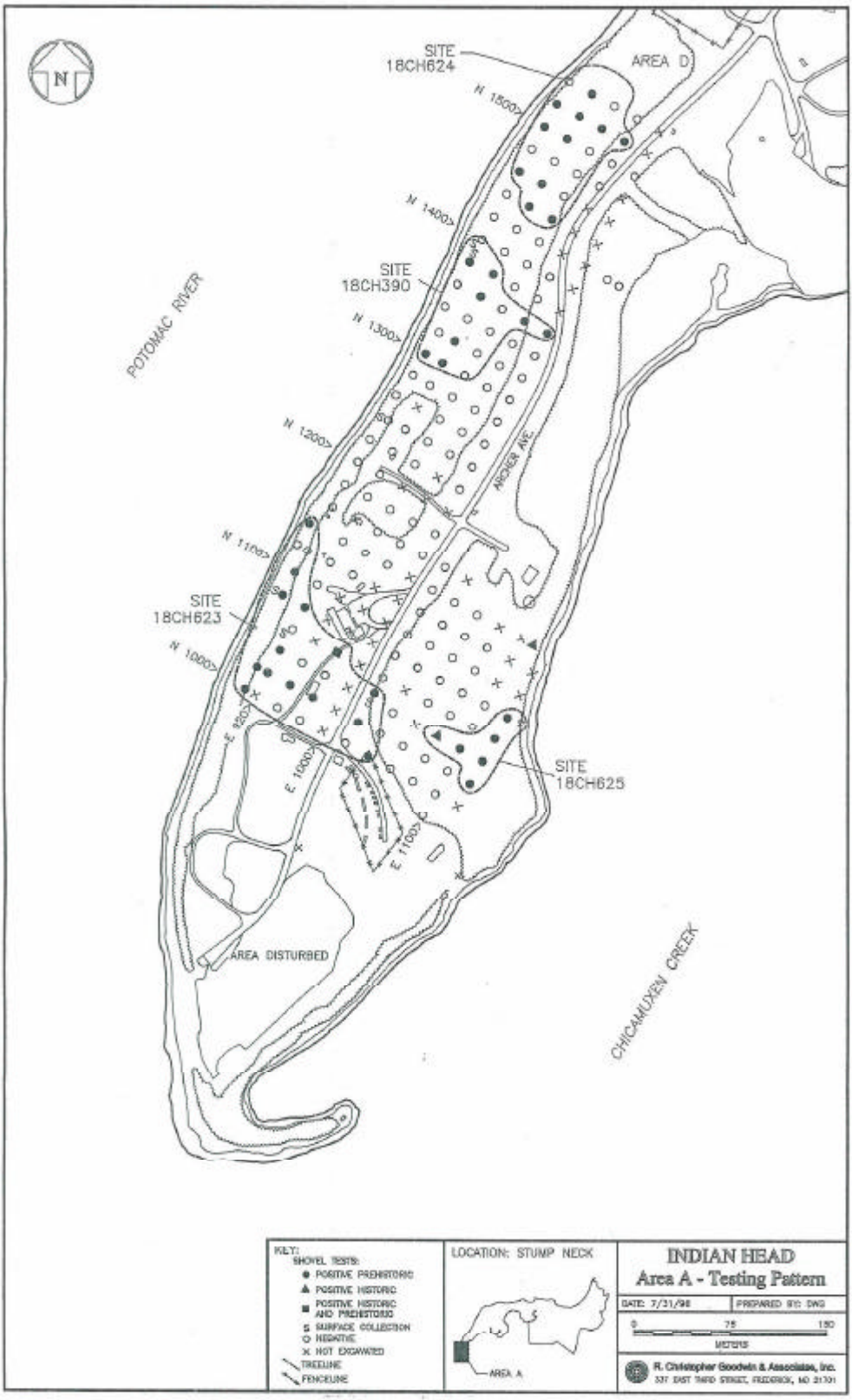


Figure 32. Map of Area A, showing shovel test pattern and site boundaries

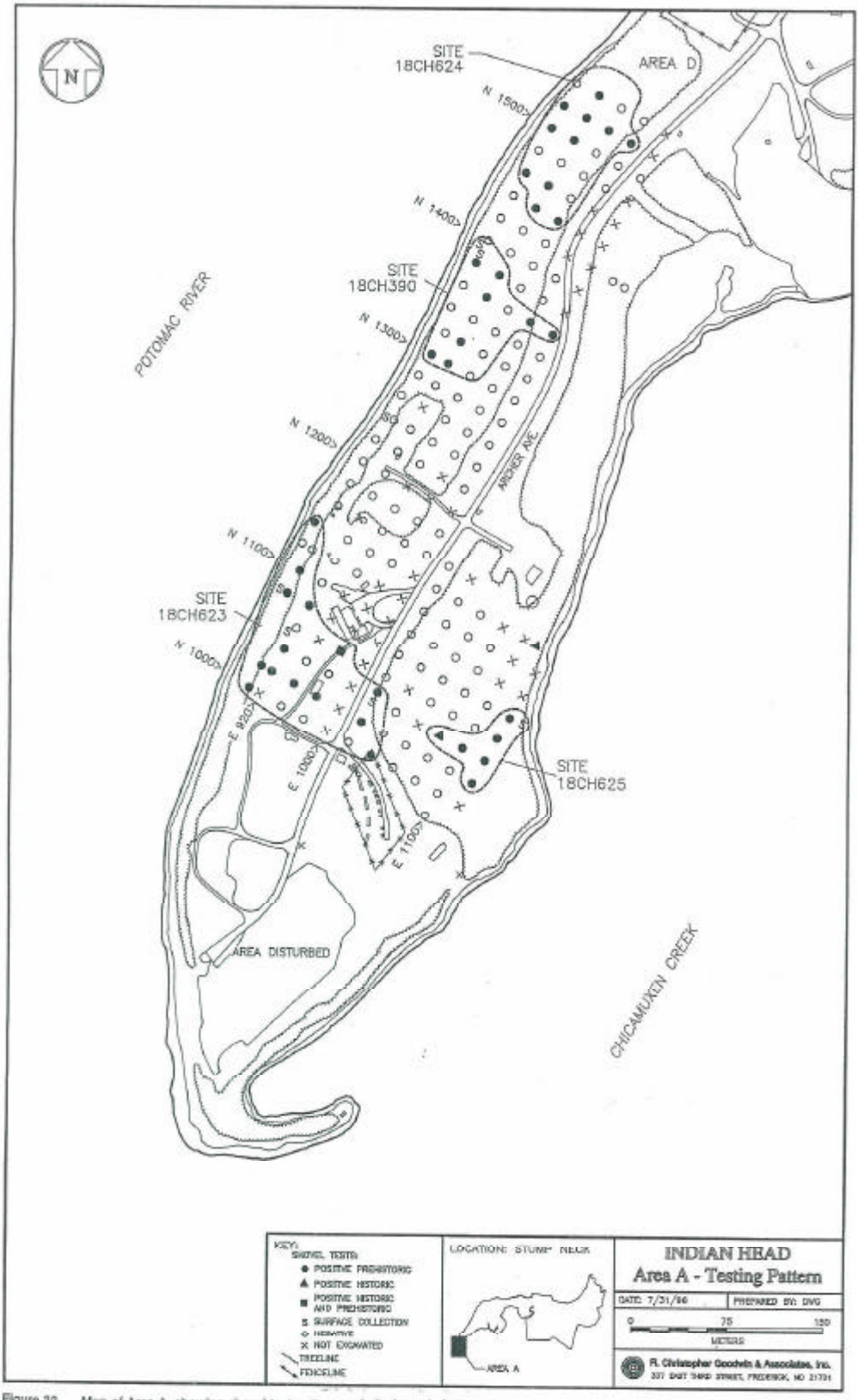


Figure 32. Map of Area A, showing shovel test pattern and site boundaries

Figure 33. Adze/celt from Site 18CH390 (FS# 3)

recovered from three shovel tests, up to a depth of 53 cmbs, but primarily from the second stratigraphic level between 13-24 cmbs. Across the site nearly 40 per cent of the artifacts were recovered from below the Ap horizon. Although an unknown portion of the site has been destroyed through the erosion of the bluff, the presence of artifacts below the plowzone suggests that intact cultural deposits may remain at the site.

Site 18CH623. Site 18CH623 is a Late Woodland period site located at the southern end of Area A on the high bluff overlooking the Potomac (Figure 32). The site extends eastward across Archer Avenue, downslope to the top of the small terrace above Chicamuxen Creek. The site measured approximately 100 x 120 m (328 x 393.7 ft). At the time of these investigations, most of the site was covered in grass; only the southeast corner was covered in mixed hardwoods. Human disturbance at the site included the construction of Archer Avenue, Buildings 8159, 2092, and Building 2000 and its parking area. Erosion of the bluff along the Potomac River also was present. Within the site boundaries, five planned shovel tests were not excavated due to these disturbances.

A total of 65 artifacts were recovered from the 15 positive shovel tests and two surface collections that define the site. Historic artifacts comprised only a small portion of the artifacts from the site; these include 3 fragments of unidentified iron or steel and 1 metal rivet. All of the historic material was recovered from the upper 15 cmbs and relate to recent military activities.

The 61 prehistoric artifacts recovered included 39 pieces of debitage, 7 pieces of fire-cracked rock, 7 ceramic sherds, 2 projectile point/knives, 1 biface fragment, 2 utilized flakes, 1 core, 1 abrader, and 1 hammerstone. The debitage was predominately non-cortical; the balance of the debitage was comprised of secondary flakes (20 per cent) and block/shatter (15 per cent). Two flakes, one secondary and one non-cortical, were utilized. The small multifaceted quartzite core retained approximately 60 per cent of its cortex and weighed 24.96 g. The prehistoric ceramics from the site included 5 Potomac Creek sherds and 1 Townsend sherd (Figure 34- bottom). The surface treatment on the coarse sand-tempered Potomac Creek ware sherds varied from cord-wrapped dowel impressed, cordmarked, and plain. The shell tempered Townsend ware rim sherd exhibited fabric impressions on the interior and possible cord wrapped dowel on the lip. The

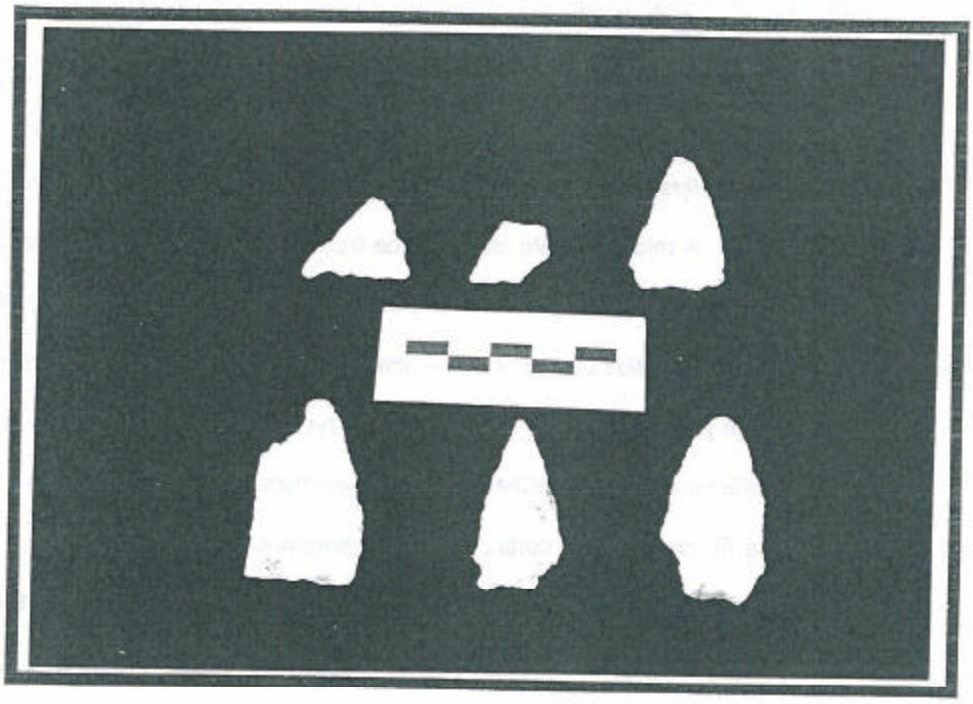


Figure 34. Above: Projectile points/knives from Site 18CH623 and Site 18CH625 (Clock-wise from upper left) [a] FS# 46; [b] FS# 46; [c] FS# 72; [d] FS# 46; [e] FS# 81; [f] FS# 44)
Below: Selected prehistoric ceramics from Sites 18CH390, 18CH623, and 18CH625 (L-R) [a] FS# 4; [b] FS# 67; [c] FS# 100; [d] FS# 4

projectile points included: a well-thinned triangular quartz point (FS# 72) with a flat base consistent with the Madison type (Ritchie 1971) and a corner notched quartz point (FS# 81) with shallow notches and a concave base similar to the Potts or Waratan type (Fogelman 1992:188) (Figure 34 - top). Potts and Waratan points date from the Middle Woodland while Madison points are Late Woodland in age. A middle to late stage biface fragment with cortex also was recovered. The diversity and character of the prehistoric assemblage from Site 18CH623 is generally indicative of a temporary camp. Activities such as lithic reduction, stone tool maintenance, food preparation, and possibly resource procurement are indicated by the types of artifacts present.

The artifacts from Site 18CH623 were concentrated on the high ground along the bluff overlooking the Potomac River, particularly in the southwest portion of the site. Only six of the prehistoric artifacts and all of the historics were recovered from the lower edge of the slope and the top of the terrace. The soils at Site 18CH623 were sand with some loam and contained much deeper cultural deposits than encountered elsewhere in the area or on the rest of Stump Neck. Twenty-three artifacts were recovered from depths averaging 25-75 cmbs, with some from as deep as 107 cmbs. Several of the deep deposits were on the slope leading down to the road and the terrace; however the shovel tests on the top of the ridge also contained artifacts below 50 cmbs. Although only 43 per cent of the prehistoric artifacts from shovel tests was from below the A horizon, the presence of deeply stratified artifacts on the ridge and slope indicate that the site may retain stratigraphic integrity.

Site 18CH624. Site 18CH624 was located in the extreme northern end of Area A, on the northwest side of Archer Avenue and extends 20 m into Area D (Figure 32). The site was separated from Site 18CH390, located to its south, by 60 m, and measured approximately 60 x 120 m (96.8 x 393.7 ft). Site 18CH624 was situated on a ridgetop overlooking the Potomac River and the landform sloped gradually down to the west from the crest along Archer Avenue. The vegetation on the site was characterized by mature mixed hardwoods including cherry, beech, oak, and holly, as well as undergrowth of green briar. Surface disturbance primarily was observed along the edge of the wooded area where large pushpiles and dug out areas were observed. No evidence for

erosion or deflation was present at the site; no artifacts were recovered from the eroding bluff margin nor from the surface of the site.

The boundaries of Site 18CH624 were distinguished on the basis of 11 positive shovel tests in Area A and two additional positive tests in Area D. A total of 22 prehistoric artifacts were recovered from these 13 shovel tests; none were temporally diagnostic. A majority of the artifacts (n=11) were fire-cracked rock fragments. The remaining artifacts included 10 pieces of debitage and one utilized quartz secondary flake. The debitage included 3 secondary flakes, 3 non-cortical flakes, and 4 pieces of block/shatter. Chert, jasper, quartz and quartzite were present in the debitage and fire-cracked rock assemblage. The relatively small and homogeneous assemblage is indicative of small resource procurement sites or temporary hunting camp.

The artifacts were distributed fairly evenly across the entire site. The highest concentration of artifacts within the site was only four artifacts recovered in one shovel test (N1500/E920) situated on the bluff overlooking the Potomac River. Over two-thirds of the artifacts from the site were from below a relatively shallow A horizon. Although the site appears to retain integrity the limited assemblage and lack of diagnostic artifacts from the site limit the research potential of the site.

Site 18CH625. Site 18CH625 was a Late Archaic and Late Woodland period site located on the low terrace above Chicamuxen Creek, approximately 70 m (229.6 ft) east of Site 18CH623 (Figure 32). The site measured 50 x 60 m (164 x 196.8 ft) and was eroding out of the bank onto the narrow beach below where several artifacts were recovered. The landform slopes down to the east towards the creek and was forested with mature mixed hardwoods. Near the water the undergrowth was relatively dense with greenbriar and other vines. Relatively little surface disturbance was observed within the site boundaries; however, a large depression filled with water and other signs of military activities were noted between Sites 18CH623 and 18CH625. An unknown portion of the site has eroded into Chicamuxen Creek.

The site boundaries were delineated by six positive shovel tests and a surface collection of the beach. In addition to 45 prehistoric artifacts, a single unidentified fragment of iron or steel was recovered. The prehistoric assemblage included 31 pieces of debitage, 2 projectile points, 2

bifaces, 2 cores, 1 retouched flake, 2 ceramic sherds, and 5 pieces of fire-cracked rock. A sizable portion (35 per cent) of the debitage was cortical and indicated that core preparation or early stage biface reduction occurred at the site. The presence of cores retaining only 20 and 30 per cent of their cortex is consistent with this interpretation. The recovery of two middle to late stage bifaces and a biface thinning flake provide limited evidence of biface reduction at the site. One biface is triangular in shape and probably represents a failed attempt to thin a biface to form a triangular projectile point. The other biface is a wide, well-thinned quartz biface tip; the sinuous edges of the specimen suggest that it was broken during the final thinning and shaping of the biface.

The projectile points recovered at the site include a small, well-formed and thinned, triangular quartz point (FS# 46-a)(Figure 33 - top). The thin cross-section and roughly equilateral shape of the point was consistent with the Late Woodland period Madison type (Ritchie 1971). The second quartz projectile point (FS# 46-b) exhibited a broad blade, a small well-defined shoulder, and a large, squarish stem; one shoulder appears to have been sharpened away. The overall morphology of the point was similar to the Late Archaic period Bare Island type (Kinsey 1959).

The two ceramic sherds were both sand-tempered and had eroded surfaces. One was an unidentified body sherd. The other was a neck sherd classified as the Late Woodland period Potomac Creek ware (Stephenson et al. 1963)(Figure 33 bottom).

The artifact assemblage from the site suggested that early stage reduction of cores and early stage bifaces as well as later stage production of bifaces occurred at the site. Fire-cracked rock and ceramics suggest that the occupation was not transitory, and probably included the processing and/or processing of food. The presence of diagnostic artifacts dating from the Late Woodland and Late Archaic periods indicate that the site contains multiple components.

Nearly all of the artifacts were recovered from three shovel tests placed at the edge of the terrace (E1120 line) and from the collection made on the beach below. Only four artifacts were recovered from the rest of the site. The majority (71 per cent) of the artifacts recovered in shovel tests were from below the A horizon. Historic artifacts were observed only within the A horizon, while prehistoric artifacts were recovered from depths up to 62 cmbs. Soil profiles across the site

generally were consistent with the Matawan loamy sand mapped for the area; the site does not appear to have been plowed. The site is located in a setting where deposition of alluvium and colluvium is likely; such deposition would have served to preserve the integrity of the prehistoric deposits at the site. Erosion of the site along Chicamuxen Creek has destroyed an unknown portion of the site.

Area B

Area B encompassed 61.3 acres located between the intersection of Archer Avenue and Roach Road and the Storage complex including Buildings 2083 and 2084 (Figure 35). The Potomac River and Chicamuxen Creek form the other boundaries. The entire area, with the exception of the swamp, was designated as high probability for prehistoric resources by Milner & Associates (1995). The swamp was considered low probability; thus, it was not tested as part of the current study.

The topography of Area B is typical of the Stump Neck landform. The highest elevations on the relatively flat neck are adjacent to the Potomac River and Mattawoman Creek where steeply eroded escarpments are common. The land slopes gradually toward Chicamuxen Creek were it is bounded by wetlands. Elevations within Area B are mostly below 10 ft ASML and rise to a maximum height of 20 ft ASML on the western margin of the survey area. A smaller ridge was observed in the south center, parallel with Chicamuxen Creek. The remainder of the area is nearly flat. A narrow causeway in the northeastern portion of Area B joins Stump Neck to the mainland. Low marshland associated with the upper Chicamuxen Creek drainage borders the causeway, setting Stump Neck off from the mainland.

Soils of Area B belonged to the Evesboro-Keyport-Elkton soil association. The areas surveyed were mapped predominantly as Mattapex silt loam and Keyport silt loam, with some Elkton silt loam as well (Hall and Matthews 1974). A large part of the southeastern portion of Area B was mapped as tidal marsh, most of which was not surveyed. The soil profiles in Area B varied frequently depending on location and land use or disturbance. A representative profile for shovel tests containing Mattapex silt loam consisted of a 0-16 cm dark grayish brown (10YR 4/2) silt loam;

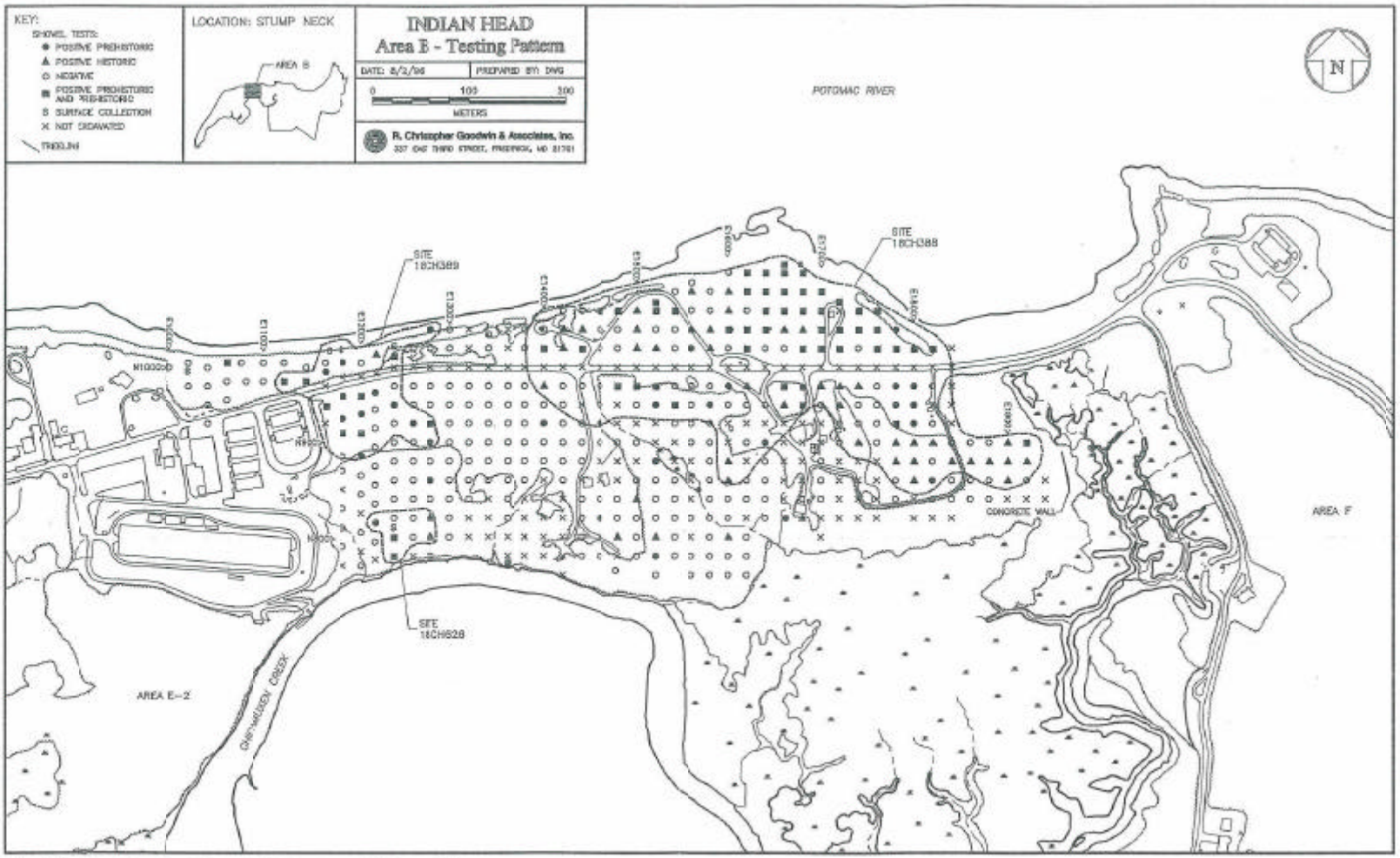


Figure 35. Map of Area B, showing shovel test pattern and site boundaries

a 16-32 cm yellowish brown (10YR 5/4) silt loam; and a 32-45 cm yellowish brown (10YR 5/8) silt loam. These soils were found primarily along the Potomac shoreline and south of Archer Road to the edge of the swamp. The upper stratum within this series appears to be a plowzone matrix exhibiting the well-defined interface and uniform matrix typical of such a horizon. Keyport soils were found at the western end of Area B around site 18CH389. A typical profile for these soils consisted of: a 0-16 cmbs dark gray (10YR 4/1) silt loam plowzone matrix; a light yellowish brown (2.5Y 6/4) silt loam with some clay to 31 cmbs; and a yellowish brown (10YR 5/6) silt clay loam to 41 cmbs. Much of the area mapped for Elkton soils was disturbed; therefore, few excavated shovel tests were representative of these soils.

Vegetation in Area B varied according to land use. The area north of Archer Avenue, east from the western boundary for 400 m (1,312.3 ft), was characterized by mature hardwoods including oak, sweet gum, yellow poplar, maple, and hickory. An area of dense regrowth containing green briar and pine saplings was found near the eastern margin of the wooded area. The northern portion of the area east of transect E1400 was characterized by a children's playground and a picnic area with isolated mature oak trees. A narrow treeline separated the recreation area from the beach on the Mattawoman Creek/Potomac River. A large open field of maintained lawn was located in the area east of transect E1480; a helicopter landing pad was located at N980/E1500. The central part of this field was formerly a skeet shooting range but has since been filled and graded. The western end of area south of Archer Avenue within Area B was a maintained wildlife agricultural field currently containing planted pine saplings. The field extended east for approximately 300 m (984.2 ft) from the building complex and south an average of 80 m (262.5 ft) from Archer Avenue. Mature mixed hardwood forests bordered the field to the south and east. Swamp and marsh associated with the headwaters of Chicamuxen Creek were located beyond the wooded area to the south. Large (to 60 cm [23.6 in] diameter) willow oaks predominated in the swampy land at the edge of the marsh. The marsh contained reeds and other wetland grasses and tubers. The remainder of Area B was wooded from the Archer Avenue to the edge of the swamp except for small grassy clearings around Building 2075, and the Magnetometer Complex.

The datum (N1000/E1000) for Area B was located on the edge of the escarpment overlooking the Potomac River at the boundary fence around Quarters A, approximately 40 m north of Archer Road. The baseline was established at an angle of 99° (grid East) and continued east along the south side of Archer Avenue to transect E1880. The baseline was stepped 20 m north at this point to compensate for the shape of the isthmus. The baseline continued east to E1940 where the baseline was stepped again 15 m north. The baseline continued to E2000 where it was stepped 15 m north a final time and ended at transect E2040. Fifty-three transects were established along the baseline at a 20 m (65.6 ft) interval; transect orientation was 9/189°. A total of 361 shovel tests were placed at 20 m intervals along the transects, with 135 additional shovel tests not excavated because of modern surface disturbances or slopes greater than 15 per cent. Several of the shovel tests were placed at shorter intervals within the boundaries of Site 18CH388 on the north side of the baseline to ensure that the edge of the landform along the river was fully tested.

Severe disturbance was present in several places within Area B, particularly in the wooded area south of Archer Avenue at the edge of the marsh. The forested area along the edge of the Chicamuxen marsh had been dug out in many places creating large puddles and push piles. An area, approximately 20 x 80 m (65.6 x 262.5 ft) in size, at transect E1860 in the far eastern portion of Area B was extensively trenched and graded, perhaps for a buried cable. A reinforced concrete retaining wall approximately 40 m (131.2 ft) long and 10 m (32.7 ft) high bordered the marsh in the same general area. The portion of Stump Neck joining it to the mainland narrowed to form an isthmus 30 m wide between Mattawoman Creek to the north and Chicamuxen Creek and marsh to the south. This strip of land was highly disturbed; construction of Archer Road, utility lines, and rip rap barriers for erosion control on the Mattawoman/Potomac side of the isthmus effectively destroyed all potential sites on the causeway. Because of the extensive disturbance no shovel tests on the isthmus were excavated. The land around each of the buildings in Area B was disturbed by construction and subsequent grading and filling. The deepest area of fill documented was at the former skeet range where several of the shovel tests encountered up to 85 cm (33.46 in) of fill before reaching intact soils. Erosion was evident along the entire shoreline.

Phase I shovel testing located three sites: two previously identified (18CH388 and 18CH389) and one new site (18CH626). Isolated finds were recovered in 15 shovel tests. Site 18CH388 is a large multi-component site located on the shore of the Potomac River on the north side of Stump Neck; occupation of the site dates from the Middle to Late Woodland periods and from the mid-nineteenth to early twentieth centuries. Site 18CH389 is a multi-component site located on the shore of the Potomac River on the western margin of Area B; occupation of the site dates from the Late Archaic and early Middle Woodland periods and from the early twentieth century. Site 18CH626 is a small multi-component site located along the edge of the swampy ground bordering Chicamuxen Creek: occupation of the site dates from Woodland period and nineteenth to twentieth centuries. The 22 artifacts recovered as isolated finds included window glass, porcelain, transfer-printed whiteware, ironstone, bottle glass, wire nails, fire-cracked rock fragments, 2 core fragments, 4 flakes, and 1 unidentified coarse sand-tempered eroded prehistoric sherd. These artifacts were similar to the assemblages from the sites in Area B. Twelve of the isolated positive shovel tests were in the general vicinity of Site 18CH389; it is possible that these isolated finds represent activity associated with the site.

Site 18CH388. Site 18CH388 was identified during the Phase IA reconnaissance survey of Stump Neck (Stevens et al. 1995). Cultural materials were recovered in surface collection on the shoreline of Mattawoman Creek and in two shovel tests placed in the mown grass field on the north side of Archer Road. The site was recorded as a mixed component prehistoric and historic site with unknown cultural and temporal affiliations; the report indicated the possibility that this site corresponded to Indian Head Quad File #4, a Late Woodland Indian village reported by Graham (Stevens et al. 1995:44). Delineation of the site boundaries during Phase IB testing indicated that it measured approximately 200 x 520 m (656 x 1,706 ft). Diagnostic artifacts indicated a prehistoric occupation during the Middle through Late Woodland periods and a historic occupation between the mid-nineteenth and early twentieth centuries. The soil profiles across the site were generally consistent with the Mattapex silt loam mapped for the area. However, the soil profiles in shovel tests within the grassy field near the former skeet range indicated several layers of fill, as deep as

85 cmbs (33.46 inbs), on top of the natural stratigraphy. Additional disturbance was present around Buildings 2012 and 2075, in the vicinity of the Munitions Magnetometer Testing Area, and in the southeastern end of the site where a large area had been dug out. Despite these disturbances, large portions of the site appear to remain intact.

A total of 645 artifacts were recovered during Phase IB testing of Site 18CH388. The prehistoric assemblage was comprised of 185 artifacts from 13 shovel tests containing only prehistoric artifacts and 47 shovel tests containing mixed historic and prehistoric materials. The historic assemblage was comprised of 460 artifacts from 38 shovel tests containing only historic materials and the 47 mixed shovel tests. The prehistoric assemblage included 103 pieces of debitage, 3 cores, 30 pieces of fire-cracked rock, 3 bifaces, 1 projectile point, 2 utilized flakes and 42 ceramic sherds. One very small fragment (0.32 g) of burnt bone was recovered in a shovel test placed in the northern portion of the site.

Over half (56 per cent) of the prehistoric artifacts were debitage. Most of this debitage was the result of the later stages tool manufacture and maintenance. Although approximately 32 per cent of the assemblage was cortical debitage, relatively few of these pieces were primary flakes. Most (69.5 per cent) of the debitage was quartz. Other debitage material types included quartzite, chert, and rhyolite. The core/core fragments from the site included one quartz core fragment, a quartzite core fragment, and a quartzite multifaceted and multidirectional core. The cores were reduced extensively; the percentage of cortex remaining on the cores ranged from 0 to 20 per cent.

The bifaces included two amorphous bifaces, a quartzite early stage biface, and a small rhyolite projectile point fragment. This fragment appears to be the base of a small quartz triangular point (Figure 36 - top). The general morphology of this point is consistent with the Late Woodland Madison type (Ritchie 1971).

The 42 ceramic sherds from the site include six sherds of Mockley ware, four sherds of Potomac Creek ware, and one sherd of Townsend ware (Table 6) . The remaining 31 sherds could not be attributed to a ceramic type due to their small and eroded state. Most of the unidentified ceramic sherds were quartz-tempered or tempered with a combination of shell and other tempering

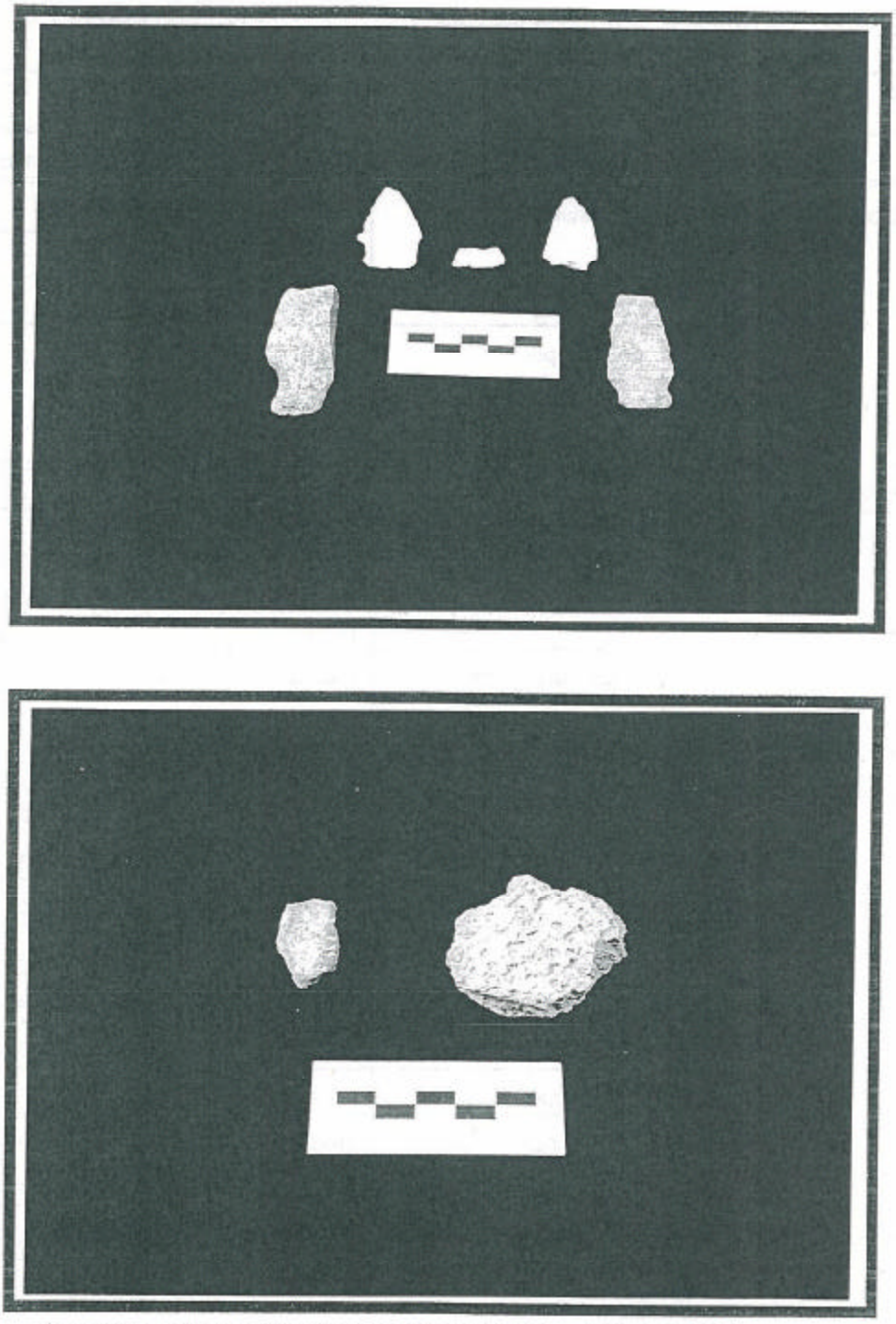


Figure 36. Above: Projectile points/knifes from Site 18CH388 and Site 18CH389 (Clock-wise from upper left) [a] FS# 12; [b] FS# 79; [c] FS# 32; [d] FS# 30; [e] FS# 41) Below: Selected prehistoric ceramics from Site 18CH388. (L-R) [a] FS# 41; [b] FS# 61

TABLE 6. SITE 18CH388 - SUMMARY OF PREHISTORIC CERAMICS

Ceramic Type	Temper	Surface Treatment	Count
Mockley	combination temper	eroded	1
		roughened	1
	quartz temper	cord marked	1
	shell temper	eroded	1
		net impressed	1
		roughened	1
Other ceramic	quartz temper	eroded	2
Potomac Creek	coarse sand temper	eroded	1
		fabric impressed	1
		plain	1
	combination temper	cord marked	1
Townsend	shell temper	cord marked	2
Unidentified	coarse sand temper	burnished	1
		plain	2
	combination temper	cord marked	1
		eroded	9
	other temper	net impressed	1
	quartz temper	eroded	4
		plain	3
	sand temper	eroded	2
	shell temper	eroded	4
	unidentified temper	eroded	1
Grand total			42

materials also were common; shell, sand, and unidentified-tempered sherds also were identified within the assemblage from the site. Three Mockley sherds were decorated; one was cord-marked, one was net impressed, and one was roughened. One of the Potomac Creek sherds was cord-marked. Twenty of the 42 prehistoric ceramics recovered during the survey were from the first stratigraphic level. The rest of the sherds were evenly divided between the second and third. Four of the identified sherds came from the third level.

The prehistoric artifacts were concentrated between Transects E1620 and E1800 on the north side of Archer Road at the old skeet range, with a few artifacts on the south side of the road especially around Transects E1780 and E1800. Another smaller concentration occurred between Transects E1480 and E1540 in the area of the playground and immediately on the south side of the road.

The diverse and extensive nature of the prehistoric assemblage from the site may be indicative of a camp or village. At a minimum, activities included early and middle stage bifacial tool production, flake tool use, and food preparation. The presence of fire-cracked rock, ceramics, and burned bone on the site suggest that subsurface features and/or activity areas might be present on the site.

The historic assemblage from Site 18CH388 was dominated by domestic debris. Of 460 artifacts, 219 were ceramic sherds and 179 were glass fragments (Table 7). Over half of the ceramics (n=118) were later porcelain sherds of different types, primarily undecorated hard porcelain. There were also 31 institutional/hotel type sherds. This type of porcelain dates from after 1880. Other nineteenth to twentieth ceramics recovered included ironstone, whiteware, and 1 yellow ware sherd. A few earlier ceramics were also recovered, including: 1 Pearlware, 1 Overglaze Chinese Export Porcelain, and 2 Tin Enamelled earthenware sherds. These earlier specimens are not present in sufficient quantities to suggest an earlier occupation. All of the identifiable glass fragments date from the last quarter of the nineteenth century or later. There were no non-machine made bottle fragments recovered. The only other diagnostic historic artifact were six cut/wrought

Table 7. Site 18CH388 - Functional and Typological Breakdown of Historic Artifacts

Functional Group	Artifact Group		Count
Activities	Miscellaneous	Lamp Glass	4
		Plastic Toy	2
	Toy	Doll Part	1
Architecture	Brick	Fragment	4
	Construction Hardware	Hook	2
	Miscellaneous	Sewerage/Drainage Pipe	1
	Unidentified	Cut/Wrought Nail	7
		Nail	4
	Wire Nail, Common	2-4"	1
Arms	Miscellaneous	Clay pigeon (skeet)	12
	Projectile Part	Centerfire Cartridge .32	4
		Centerfire Cartridge .38	6
		Lead Shot	1
		Other	4
Furniture	Miscellaneous	Figurine	1
Kitchen	Early Porcelain Type	Overglaze China Export	1
	Embossed Panel Bottle	Clear	1
		Solarized	1
	Industrial Stoneware	Late White Stoneware	1
		Rockingham-type Glaze	1
	Ironstone	Colored Glaze	1
		Decal	2
		Gray Undecorated	2
		Hand-Painted	1
		Molded	3
		Transfer-Printed	1
		White Undecorated	58
	Later Porcelain Type	Decal Porcelain, Hard	17
		Decal Porcelain, Soft	1
		Institutional/Hotel	31
		Molded, Hard	4
		Overglaze Porcelain, Hard	2
		Transfer-Printed Porcelain, Hard	4
		Undecorated Porcelain, Hard	58
		Undecorated Porcelain, Soft	1
	Lid Liner	Milk Glass	1
	Machine Made Bottle	Amber	13
		Aqua	9
		Clear	99
		Green	3
		Light Green	5
		Silk Screened	2
	Machine Made Lip	Clear	2
		Solarized	1
	Melted Glass	Clear	1
		Light Green	1
	Pearlware	Other Transfer-Printed	1
	Redware	Brown Glaze	1
	Shell	Unidentifiable	2
	Table Glassware	Unidentified Tableglass	2
	Tin Enamelled Earthenware	Blue & White	1
		Plain White Delft	1
	Unidentifiable Bottle Glass	Aqua	4
		Clear	25
		Cobalt Blue	1
		Milk Glass	3
		Solarized	4
	Unidentifiable Fragment	Clear	1
	Whiteware	Polychrome Hand-Painted	2
		Shell-Edged	1
		Transfer-Printed, Blue/Black/Brown	2
		Transfer-Printed, Red/Green/Purple	3
		Undecorated	16
		Willow Transfer-Printed	1
	Yellow Ware	Rockingham/Bennington	1
Miscellaneous	Miscellaneous Stone	Coal Slag	1
	Unidentified Object	Iron/Steel	4
	Wood	Unmodified Wood	1
Grand Total			460

nails and a wire nail from the first stratum; one cut nail was recovered from a possible buried plowzone.

The late nineteenth to twentieth century dates for the ceramics and glass from the site indicate that the historic occupation of the site was probably associated with the turn-of-the century hamlet of Winthrop that appears on maps of the area. Stevens (Stevens et al. 1995) suggested that Site 18CH389, located only 200 m west of the site, also was associated with this hamlet. No historic features associated with this possible occupation have been located to date.

The highest concentration of historic artifacts within Site 18CH388 was located in the eastern half of the site, in the vicinity of the abandoned skeet range. A second concentration was located in the southeastern corner of the site, between Transect E1780 and the concrete retaining wall at the edge of the marsh and swamp. This concentration contained many late porcelain and whiteware sherds as well as modern bottle glass; almost no prehistoric artifacts were recovered from the concentration. Although portions of the site may have disturbed by the filling and grading of the area in the vicinity of the former skeet range, this disturbance appears to have been minimal. Soil profiles apparently were intact beneath the fill emplaced upon the skeet range. The buried plowzone (Apb horizon) included both historic and prehistoric artifacts; the frequency of historic artifacts is significantly lower in the strata below the Apb horizon across large portions of the site. Shovel tests in the extreme northeastern portion of the site reveal probable an intact prehistoric cultural horizon below the historic disturbance. Shovel tests in the western portion of the site produced fewer prehistoric artifacts and a slightly higher frequency of historic artifacts than did the eastern portion. Modern artifacts, particularly glass, were common in the first stratigraphic horizon and in the fill horizons at the former skeet range.

Although shovel testing revealed considerable disturbance to portions of the site, several areas may retain sufficient integrity to provide accurate data regarding the prehistoric and historic occupations of the site. The layer of fill associated with the former skeet range in the northern portion may have preserved that portion of the site. Evidence from shovel tests placed on the northeastern margin of the site, between E1760 and E1820 suggests that at least that portion of the

site remains undisturbed. That area also contains one of the densest concentrations of prehistoric artifacts within the site.

Site 18CH389. Site 18CH389 was recorded during the Phase IA Reconnaissance Survey as a multiple component early Middle Woodland and early twentieth century site (Stevens et al. 1995). The site was originally identified through a pedestrian survey of the plowed field south of Archer Road. Delineation of the site during the current study determined that the site measured approximately 120 x 160 m (394 x 525 ft) in size (Figure 35). The presence of fill on top of the cultural horizons was observed in several of the shovel tests. Two poured concrete foundations were located north of Archer Avenue. One foundation measured approximately 8 x 14 m (26.2 x 45.9 ft) and was about 2 m (6.6 ft) deep. Military and other historic activities within the area appear to have compromised the integrity of both the prehistoric and historic components at the site severely. A total of 20 shovel tests produced artifacts: nine produced prehistoric artifacts; one produced historic artifacts; and 10 produced both historic and prehistoric artifacts. Three additional prehistoric artifacts were recovered from the surface within the site boundaries. The assemblage from the site included a total of 71 prehistoric and 30 historic artifacts.

The 71 prehistoric artifacts recovered from the site during Phase IB testing included: 56 pieces of debitage, 2 cores, 9 pieces of fire-cracked rock, and 4 projectile points. The debitage was predominately (83.9 per cent) quartz and quartzite with chert, jasper, rhyolite, and sandstone minimally represented. Approximately a quarter of quartz/quartzite debitage was cortical. The relatively high amount of cortical debitage and the presence of a moderately reduced core suggests that reduction of local cobbles was a significant activity on the site. Fire-cracked rock from the site was predominantly quartzite and sandstone. Several of the pieces of fire-cracked rock were from the northeastern portion of the site, near where one of the projectile points was recovered. The projectile points included: one quartzite point (FS #30) with the tip missing; one quartz Calvert Stemmed point (FS #12); and, a very rounded quartzite Archaic stemmed point (FS #21), also with the tip missing (Figure 36 - top). Another quartz point (FS #32) was recovered but was not identifiable. None of the four points were recovered from a stratified context; three were surface

finds and one came from the upper 10 cm of a shovel test. These diagnostic artifacts place the occupation of the site minimally during the Early Archaic, Late Archaic, and Early to Middle Woodland periods. Previous investigations at the site recovered one Popes Creek Net Impressed body sherd was recovered (Stevens et al. 1995).

Nearly all of the prehistoric artifacts recovered from Site 18CH389 were from the plowzone, fill horizons and disturbed areas on the site. Prehistoric artifacts were recovered from below these disturbed horizons in only one shovel test. Three pieces of debitage were recovered in Shovel Test N930/E1180 in a B horizon beneath an Ap horizon and two fill horizons. Historic artifacts were recovered with prehistoric materials in the B horizon identified in 6 other shovel tests. The northern margin of the site also has experienced considerable erosion; three of the projectile points in the prehistoric assemblage were surface collected in these areas. The extensive nature of the disturbance and destruction of Site 18CH389 by natural and human factors has compromised the integrity of the prehistoric component at the site. Prehistoric occupations at the site are conflated and/or disturbed.

The historic materials on the site were concentrated on the extreme western edge of Area B south of Archer Road. The 30 historic artifacts were all kitchen-related, with the exception of the two pieces of window glass, six nails, and five pieces of unidentified iron or steel. Ceramics formed the largest artifact class (43.33 per cent) within the assemblage. The most common ceramic type was late hard paste porcelain. Other ceramics recovered included 3 whiteware sherds, 1 underglazed polychrome pearlware sherd, 1 undecorated ironstone sherd, and 1 light yellow creamware sherd. The bottle glass fragments recovered were predominately machine-made, although one dark green non-machine made bottle glass fragment also was recovered. Architectural debris recovered from the site included 1 machine cut nail, 1 cut/wrought nail, 1 common wire nail, 2 unidentified nail fragments, 2 shards of window glass, and a piece of ceramic sewage/drainage pipe.

The assemblage predominately dates from the twentieth century. Only three artifacts predate the twentieth century. Most of the remaining artifacts are manufactured to this day. It is

possible that this artifact scatter was related to the hamlet of Winthrop, located on Stump Neck between 1913 and 1953. The two poured concrete foundations located in the northern portion of the site may be the remains of one of the structures depicted on historic maps of the project area, although this construction technique was not common until later in the twentieth century. Disturbance to this component of the site is considerable. Nearly all of the artifacts were recovered from disturbed contexts; only a few historic artifacts were recovered from within the B horizon. No historic artifacts were associated with a clearly defined feature or cultural horizon.

Site 18CH626. Site 18CH626 was a small Woodland period site located in a wooded area in the southwestern portion of Area B (Figure 35). The site lies at the edge of Chicamuxen Creek approximately 80 m south of Site 18CH389. The site measured approximately 40 x 60 m (131 x 197 ft). Artifacts were recovered from five shovel tests and one location on the surface of the site. The 17 prehistoric artifacts recovered from the site include 3 shell and sand-tempered ceramic sherds and 14 pieces of debitage. The quartz, quartzite, rhyolite and sandstone debitage was predominately non-cortical; only three flakes retained cortex. The eroded and fragmentary shell and sand-tempered ceramics may date from either the Middle or Late Woodland periods. The site probably represents a small campsite; however, the assemblage is insufficient for accurate characterization of the nature of the prehistoric occupation. Eleven of the prehistoric artifacts recovered were from the A and B horizon in single shovel test (N800/E1240). These strata were covered by a layer of fill that extended across much of the southwestern portion of Area B.

The 16 artifacts in the historic assemblage from Site 18CH626 are indicative of a late nineteenth through early twentieth century occupation. Ceramics were the most numerous artifact type recovered; the assemblage included 1 transfer-printed whiteware sherd, 4 undecorated whiteware sherds, 4 late porcelain sherds, 2 ironstone sherds, and 1 possible fragment of a figurine. The remaining four historic artifacts all were fragments of modern bottle glass. Most of these historic artifacts were recovered from the A horizon in a single shovel test (N820/E1280). The limited nature of the historic assemblage from this site suggests that it may be the result of historic dumping activity. It is likely that this material is in secondary context and that the historic

occupation that generated this refuse was nearby. The historic assemblage was composed entirely of domestic debris, nearly all of which were kitchen-related. Only one architectural artifact, a piece of plate glass, was recovered.

The deposition of the fill horizon on the site is probably related to the truncated profiles observed in shovel tests placed to the north of the site. The grading activity that produced the fill horizon appears to have disturbed most of the artifacts associated with Site 18CH626. The limited nature of the prehistoric component and the potentially dumped or redeposited historic component indicate that the site lacks research potential.

Area C

Area C encompassed 133.22 ac covering the entire peninsula containing Rum Point (Figure 31). The landform was bounded on the east and west by tributaries of the Mattawoman Creek, and on the north by the creek itself. The southern boundary was set arbitrarily as the edge of a ridge south and across Rum Point Road from the skeet range. Area C was subdivided into two areas for the survey, Areas C-1 and C-2. The division was made primarily on the basis of modern human disturbance in the form of a skeet range and a gravel road that provided a logical boundary line between the two areas. Shorelines along Mattawoman Creek generally were low with gradual slopes and little erosion, except for a small section of bluff along the western edge of Rum Point. Erosion was visible along the drainages in the higher areas found within Area C-1. The topography of Area C formed a relatively flat peninsula sloping down gently to the north towards Mattawoman Creek. This landform was cut by several drainages leading into small tributaries of the creek.

Soils mapped for Area C varied greatly and included Sassafras sandy loam, Othello silt loam, Woodstown sandy loam, Mattapex silt loam, and Galestown loamy sand. Much of the land around the drainages on the western and eastern boundaries was mapped as steep gravelly land; these areas generally were not tested because of slopes greater than 10 per cent.

The vegetation in Area C primarily was mature forest with a moderate amount of undergrowth. Dominant tree species included white oak, red oak, beech, maple, yellow poplar,

cherry and holly. Pines were present in areas of regrowth. These areas contained saplings as well as green briar, poison ivy, and devil's walking stick. Several cleared grassy areas were present in Area C-2, one such area was a wildlife feeding field. The land around the subsurface testing compound in the central portion of Area C-2 also was cleared.

Most of Area C is currently used as a woodlot with disturbance primarily from one subsurface testing area and a skeet range. An abandoned Boy Scout camp and a number of pushpiles were present near the tip of Rum Point.

Phase I survey in Area C located and delineated three previously identified sites and four new sites. These sites were predominately prehistoric, ranging in age from the Late Archaic to Late Woodland periods. Historic occupation as early as the eighteenth century also was indicated. Historic maps place a structure in the west-central portion of Rum Point by 1900 (Stevens et al. 1995: Figures 11 and 13). A foundation identified in the northern portion of Rum Point may be associated with the landing of Union Troops under Hooker during the Civil War.

Area C-1

Area C-1 was located towards the base of Rum Point, between Area N to the south and Area C-2 to the north (Figure 37). The eastern and western boundaries of the area were defined by two large drainages that fed into Mattawoman Creek; the eastern drainage is dammed to form a large beaver pond.

The datum for Area C-1 (N1000/E1000) was placed in the southwestern corner of the area, 20 m west of Rum Point Road. The baseline extended east and west at a bearing of 90° (magnetic north) and 17 transects were extended from the baseline at 0°. A control line was flagged along the E1100 transect. A total of 120 shovel tests were excavated, while 45 planned shovel tests were not dug because of slope or surface disturbance.

Several areas of C-1 were disturbed. A gravel pit was located in the eastern part of the area, and there was visible surface disturbance from logging activities across portions of the area. A historic road trace wound its way along the western edge of the area. Three small drainages flowing into Mattawoman Creek cut the area.

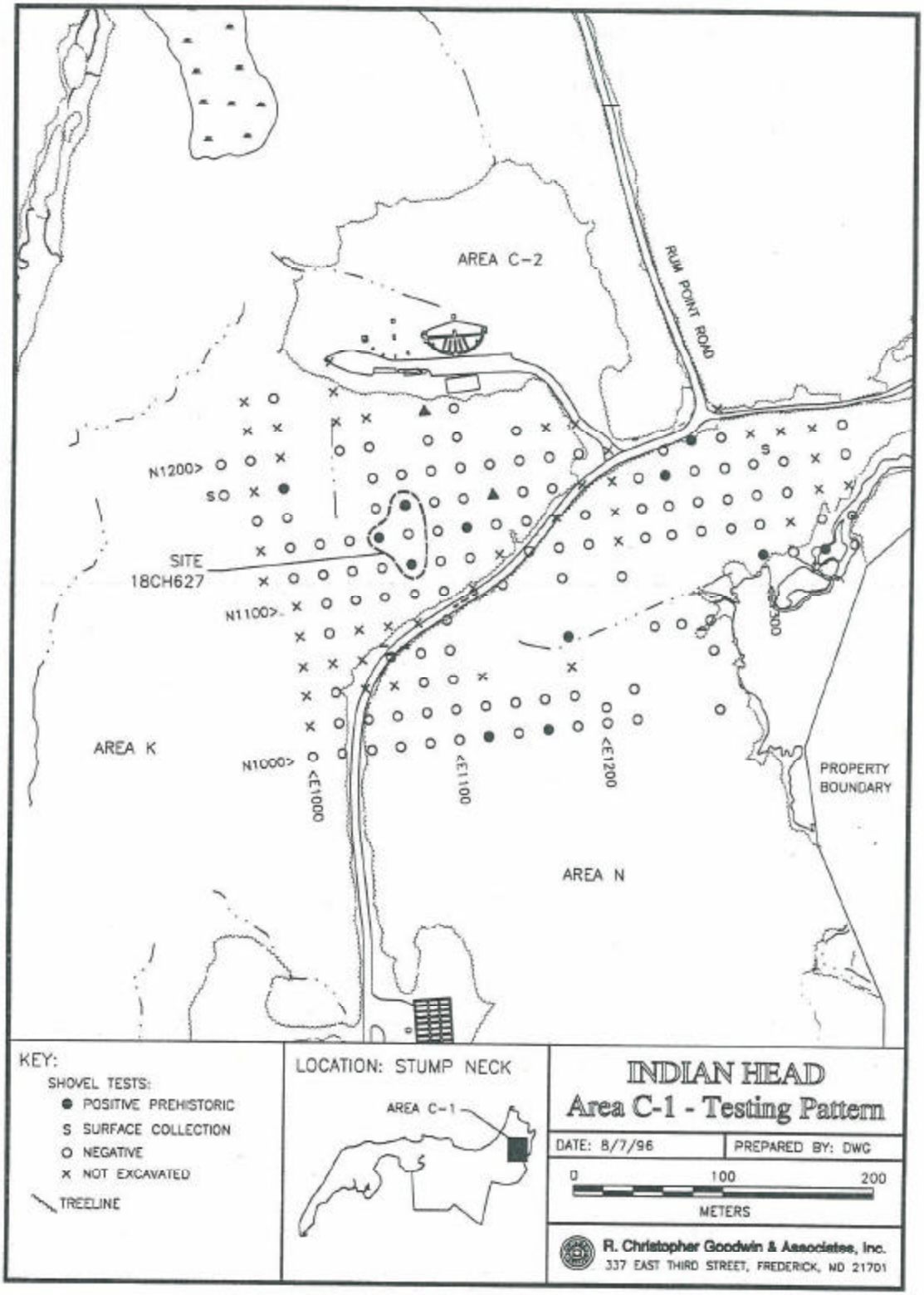


Figure 37. Map of Area C-1, showing shovel test pattern and site boundaries

Vegetation in Area C-1 was divided between old growth, mature forest and dense regrowth which occurred primarily along the baseline in the southern half of the area. Tree species included oak, maple, beech, tulip poplar, cherry and holly. The regrowth contained saplings of the same species with undergrowth of green briar and devil's walking stick.

A representative soil profile from Area C-1 consisted of: a 0-11 cmbs dark grayish brown (2.5Y 4/2) silt loam; a 11-37 cmbs light yellowish brown (10YR 6/4) loamy silt; and, a 37-50 cmbs yellowish red (5YR 5/6) clay. This profile corresponds generally to the Aura soils mapped for much of the area (Hall and Matthews 1974).

Shovel testing identified one small prehistoric site and 13 isolated positive shovel tests and three surface finds. All but five of the 23 non-site artifacts recovered from Area C-1 were prehistoric. The historic artifacts not attributed to any site consisted of three creamware sherds and a fragment of lamp glass from Shovel Test N1220/E1100, and 1 clear glaze slipware sherd from another test. The prehistoric non-site artifacts included 9 flakes, 5 fire-cracked rock fragments, 1 quartz triangle point/knife, (Figure 38, FS #15), and 3 coarse sand temper Potomac Creek sherds.

Site 18CH627. Site 18CH627 was located on a ridgetop 40 m (131 ft) north of the access road in mature forest. A total of 5 artifacts were recovered from three shovel tests including 2 quartz flakes, 2 quartzite flakes, and 1 chert block/shatter fragment. No diagnostic artifacts were recovered. Three of the artifacts were from below the Ap horizon at 12-24 cmbs. The relatively shallow depth of the artifacts and their limited number reduce the likelihood that intact deposits exist in this upland area. The small assemblage from this lithic scatter site make interpretation difficult; it is likely that they site represents a briefly occupied lithic reduction or resource procurement site.

Area C-2

Area C-2 was located directly north of Area C-1 and extended all the way to the tip of Rum Point (Figure 39). The topography was characterized by a relatively flat peninsula that sloped down towards the point. The area was bounded by Mattawoman Creek and Area C-1. The southwestern edge of the area was formed by a large beaver pond, which appeared to be quite old. A couple

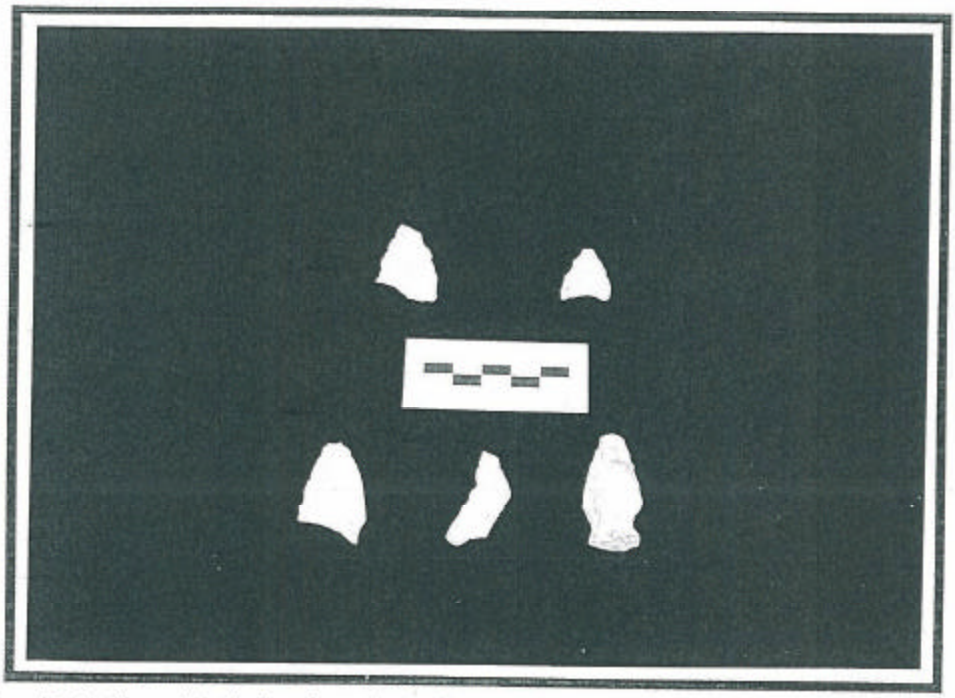


Figure 38. Projectile points/knives from Areas C-1 and C-2, non-site, and Sites 18CH84 and 18CH391. (Clock-wise from upper left) [a] FS# 15; [b] FS# 11; [c] FS# 60; [d] FS# 70; [e] FS# 57)

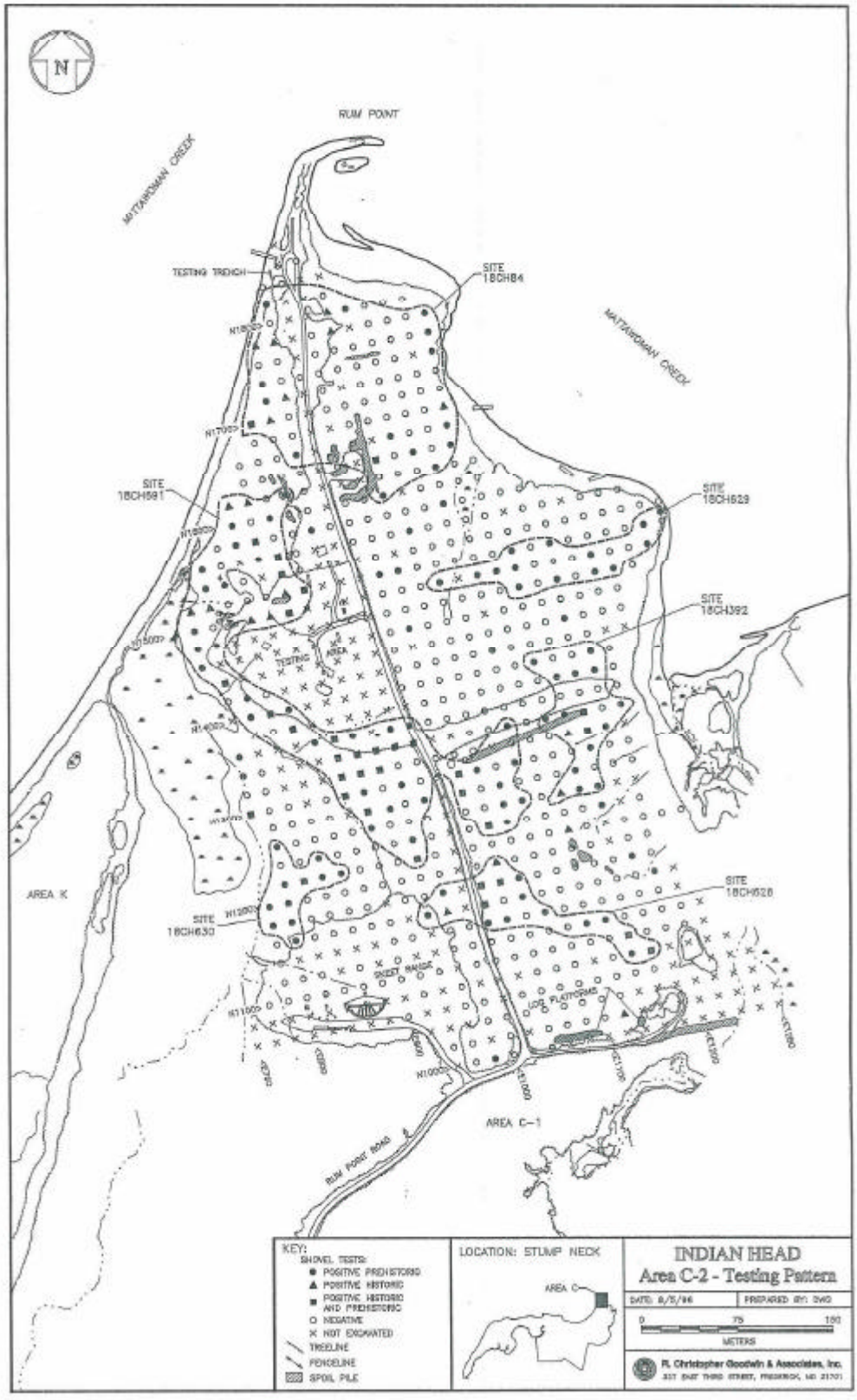


Figure 39. Map of Area C-2, showing shovel test pattern and site boundaries

of drainages cut through part of Area C-2, but most of the disturbances were from recent human activity.

The datum for Area C-2 was established 5 m northwest of the intersection of Rum Point Road and the road leading to the parking area near the gravel pit. A baseline was extended north on a bearing of 0° (magnetic north), and 44 transects extended east and west at a bearing of 90/270°. A total of 585 shovel tests were excavated, and an additional 203 planned tests were not dug because of surface disturbances, standing water, or excessive slope.

Area C-2 contained sizable areas of disturbance, almost all were the result of human activity. At the southern end of the area, the skeet range and associated buildings prevented testing. A large gravel pit also was located in the southern end of the area. A sub-surface testing compound located west of Rum Point Road in the central portion of the area precluded testing and appears to have destroyed a large section of Site 18CH391. An abandoned Boy Scout camp characterized by surface garbage and campfire pits was located in the northern end of the area, near the tip of Rum Point. Around the camp was an area containing large pushpiles, deposits of gravel, and standing water in a large bulldozed depression. At the very tip of the point, the ground was disturbed by the remains of a missile launching mechanism that prevented testing north of the turning circle. Other disturbance came from standing water and slopes down to the drainages.

The vegetation in Area C-2 consisted mainly of 30-50 year old hardwoods and some pine with patches of regrowth around the edges of cleared areas. The predominant species were the same as those described for Area C-1, and included oak, maple, beech, sweet gum, yellow poplar, hickory and pine. The undergrowth was relatively light except in areas of regrowth where there were briars, vines, and poison ivy.

The mapped soils for Area C-2 vary greatly, and include soils from the Sassafras, Woodstown, Othello, and Galestown series (Hall and Matthews 1974). In contrast, shovel testing revealed a certain degree of continuity across the area. A typical profile for Area C-2 consisted of: a 0-7 cmbs grayish brown (10YR 5/2) silt loam; a 7-31 cmbs pale brown (10YR 6/3) silt loam; and, a 31-40 cmbs yellowish brown (10YR 5/4) clay loam. This profile corresponds the Sassafrass series

mapped for the southern portion of the area. The high water table often flooded shovel tests at only 25 cm below surface, hampering excavation and recording of soil profiles.

Phase I survey in Area C-2 relocated and defined the boundaries of three previously identified sites; two were multi-component prehistoric and historic sites (18CH391 and 18CH392) identified during the Phase IA reconnaissance survey (Stevens et al. 1995). The character of the remaining site (18CH84) was poorly known but was identified only as dating from the Archaic and Woodland periods. The survey also located three new sites (18CH628, 18CH629, and 18CH630). Site 18CH629 was a prehistoric site of an unknown age. Site 18CH628 was a Woodland site with an early to middle nineteenth century historic component. Site 18CH630 was a Woodland period site with a single historic artifact. In addition to the six sites, 18 artifacts were recovered from 15 isolated shovel tests. These artifacts included 3 historic ceramics, a lead slug, 11 quartz or quartzite flakes, 1 fire-cracked rock fragment, and 2 prehistoric ceramics. One sherd was coarse sand-tempered Potomac Creek Plain. The other was an unidentified shell-tempered sherd. Three of these artifacts could possibly be related to Site 18CH391, but have been separated from the main concentration by the disturbance from the testing facility.

Site 18CH84. Site 18CH84 was described in the Phase IA reconnaissance survey report as an Archaic/Woodland site with Potomac Creek ceramics (Stevens et al. 1995). The site boundaries were delineated and expanded during the current survey; a historic component also was identified. Among the evidence of historic activity was a brick feature that was partially exposed during the survey. The site measured approximately 180 m x 210 m (590.5 x 689 ft) with positive shovel tests forming a crescent-shaped curve from the shoreline at the northeastern end of the point down the west side and back across the peninsula to the eastern edge (Figure 39). Diagnostic artifacts recovered during the Phase IB survey indicate occupation of the site during the Late Woodland period and the mid-nineteenth to early twentieth centuries. The site was partially disturbed along its southern boundary, where large pushpiles and evidence of bulldozing and filling was present. Several prehistoric and historic artifacts were recovered from the edge of a pushpile at Shovel Test N1640/E980. The northern end of the site was totally disturbed by the missile launching apparatus

and other grading. Outside of these disturbed patches, the excavated soils corresponded to the Galestown loamy sand mapped for the area.

The prehistoric sub-assemblage from Site 18CH84 contained 28 artifacts from 16 shovel tests: 14 shovel tests contained only prehistoric artifacts; and two contained both historic and prehistoric artifacts. Seven of the shovel tests were located in the southeastern corner of the site, east of the pushpiles and disturbance. These shovel tests contained a total of 13 artifacts, including a quartz-tempered body sherd and a quartz Madison point.

The prehistoric assemblage from Site 18CH84 included 20 pieces of debitage, 2 pieces of fire-cracked rock, 1 retouched flake, 2 utilized flakes, 1 projectile point, and 2 ceramic sherds. The debitage was principally non-cortical in nature; only one primary and two secondary flakes were recovered. Although nearly all of the debitage was locally available raw materials; evidence for primary and secondary reduction was notably absent.

Flake tools included a bifacially retouched non-cortical quartz flake and two utilized secondary quartz flakes. The two utilized flakes were recovered from the southeastern portion of the site in the vicinity of the point and a ceramic sherd. The retouched flake was recovered in the western portion of the site approximately 40 m from a second sherd. The projectile point was a small quartz triangle with a thick cross-section and steeply retouched edges. The overall morphology of the point is consistent with the Madison or Potomac types (Ritchie 1971; Stephenson et al. 1963). The ceramics included one eroded quartz-tempered unidentified body sherd and one sand-tempered Moyaone body sherd. The Moyaone sherd appeared to exhibit a burnished exterior surface treatment.

The general character of the assemblage was indicative of activities associated with a short-term camp such as tool maintenance and resource procurement. Although the prehistoric artifacts were disturbed by plowing and other historic activities, the horizontal distribution of the assemblage from the site suggests that activity areas might be isolated. Clusters of prehistoric artifacts in the southeastern, northeastern, and western portions of the site may be functionally or temporally distinct. Most of the prehistoric component at the site lies within the plowzone. Only

five prehistoric artifacts (17.9 per cent) were recovered from below the plowzone (Ap horizon); all were from shovel tests placed in the eastern portion of the site. This portion of the site may retain integrity.

The historic component at the site was characterized by a light scatter of nineteenth and twentieth century artifacts across most of the site and a brick and stone foundation located in the northwestern portion of the site. A total of 18 artifacts were recovered from nine shovel tests across the site; half of these artifacts were clearly modern. The remaining artifacts included 1 imported gray Westerwald stoneware sherd with blue decoration, 1 undecorated pearlware sherd, 1 brown transfer printed whiteware sherd, 1 imported brown stoneware bottle sherd, 1 unidentified cut/wrought nail, 2 unidentified nails, and 2 manufactured brick fragments. These artifacts date from the nineteenth and twentieth centuries.

Stone and Brick Foundation. A stone and brick foundation was encountered in a shovel test (N1800/E900) on the western edge of the tip of Rum Point, in the northwestern corner of Site 18CH84. A 0.5 m (1.6 ft) wide trench was placed across the feature in an effort to identify the nature of the feature (Figure 40). The 5.5 m-long trench, located 2 m north of the shovel test was excavated in 50 x 50 cm (19.7 x 19.7 in) units that were oriented parallel the shovel test transects. The brick surface or a possible floor was exposed in the trench at a maximum depth of 43 cmbs (63 cmbd).

The trench revealed a brick, stone, and mortar rubble feature, at least 5.5 m (18 ft) wide, with a possible stone foundation and floor, and a probable brick wall collapse. Intact bricks and decayed brick rubble with mortar extended across a large portion of the exposed surface. The mortar remained between the bricks in several places; it was characterized by sand with lime flecking. The riverward wall appears to have collapsed towards the east, in on the structure, and now lies on what was probably a mortared stone floor and foundation. A possible builder's trench for the rough cut stone foundation was identified on the western edge of the feature. The trench contained olive brown (2.4Y 4/4) silty sand.

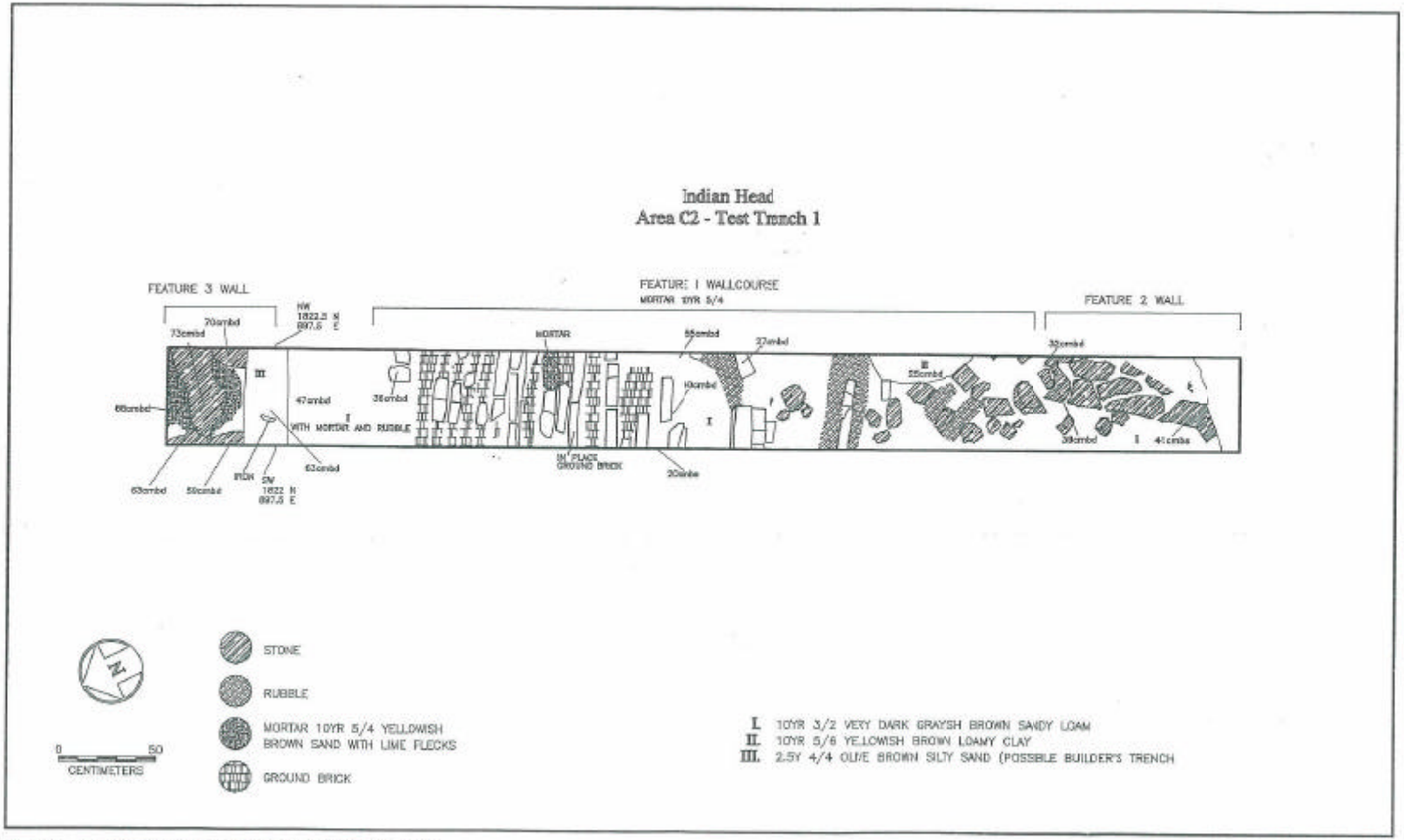


Figure 40. Area C-2: Planview of Historic Stone foundation in Trench 1

A total of 259 artifacts were recovered from the trench, including 89 modern artifacts which were discarded as modern after analysis (Table 8). The modern artifacts included bottle glass, pull tabs, screw caps, tar paper shingle, and plastic. Most of the artifacts remaining were architectural; only 11 historic ceramic sherds were recovered. Other domestic artifacts were recovered including animal bone, bone buttons, oyster and clam shells, and bottle glass. The ceramics from this feature included 2 possible creamware sherds, 7 undecorated whiteware sherds, 1 decal green and pink whiteware sherd, and 1 fragment of blue shell-edged whiteware. The ceramics suggest a nineteenth century date for the features. The largest artifact group was iron nails. Of the 95 nails and nail fragments recovered from Trench 1, most were machine cut (n=65); common wire nails (n= 29) and unidentifiable fragments (n= 1) were recovered in lower numbers. These architectural remains also suggest a nineteenth century construction date for the structure; the wire nails may have been the result of later efforts to repair the structure.

Archival research indicates that Rum Point was the location of considerable activity during the Civil War. General Hooker established his headquarters approximately 2 to 4 miles south of Rum Point and used the landing there to supply the encampment. He stationed a full company there to "protect the government stores and other property that were landed at that place" (Donald 1975: 35). It is possible that this structure is the remains of a storage building or guardhouse associated with the Civil War use of the landing, although none of the artifacts recovered could be associated confidently with the Civil War or Military activity on the point.

The site was disturbed in part by modern activities, perhaps associated with the nearby missile launching mechanism. Erosional damage and contamination with modern debris represent a greater threat to the integrity of the site; the site was located at the tip of the point only 3 m from the water line and was frequently subjected to wash and debris from high water. Many of the modern artifacts in the upper levels are likely the result of this process. Further testing is needed in order to determine the full dimensions of the structure and to better characterize the original use and age of this structure.

Table 8. Site 18CH84 - Functional and Typological Breakdown of Artifacts from Trench 1

Functional Group	Artifact Type		Level 1	Level 2	Count
Activities	Miscellaneous	Lamp Glass	0	1	1
	Miscellaneous Hardware	Non-Electrical Wire	0	1	1
Architecture	Construction Hardware	Bolt and/or Bracket	0	2	2
		Hook	0	1	1
	Machine Cut Nail, Common	< 2"	2	1	3
		> 4"	1	0	1
		2-4"	29	11	40
		Fragment	11	7	18
	Miscellaneous	Roofing Shingle, Tar Paper	2	0	2
	Miscellaneous Building Material	Cement	1	0	1
		Mortar	0	9	9
		Plaster	1	0	1
	Unidentified	Cut/Wrought Nail	3	0	3
		Nail	1	0	1
	Wire Nail, Common	< 2"	3	0	3
		> 4"	7	1	8
		2-4"	16	0	16
		Fragment	2	0	2
Arms	Projectile Part	Rimfire Cartridge .22	0	1	1
Clothing	Bone/Leather Clothing	Bone Button	1	0	1
	Clothing Item	Bakelite Button	1	0	1
FLAKE	UNMODIFIED	NON-CORTEX	1	0	1
Kitchen	Blown in Mold	Aqua	0	1	1
	Creamware	Lighter Yellow	0	2	2
	Food Related	Tooth	0	3	3
		Unidentified Bone	3	3	6
	Later Porcelain Type	Gilded	2	0	2
	Machine Made Bottle	Amber	13	11	24
		Aqua	0	1	1
		Clear	19	13	32
		Cobalt Blue	4	0	4
		Light Green	1	0	1
		Solarized	15	8	23
	Machine Made Lip	Clear	2	0	2
	Melted Glass	Clear	1	0	1
	Miscellaneous	Crown Cap	3	0	3
		Pull Tab/Key Opener	3	0	3
		Screw Cap	3	0	3
	Shell	Clam	2	0	2
		Oyster	4	4	8
	Storage/Service Item	Lid	1	0	1
	Unidentifiable Bottle Glass	Clear	1	0	1
	Whiteware	Decal	1	0	1
		Shell-Edged	1	0	1
		Undecorated	6	1	7
Miscellaneous	Miscellaneous	Battery Carbon	1	0	1
		Plastic/Other	9	0	9
	Unidentified Glass	Melted	0	3	3
	Unidentified Object	Iron/Steel	0	2	2
	Wood	Charcoal	1	0	1
Personal	Coins	Penny	2	0	2
	Personal Use	Powder Tin	1	0	1
Transportation	Stable Item	Harness/Saddle Part	0	1	1
Grand Total			182	88	270

Site 18CH391. Site 18CH391 was recorded during the Phase IA reconnaissance survey (Stevens et al. 1995). The multi-component site dated from the Early and Late Woodland periods based on recovered ceramics and a single Levanna projectile point. The historic artifacts, which included flow-blue whiteware and plain ironstone date from the early twentieth century. Stevens (Stevens et al. 1995) suggested that these artifacts may relate to a nearby historic settlement noted on historic maps of the area dating from between 1900 and 1945. Intensive survey of the site expanded the site boundaries to approximately 260 x 400 m (853 x 1,312 ft)(Figure 39). A large part of the site probably was destroyed by construction of the sub-surface testing compound that occupies a 140 x 180 m (459 x 590.5 ft) area in the central portion of the site. No testing occurred within the fenced compound; however, several shovel tests excavated just outside the fence did produce artifacts.

Site 18CH391 began approximately 60 m (197 ft) south of Site 18CH84 along the western edge of the point and followed the edge of the a low terrace south to the head of a drainage. The eastern edge of the site was in a heavily wooded area 80 m (262.5 ft) east of the access road. The landform generally was flat except for the western edge where it sloped down to the beaver pond and along the small drainage. Most of the site was in mature hardwood or conifer forest; only the area around the testing facility was open grass. The soils encountered across the site corresponded closely to the Woodstown sandy loam soils mapped for the area and showed little evidence of disturbance in the southern part of the site except for plowing in the two grassy fields, and erosion into the drainage, which cut formed the western boundary. Surface disturbance was more common north of the testing facility. Pushpiles and a trash dump were observed in addition to erosion associated with another drainage leading into the beaver pond.

Artifacts were recovered in 59 shovel tests: 31 tests contained only prehistoric artifacts; eight contained only historic artifacts; and 20 contained both prehistoric and historic artifacts. A total of 150 prehistoric artifacts were recovered during the Phase IB testing, including 107 pieces of debitage, 3 projectile points and fragments, 4 utilized flakes, 10 pieces of fire-cracked rock, and 26 ceramic sherds. The debitage from the site was largely non-cortical; a total of 65 non-cortical

flakes, 15 secondary flakes, 7 primary flakes, and 20 pieces of block/shatter. Cores and core fragments were notably absent in the assemblage.

The projectile points from Site 18CH391 included a rhyolite side-notched point, a fragmentary quartz triangular point, and an untyped point fragment (Figure 38). The side-notched point (FS# 60) had weakly defined shoulders, shallow side notches, and a slightly convex base. The overall morphology was reminiscent of Late Archaic projectile points such as Halifax or Brewerton Side Notched (Coe 1961; Ritchie 1971); these types date from approximately 5,000 to 4,000 B.P.; side notched points made form rhyolite also are common during the Middle Woodland (e.g., Selby Bay). The large quartz triangle (FS# 70) was well formed but heavily resharpened, producing concave blade margins. Although the tip was missing from the triangle, the size and flat base of the point were consistent with the Late Woodland Levanna type (Ritchie 1971). The untyped quartz point fragment (FS# 57) was missing the tip and most of the base. The broad blade was well-formed with excurvate margins and a possible side-notch on one side.

The 26 ceramic sherds recovered from Site 18CH391 were predominately Potomac Creek ware; in addition, 1 Mockley sherd, 1 Townsend sherd, 1 Accokeek sherd, and four unidentified sherds also were recovered (Table 9). The ceramic dates from the Late Woodland period with the exception of the Accokeek and Mockley sherds, which typically are associated with the Early and Middle Woodland periods respectively. Most of the Potomac Creek sherds were well fired and tempered with coarse sand or sand. Surface treatments included plain (n=10), cordmarking (n=7), 1 smoothed over cord or fabric (n=1); the surface of one sherd was eroded. The Townsend sherd was shell tempered and exhibited cordage or fabric impressions. The Mockley sherd was sand and shell tempered and exhibited possible fabric impressions. The Accokeek sherd was sand tempered and cordmarked.

Diagnostic artifacts recovered from the site place the occupation of the site between the Late Archaic and Late Woodland periods. The size of the site and the nature of the assemblage recovered suggest that Site 18CH391 was a base camp or substantial occupation.

TABLE 9. SITE 18CH391 - SUMMARY OF PREHISTORIC CERAMICS

Type	Temper	Surface Treatment	Count
Accokeek	sand temper	cord marked	1
Mockley	combination temper	fabric impressed	1
Potomac Creek	coarse sand temper	cord marked	5
		eroded	1
		plain	8
	combination temper	cord marked	1
	quartz temper	cord marked	1
		plain	1
	sand temper	plain	1
		smoothed over	1
Townsend	shell temper	cord marked	1
Unidentified	coarse sand temper	cord marked	1
		eroded	2
	combination temper	eroded	1
Grand total			26

Site 18CH391 contained three concentrations of prehistoric artifacts, two at the southern portion of the site and a third in the northern portion of the site. The smaller concentration was located east of Rum Point Road, 50 m (164 ft) west of Site 18CH392. Thirteen shovel tests placed in this portion of the site contained 16 prehistoric artifacts, including nine of the 26 ceramics recovered from the site. Only three of the shovel tests contained historic artifacts as well. All of the artifacts were recovered from the first stratigraphic level (a possible Ap horizon), which had an average depth from 0-30 cmbs. The second concentration, located immediately south and west of the Subsurface Testing Facility, contained 62 prehistoric artifacts from 16 shovel tests placed in this portion of the site. Eleven of the shovel tests contained historic artifacts. Two utilized flakes, 4 sherds, the point tip, and the side-notched point were among the artifacts recovered from the second concentration.

The third concentration of prehistoric artifacts was located in the northern portion of the site and contained 33 artifacts from the 19 shovel tests placed in this area (Transect N1540 and north). Five ceramic sherds, 3 fire-cracked rock fragments, 1 utilized flake, and 1 Levanna point were among the artifacts recovered from this area. Prehistoric artifacts recovered in shovel tests placed on the western margin of this concentration were stratified beneath the historic disturbance. A possible A horizon was detected in three shovel tests (N1540/E780, N1560/E780, and N1540/E800) on a low alluvial bench above Mattawoman Creek.

A shovel test (N1380/E840), placed at the edge of the fenced area in a pushpile, produced 21 prehistoric and 6 historic artifacts from 89 cm of brown loam. The soil in the pushpile was probably redeposited from within the Testing Facility.

The historic sub-assemblage from Site 18CH391 contained 66 artifacts, of which 17 were modern glass or metal fragments. The remaining artifacts were divided between architectural elements and domestic artifacts. Relatively few ceramics were recovered from Site 18CH391; these included 2 creamware sherds, 1 pearlware sherd, 4 whiteware sherds, 1 redware sherd with a dark brown-black glaze, and 1 yellow ware sherd. Whiteware, a nineteenth and twentieth century ware was found in the northern portion of the site, while late eighteenth and early nineteenth century

artifacts such as creamware, pearlware, and cut nails were found in the southern portion. The frequency of historic artifacts was low across the entire site and modern debris was mixed throughout the strata containing historic materials. In the absence of artifact concentrations or features, the historic component does not appear to retain the qualities of integrity and research potential.

Site 18CH392. Site 18CH392 also was identified during Phase IA reconnaissance survey (Stevens et al. 1995). The site was located during random surface survey of the agricultural field, east of Site 18CH391. Several flakes, an early stage biface, and a purple decorated Westerwald stoneware sherd were recovered at the end of the field. The site was relocated during intensive archeological survey approximately 50 m (164 ft) east of the edge of Site 18CH391 near the end of the agricultural field (Figure 39). The site measured 80 m east-west by 140 m (262.5 x 459 ft) north-south and extended into the forest surrounding the open field. Logging activities in the area immediately south of the field and erosion along a small drainage that traversed the southern portion of the site were the only forms of disturbance observed on the site. Testing of the site was complicated by a high water table at approximately 25 cmbs.

Artifacts were recovered from 17 shovel tests: 13 contained only prehistoric artifacts; two contained only historic artifacts; and two contained both prehistoric and historic artifacts. A total of 43 artifacts were recovered, of which 23 were prehistoric. The Potomac Creek cord marked body sherd was the sole diagnostic artifact recovered from the site The artifacts included 16 pieces of debitage (8 non-cortical flakes, 3 secondary flakes and 1 primary flake); 1 utilized primary flake; 1 core; 1 ceramic sherd; and, 5 fire-cracked rock fragments; and 3 block/shatter. The prehistoric artifacts suggest a resource procurement site or temporary campsite.

The small historic assemblage recovered was concentrated in the central portion of the site and consisted almost entirely of early to mid-eighteenth century artifacts (Table 10). These included: 1 English flint flake, 2 pipe bowl fragments, 2 pipe stem fragments, 2 slipped dipped early white stoneware sherds, 1 blue and white tin-enamelled earthenware (Delft), 1 Faience tin-glazed earthenware, 3 redware, 1 possible brass fragment, and 2 unidentified pieces of iron. Only a cut

TABLE 10. SITE 18CH392 - SUMMARY OF DIAGNOSTIC HISTORIC ARTIFACTS

Artifact	Count	Date Range
Stoneware, early white slip dipped	2	1720-1775
Earthenware, tin enamelled blue and white	1	1620-1800
Earthenware, faience plate, pink body with blue and red decoration	4	18th century
*Westerwald stoneware, purple decoration	1	1700-1775
English gunflint flake	1	17th and 18th centuries
Machine cut nail fragment	1	1815-1890

*Artifact was recovered during Phase IA survey (Stevens et al. 1995)

nail from Shovel Test N1320/E1140 dated after the eighteenth century. Although all of these artifacts were recovered from the plowzone, they were concentrated tightly, with 17 of 20 historic artifacts recovered from two adjacent shovel tests (N1320/E1140 and N1340/E1140). In fact, 14 artifacts were recovered from a layer of brown loam between 0 and 68 cmbs in Shovel Test N1320/E1140. The extreme depth and color of this horizon may indicate disturbance; it is equally probable that it is within a feature.

Archival and archeological evidence of an eighteenth century occupation on Stump Neck or Rum Point is scant. Scattered eighteenth century artifacts were recovered in other areas; however, the concentrated nature of this material and the near absence of later artifacts on the site was notable. The potential feature encountered in one shovel test warrants additional investigation. The variety of artifact types indicate that it is unlikely that the historic component was the result of dumping or secondary redeposition.

Site 18CH628. Site 18CH628 was a small Late Woodland Site located at the southern end of Area C-2, approximately 50 m (164 ft) south of Site 18CH391 (Figure 39). The site was situated in a level wooded area with severe disturbances at the eastern and western ends. The disturbed soils associated with the skeet range lie at the western edge of the site. A large graded area with disturbed soils and dotted with push piles lies at the eastern edge of the site. Site 18CH628 measured approximately 60 m by 220 m (197 x 721.8 ft) and was defined on the basis of 17 positive shovel tests: 10 of them containing only prehistoric artifacts; two with only historic artifacts; and five with mixed artifacts. A total of 36 artifacts were recovered from the site; 27 were prehistoric and 9 were historic.

The prehistoric assemblage from Site 18CH628 included: 14 pieces of debitage, 4 core fragments, 3 pieces of fire-cracked rock, 1 utilized quartzite flake, 4 ceramic sherds, and 1 piece of shell. The debitage was entirely of locally available materials such as quartz and quartzite; a single piece of ironstone block/shatter was recovered. Among the debitage were 1 primary, 3 secondary, and 6 non-cortex flakes, and 5 pieces of block/shatter. All four cores were extensively reduced and manufactured from quartzite cobbles.

All of the ceramics were sand-tempered; three sherds were coarse sand and one was fine sand. The fine sand-tempered sherd was classified as a Moyaone eroded body sherd. Two of the coarse sand-tempered sherds were classified as possible Potomac Creek, both exhibited cord marked exteriors. The fourth sherd was an unidentified eroded body sherd. Potomac Creek and Moyaone wares date from the Late Woodland period (Stephenson et al. 1963).

The prehistoric artifacts were recovered in almost equal numbers from the A and B horizons. Nearly all historic artifacts from the site were recovered from within the A horizon; only one historic ceramic was recovered from the B horizon. The artifacts were scattered thinly across the site. A small concentration of seven artifacts in three shovel tests was identified in the southeastern portion of the site; the cores and cortical flakes were recovered from these shovel tests. The ceramics were recovered in four shovel tests placed within 40 m of each other in the northwestern portion of the site. The character of the prehistoric assemblage indicated activities associated with procurement and manufacture of stone tools and possible campsite activities. The occupation of this site was probably associated with the occupation of the southern portion of Site 18CH391 to the north.

The historic sub-assemblage was comprised of nine artifacts, mostly from shovel tests placed in the vicinity of the gravel access road at the center of the site. The historic artifacts recovered during shovel testing included, 2 undecorated whiteware sherds, 1 whiteware sherd with a blue molded rim, 1 green shell edged pearlware sherd, 1 modern machine-made bottle fragment, 1 unidentified nail, 1 window glass fragment, 1 manufactured brick fragment and 1 piece of coal slag. All of the artifacts were recovered from the A or Ap horizon and probably result from field dumping or overwash of the peninsula. The presence of a significant percentage of the prehistoric artifact assemblage within the B horizon and lack of historic materials below the A horizon suggests that the site retains a moderate to high degree of integrity. Although the prehistoric assemblage from the site was relatively small, the distribution of artifacts across the site indicates that functionally distinct activity areas may be present the site. These findings suggest that Site 18CH628 may possess research potential, therefore Phase II evaluation appears warranted.

Site 18CH629. Site 18CH629 was a small and diffuse prehistoric site located in the northeastern portion of Area C-2, midway between Sites 18CH392 and 18CH84. Eighteen artifacts were recovered from 14 shovel tests placed over an area measuring 40 x 240 m (131.2 x 787.4 ft). Site 18CH629 was situated primarily on flat high ground in open mixed hardwood forest. The soils were consistent across the site and characteristic of the Othello silt loam mapped for that portion of Rum Point. The assemblage of 18 prehistoric artifacts included: 1 silicified sandstone hammerstone; 5 non-cortical flakes and 6 secondary flakes; 2 block/shatter; 3 fire-cracked rock fragments and 1 core fragment. Fourteen of the artifacts were recovered from the second stratigraphic horizon (B horizon) up to 40 cmbs. The assemblage was characteristic of procurement and production of stone tools. This site probably represents a resource procurement or hunting camp.

Site 18CH630. Site 18CH630 also was a small prehistoric site located in the southern portion of Area C-2 on the western edge of Rum Point. The 80 x 100 m site occupied a low terrace between two drainages leading to the large beaver pond on the west side of the point. The terrain generally was flat. The soils were consistent across the site and corresponded to the Sassafras silt loam mapped for the landform (Hall and Matthews 1974).

The 31 artifacts recovered from the site were predominantly prehistoric; a single redware sherd was the sole historic artifact recovered. The prehistoric assemblage included 12 pieces of debitage, 1 core, 13 pieces of fire-cracked rock, 1 retouched flake, and 3 sand-tempered ceramic sherds. The debitage was entirely non-cortical and the core was reduced extensively. The large bifacially retouched quartz flake was recovered from the A2 horizon. Two of the ceramic sherds were classified as Potomac Creek ware; one exhibited a burnished, plain exterior, the other had a cordmarked exterior. One sherd was classified as possible Moyaone ware. The exterior of this sand-tempered sherd was smoothed over cord marking.

Although more than half of the prehistoric artifacts were recovered from three shovel tests (N1220/E820, N1220/E840, and N180/E780), no clear pattern was visible in the artifact distribution across the site. Soil profiles across the site revealed a clear A1-A2 horizon sequence described for

unplowed Sassafrass Silt Loam soils by the U.S. Soil Conservation Service (Hall and Matthews 1974). The artifacts were concentrated in the upper A horizons on the site and appear to retain their vertical integrity. The lack of a plowzone at the site and the quantity and diversity of artifacts recovered suggest that enough integrity and research potential may remain to permit isolation of activity areas. The presence of fire-cracked rock suggests that features may be present. As a result, Phase II evaluation of Site 18CH630 appears warranted.

Area D

Area D was is situated between Areas A and E-1, in the vicinity of Range 3, on the Stump Neck peninsula. The 34.12 acre area was bounded by Area A to the south, Area E-1 to the north, the Potomac River to the west, and Chicamuxen Creek to the east (Figure 41). The peninsula forms a long ridge running the length of the area sloping down towards the water on either side. The ridge slopes gently towards the southeast forming in a series of terraces down to a low floodplain approximately 2 m above the water of Chicamuxen Creek. This flat was very wet during the winter months. The ridge slopes gently towards the Potomac River to the northwest then drops off abruptly to form a 6 - 9 m (20 - 30 ft) high bluff. This side is cut by several small drainages flowing into the Potomac River.

The vegetation in Area D was similar to that elsewhere on the peninsula, and consisted of mixed hardwood forest with light to medium undergrowth except at the edge of the treeline where it is much more dense. Dominant tree species in the area were oak, beech, maple, cherry, sweet gum, holly and dogwood. The undergrowth was primarily green briar and other vines, with paw paw, poison ivy and other low plants commonly represented. The land around the military buildings and testing area was short mown grass, as was the 20 m wide easement on either side of Archer Avenue. An unmown grass field surrounded Building 2107 at the eastern end of Porter Road.

The soils in Area D varied slightly with the terrain. Some shovel tests contained both an A1 and an A2 horizon as well as a B horizon, while others had only an A1 and a B horizon; still others had an A-C horizon sequence. A representative soil profile from a shovel test with A1, A2 and B

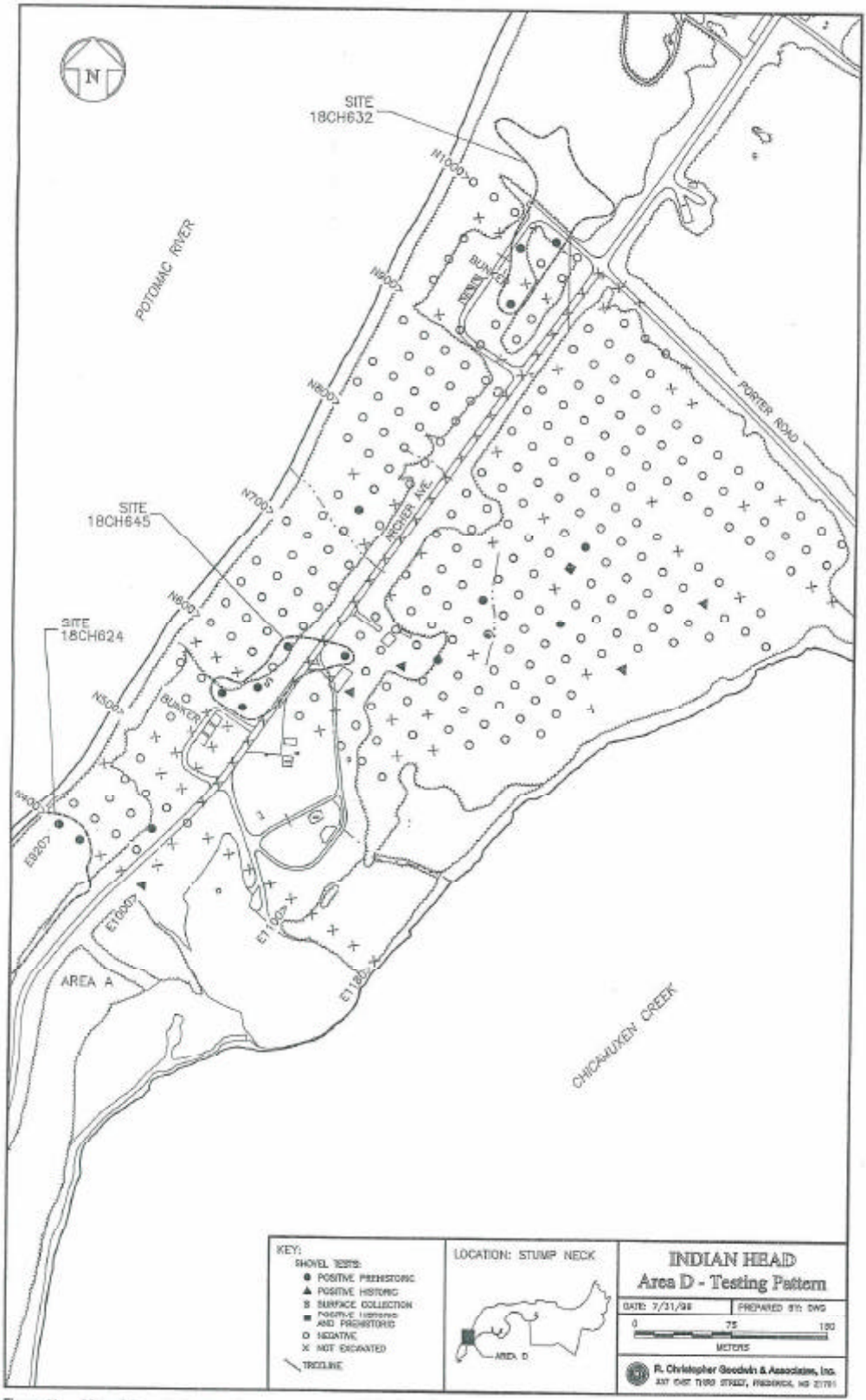


Figure 41. Map of Area D, showing shovel test pattern and site boundaries

Installation	Range	Building #	Date built	current use	other
Stump Neck	Area 8	19SN	1943	training Bldg.	AFD
Stump Neck	Marine Rifle Range	D- 21CSN	1918	Demolished	
Stump Neck		31SN	1945	Demolished	
Indian Head	The Valley	45A	1942	Marina Safety/Info.Ctr	
Indian Head	The Valley	48	1900	storage/shelter	
Indian Head	The Valley	54	1908	storage	
Stump Neck	Area 8	55SN		Demolished	
Stump Neck	Area 8	60SN	1943	storage	
Indian Head	The Valley	62	1903	conference room	
Stump Neck	Area 8	65SN	1931	training area/fish pond	
Stump Neck	IED	69SN	1953	storage Bldg.	AFD
Indian Head	The Valley	70	1904	storage	
Indian Head	The Valley	71	1904	storage	
Indian Head	The Valley	100	1941	pumping station	
Indian Head	Single Base Propellant	174	1910	dry house - storage	
Indian Head	Single Base Propellant	175	1902	dry house - storage	
Indian Head	Single Base Propellant	176	1899	dry house - storage	
Indian Head	Single Base Propellant	177	1903	dry house - storage	
Indian Head	Single Base Propellant	178	1904	dry house - storage	
Indian Head	Single Base Propellant	180	1910	dry house - storage	
Indian Head	Single Base Propellant	181	1910	dry house - storage	
Indian Head	Single Base Propellant	183	1910	dry house - storage	
Indian Head	Single Base Propellant	187	1910	dry house - storage	
Indian Head	Single Base Propellant	188	1910	dry house - hvac shop	
Indian Head	Single Base Propellant	204	1915	dry house - storage	
Indian Head	Single Base Propellant	205	unknown	storage Bldg. - housing	EXC
Indian Head	Single Base Propellant	207	1915	dry house - storage	
Indian Head	Single Base Propellant	208	1915	dry house - storage	TBD
Indian Head	Single Base Propellant	210	1915	dry house - storage	TBD
Indian Head	The Valley	253	1916	lab	TBD
Indian Head	The Valley	254	1918	pumping station	
Indian Head	NG Slums	738	1953	storage Bldg.	
Indian Head	FDR Skeet Range	807	1953	storage Bldg.	
Indian Head	FDR Skeet Range	807A	1953	ac/heater house	
Indian Head	NG Slums	1216	1961	storage	
Indian Head	NG Slums	1451	1988	storage	TBD
Indian Head	The Valley	1703	1985	operators Bldg.	
Indian Head	The Valley	1704	1985	dechlor/cholor-iniation Bldg.	
Indian Head	The Valley	1705	1985	chlorine contact chamber	
Indian Head	FDR Skeet Range	1844	1985	pumping station	
Indian Head	The Valley	1847	1985	pumping station	
Indian Head	Single Base Propellant	1890	1994	Natural Resources Field Office	
Stump Neck	IED	2012	1960	chlorinator house	
Stump Neck	Marine Rifle Range	2019	1962	offices	TBD
Stump Neck	IED	2059	1953	firing bunker	
Stump Neck	IOD	2063	unknown	firing bunker	AFD
Stump Neck	Small Arms Range	2070RP	unknown	pistol range	ABN
Stump Neck	Marine Rifle Range	2075	1949	shredder ops. Building	
Stump Neck	Area 8	2077	1966	storage	TBD
Stump Neck	Area 8	2078	1966	storage	TBD
Stump Neck	Area 8	2079	1966	storage	TBD

Installation	Range	Building #	Date built	current use	other
Stump Neck	Area 8	2080	1966	storage	TBD
Stump Neck	Area 8	2083	1966	training Bldg.	
Stump Neck	Area 8	2084	1966	training Bldg.	
Stump Neck	IOD	2086	1967	x-ray Bldg.	
Stump Neck	IED	2087	1967	offices	
Stump Neck	IOD	2090	1950	training Bldg.	
Stump Neck	Old Demo	2097	1969	storage	
Stump Neck	Marine Rifle Range	2101	1972	shelter	TBD
Stump Neck	Area 8	2102	1972	shelter	TBD
Stump Neck	Area 8	2104	1972	training Bldg.	TBD
Stump Neck	Marine Rifle Range	2105	1974	storage	TBD
Stump Neck		2107	1976	testing Bldg.	
Stump Neck	Area 8	2125	1984	training Bldg.	TBD
Stump Neck		2127	1984	storage	TBD
Stump Neck	Marine Rifle Range	2128	1988	storage	TBD
Stump Neck		2131	1989	test Bldg.	TBD
Stump Neck	Test Area 2	2145	1987	test range	
Stump Neck	Marine Rifle Range	2147	2002	equipment maintenance support	
Stump Neck	Marine Rifle Range	2147	1990	storage	
Stump Neck	Marine Rifle Range	2148	1990	storage	
Stump Neck	Marine Rifle Range	2150	1991	office/storage	
Stump Neck	Marine Rifle Range	2151	1991	storage	
Stump Neck	Rum Point Skeet Range	2152RP	unknown	unknown	
Stump Neck	Rum Point Skeet Range	2153RP	1991	club house	
Stump Neck		2154A	1991	offices	TBD
Stump Neck		2154B	1991	training Bldg.	TBD
Stump Neck		2154C	1991	offices	TBD
Stump Neck	Marine Rifle Range	2155	1991	offices	
Stump Neck	IOD	2158	1991	shelter	
Stump Neck	Rum Point Skeet Range	2164RP	1991	skeet range support Bldg.	
Stump Neck	Marine Rifle Range	2165	1991	AC	TBD
Stump Neck	Rum Point Skeet Range	2169RP	1991	skeet range support Bldg.	
Stump Neck	Rum Point Skeet Range	2170RP	1991	skeet range support Bldg.	
Stump Neck		2173	1990	storage	
Stump Neck	IED	2174	1992	shelter	
Stump Neck	Test Area 1	2191	1998	storage	
Stump Neck	Test Area 1	2192	1998	storage	
Stump Neck	Test Area 1	2193A	1958	Tower	
Stump Neck	Test Area 1	2193B	1958	Tower	
Stump Neck	Marine Rifle Range	2195	1991	storage	
Stump Neck	Marine Rifle Range	D- 21CSN	1918	Testing Bldg.	TBD
			TBD	to be demolished	
			AFD	approved for demolitin	
			EXC	excess (mobile)	
			ABN	abandoned	

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Hunting Program Rules and Regulations

Natural Resources Office (NRO)

NSWCIHD

General Information for all Hunters:

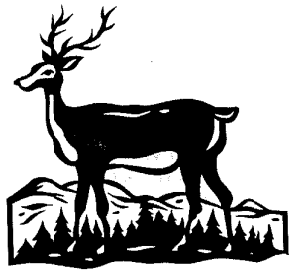
This brochure serves as a reminder of information that is discussed in the IHDIVNAVSURFWARCEN Hunter Instruction 5512.7B and the 2003-2004 Hunting Notice. Each hunter is responsible for reading, understanding and abiding by all rules and regulations present in these two documents and this brochure. Hunters failing to follow these guidelines may face suspension and permanent revocation from the hunting program.

What you'll need to be eligible to hunt...

- **Successful completion of a Hunter Safety Course for Firearms and Maryland Department of Natural Resources (MDDNR) Shooter Qualification card (annually) is required prior to firearm hunting.**
- **Successful completion of a Bowhunter Education Course and annual archery qualification sponsored by the IH Natural Resources Office is required prior to bowhunting.**
- **All hunters/trappers at IH and SN must possess and be able to produce the following items at any time while hunting on the Activity: a Maryland hunting license and IH hunting permit, and an unescorted/escorted (for dependents) visitor badge or employee Restricted Area identification along with a valid driver's license.**
- **All weapons, including firearms and bows must be registered with the Chief of Police in Building D-339.**
- **All first time hunters must meet with the NRO for a prehunt safety, explosive and security briefing prior to gaining access to the hunting areas.**
- **Hunting permits can be purchased at the Morale, Welfare and Recreation (MWR), Bldg 620 beginning on or around late August of each year. Sponsors and guardians must accompany guests and dependents to MWR to purchase their permit.**
- **Hunters must abide by all State and Federal wildlife and conservation laws or face possible suspension or revocation of their hunting privileges.**
- **Hunters must fully complete and turn in hunter data forms to the NRO within 24 hours after each hunting event.**
- **Deer hunters shall sign up no earlier than 1500 on the day of the hunt during the week and no earlier than 0500 during weekends and holidays.**

The following guidelines contain information that is not present in the hunter instruction but must be followed by all hunters at IHDNSWC.

- **Hunters wishing to scout must sign out in person no earlier than 24 hours in advance at the Natural Resources Office, Bldg D-327.**
- **Scouting shall occur seven days a week until 1 October. After 1 October, scouting will occur Wednesday through Sunday for the remainder of the hunting season.**
- **Portable deer stands must have the name of the hunter on the under side of the stand, be visible from the ground and hunters may not use more than 2 stands per day.**
- **Everyone must purchase a range permit at the MDDNR office at Myrtle Grove prior to qualifying with a firearm at Myrtle Grove.**
- **Hunters desiring to hunt at Rum Point shall sign in and out at Bldg D-327 prior to hunting.**



Authorized Personnel

Category	Credentials
Active Duty, Retired Military, or Reservist	Military ID
Active Duty Dependent	Military ID
Civilian Employee	IHD/Tenant Command Activity ID badge
Contractors	IHD/Tenant Command Activity ID badge
Retired NSWCIHD civilian employees or Dependents of civilian employees	Valid Driver's License
Guests (must be accompanied by their employee sponsor)	Valid Driver's License

**Employees can only sponsor two guests per day

Dos and Don'ts

DO:

- Avoid hunting in explosive operating areas.
- Wear blaze orange during firearm and muzzleloader seasons.
- Check clothing for ticks to prevent Lyme Disease
- Check in harvested deer/turkey at Bldg 1890 after hunting
- Park in designated areas.
- Follow directions given by the hunt captain– he is the authorized NRO representative while out in the field.
- Read and follow all rules/regulations listed in the hunter instruction.
- Adhere to any memorandums or notices posted at the NRO.
- Sign out from hunting at the NRO within one hour after sunset.
- NSWCIHD military and civilian employees are the only persons authorized to sponsor guests.

DON'T:

- Field dress your deer.
- Leave any blanks on your hunter data sheets.
- Spotlight fields or woodlands. It is illegal.
- Use bait without the authorization of the NRO and before the NRO establishes the baiting season.
- Sign-up for waterfowl hunting more than 72 hours in advance.
- Exceed the quotas for number of hunters allowed in each area or stand.
- Sign up for a deer hunting area/stand in advance.
- Sign up other hunters on the reservation sheets.
- Shoot across paved or gravel roads.
- Park behind a Government Vehicles Only sign.

Hunting Activities:

Remember, please read through the annual Hunter Notice, IHDIVNAVSURFWARCENNOTE 5512, to get all the important regulations. The information below gives some quick dates and times of hunting activities but does not include all of the restrictions and regulations. The information below could change at the discretion of the NRO.

*** SR= 1/2 hour before sunrise, ST= 1/2 hour after sunset**

Deer-Archery:
Wed-Fri, 1500 to ST
19 Sep 03–31 Jan 04

Deer-Firearm
Saturdays, SR-ST
6,13 Dec 03; 10 Jan 04
Registration for drawing begins one month prior to opening of deer firearm season.

The first deer taken on Indian Head and on the Stump Neck Annex shall be anterless.

Bucks taken on Indian Head shall have at least 4 points on one side and have a beam width outside the ears or be considered of such quality to meet the minimum requirement for Pope and Young (125 minimum) scoring. This emphasis is directed to ensure that harvested deer fall within our quality deer management program. **Antlered tags will be forfeited the following year, if the hunter fails to meet these restrictions.** There will be no restriction on bucks taken at the Stump Neck Annex.

Muzzleloader
Saturdays, SR-ST
18,25 Oct 03; 20,27 Dec 03; 3 Jan 04
Areas 12, 14, 15,16,17,19 only

Turkey
Saturdays SR-1200
17,24 Apr 04; 1,8,15,22 May 04
Orange hat must be worn whenever hunters are moving.
One bearded turkey per season.

Upland Game
Saturdays and holidays unless noted, SR-ST
See MDDNR Hunting Guide for dates and bag limits.

Other info....
Rum Point Areas 9, 10 and 11 may be hunted from Wed-Sun for deer SR to ST.

Portions of hunting Areas 9 and 11 are available for dependents ages 14 to 18 when accompanied by an adult. Otherwise, all hunters including dependents and guests must be 18 years of age or older.

Hunting Area Quotas:

Number of individuals permitted to archery hunt in an Area at any one time.

Areas with a quota of 2:
1A, 1B, 1D, 1E, 3A, 4A, 4B, 5B, 5C, 5D
6A, 6B, 6C, 9A, 10A and 18A.

Areas with a quota of 3:
1C, 2A, 5A, 6D, 7A, 9, 11A, 12A, 14A, 16A, 17A and 19A.

Areas with a quota of 4:
8A, 12A, 13A and 15A.

PICTORIAL BROCHURE

U.S. NAVAL PROPELLANT PLANT
INDIAN HEAD, MARYLAND

A NOTE TO NEWCOMERS!

Welcome aboard the U. S. Naval Propellant Plant!

Your first stop at NPP will be at the Pass Office located on Strauss Avenue at Earle Road. Authorization to enter the Station is cheerfully given to official Station visitors, guests sponsored by Station employees, approved business representatives, prospective employees, new employees and others within justified reasons.

All arrangements for official visitors are made in advance in accordance with Department of Defense regulations concerning visits and NPP Instructions. Unofficial visitors and guests desiring to visit residents within the area bounded by the security fencing will be issues passes at the Pass Office at the Main Gate when sponsored by a Station resident. This can be accomplished by telephone at the time you arrive; however, it is usually wise to contact the person you wish to visit ahead of time so that he can sponsor your visit before you reach NPP. In the case of groups coming to the Station for some particular function, arrangements should be made in advance with Station personnel and security clearance forwarded to the Security Office prior to arrival of personnel on the Station. Approved groups will, in many instances, be assigned a Station escort who will assume responsibility for the party during the visit. All passes are to be turned in at the Main Gate when leaving NPP by car or bus.

Personnel at the Pass Office will provide any information you may require on how to find your destination. Other points with which you should be familiar will be indicated on the map contained herein.

If you are an official visitor requiring quarters, arrangements should be made with the Receptionist at the BOQ (EXT 654). Meal hours are posted in a prominent place in the BOQ. NPP Instruction 1746.1?B covering Rules and Regulations are posted in each room.

If you are a new employee, or are seeking employment, you should go to the Industrial Relations Building located on Patterson Road just beyond the turn-off from Farnum Road.

The Officer-of-the-Day, who has an office in the Administration Building (EXT 604) is on duty at all hours and can be reached in any emergency situation.

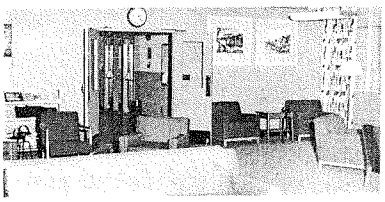
The denomination of churches in the vicinity of Indian Head include the Baptist, Episcopal, Full Gospel, Lutheran, Methodist, Nazarene, and Roman Catholic.

Commissaries located in the Washington, D.C. area are Bolling Air Force Base, Andrews Air Force Base, and Fort McNair.

Dental, medical, and optometry services are available in Indian Head and La Plata. The nearest hospital is located at La Plata.

Shopping facilities located within the vicinity of the Station include food, furniture, clothing, variety, beverage, drug, and dairy product stores.

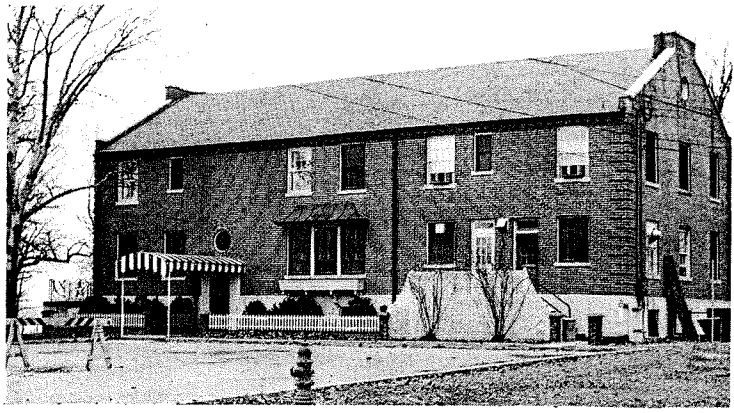
The ne rest Motels are located on Route 301 at La Plata, a distance of 13 miles from the Station.

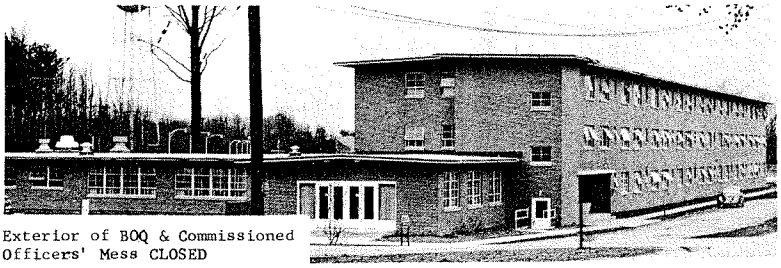


Lounge of the Bachelor Officers Quarters

Ward Room Commissioned Officers' Mess

Commissioned Officers' Mess OPEN - where social activities of the milita members and associate members are held, including picnics, bar-b-ques, e

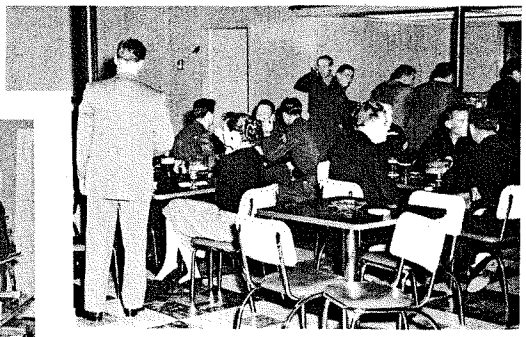




Exterior of BOQ & Commissioned Officers' Mess CLOSED

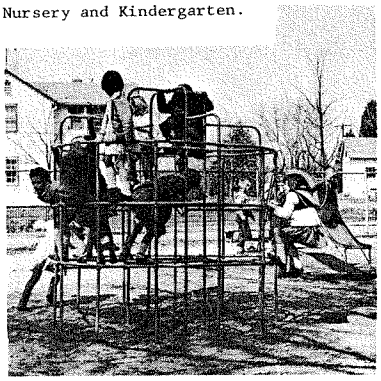
Mess Hall serving all branches of the enlisted military service attached to NPP.

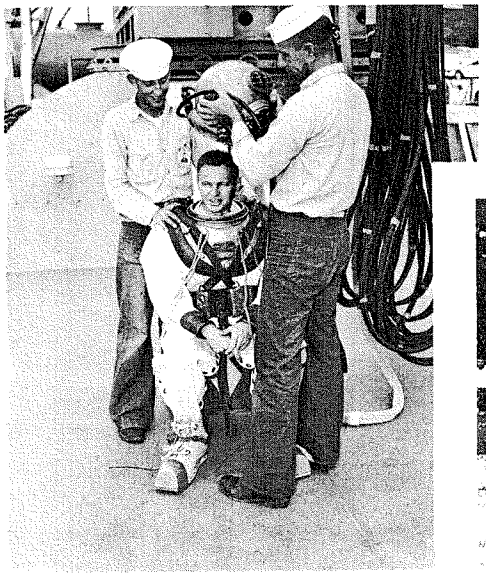
Navy Exchange Store located in the Navy Recreation Hall at NPP available to military personnel only.



EM Club where Enlisted Men can relax and enjoy their evenings together.

Playground and schoolroom of the NPP Co-op Nursery and Kindergarten.

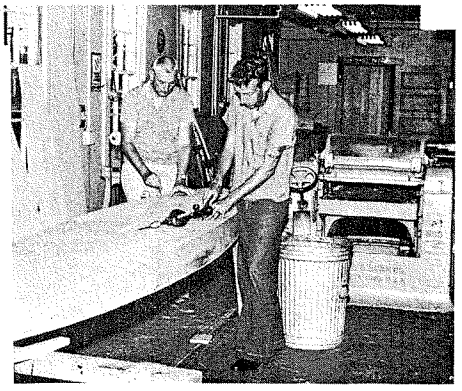




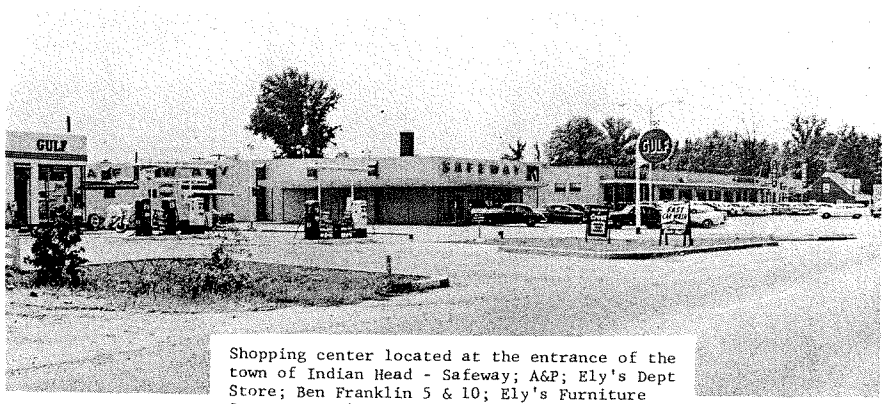
Diving equipment being adjusted in a phase of the mission of the U.S. Naval School, Explosive Ordnance Disposal, a sub-activity of NPP, where students from all branches of the Armed Forces are trained in Explosive Ordnance Disposal.

Training Class in session in NPP Industrial Relations Dept.; one of many available to both militar and civilian personnel attached to this Activity.

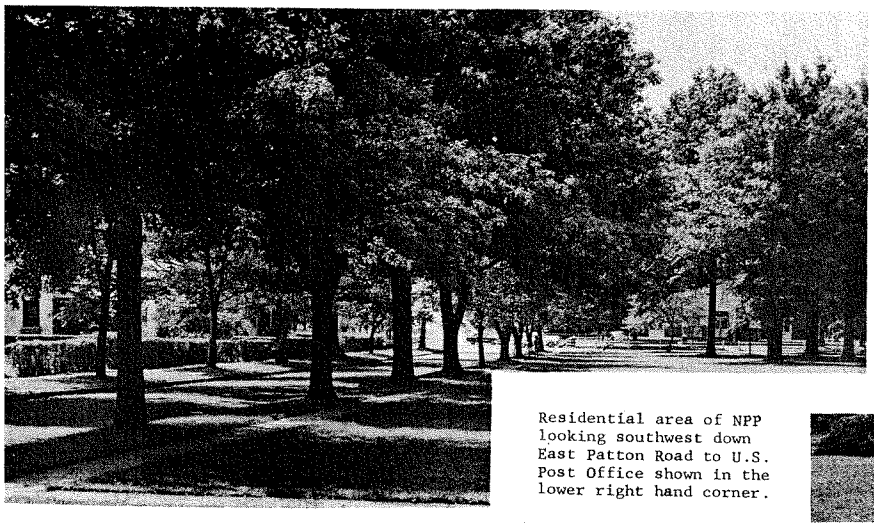
Softball league in action.



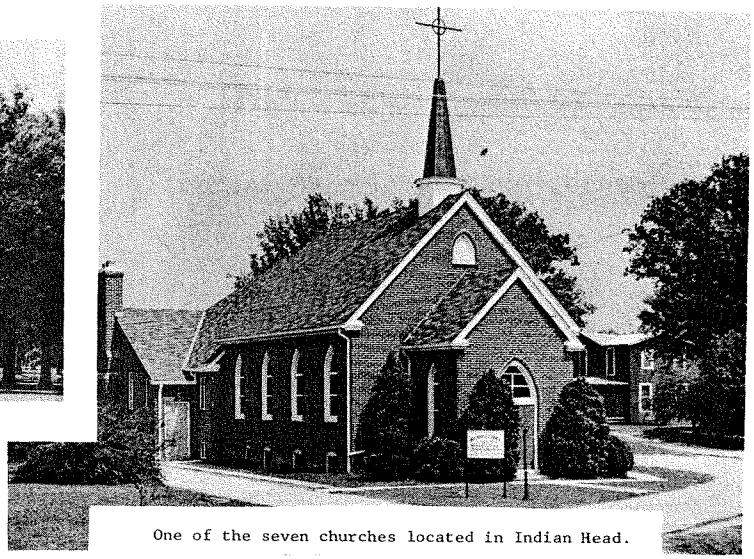
From boats to bird houses can be made in th NPP Hobby Shop.



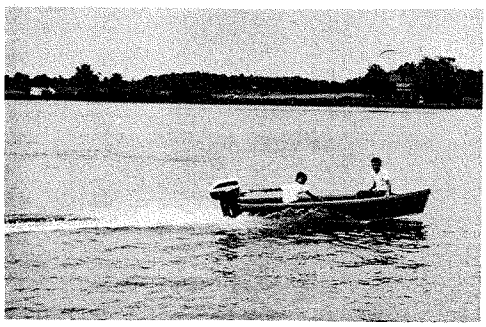
Shopping center located at the entrance of the town of Indian Head - Safeway; A&P; Ely's Dept Store; Ben Franklin 5 & 10; Ely's Furniture Store; Brown's Liquors; High's Ice Cream; Mel-Rose Drug Store.



Residential area of NPP looking southwest down East Patton Road to U.S. Post Office shown in the lower right hand corner.



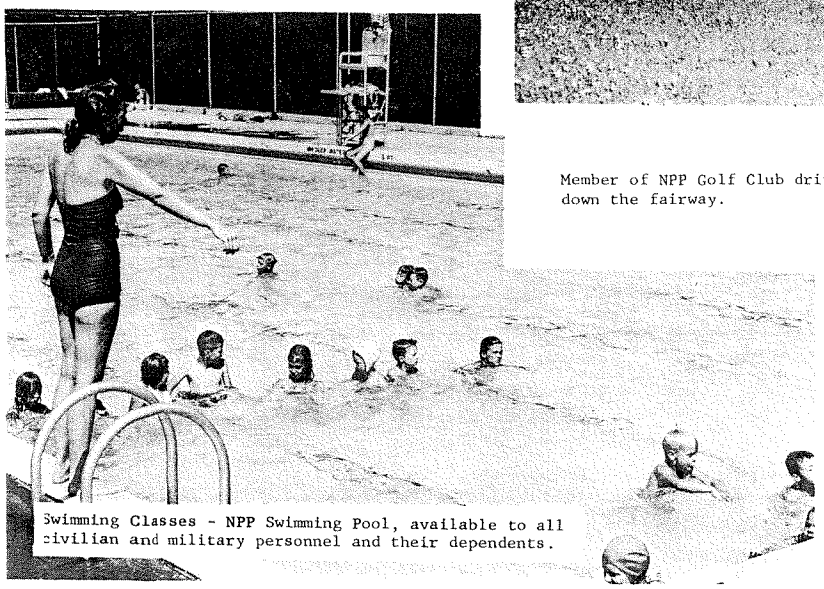
One of the seven churches located in Indian Head.



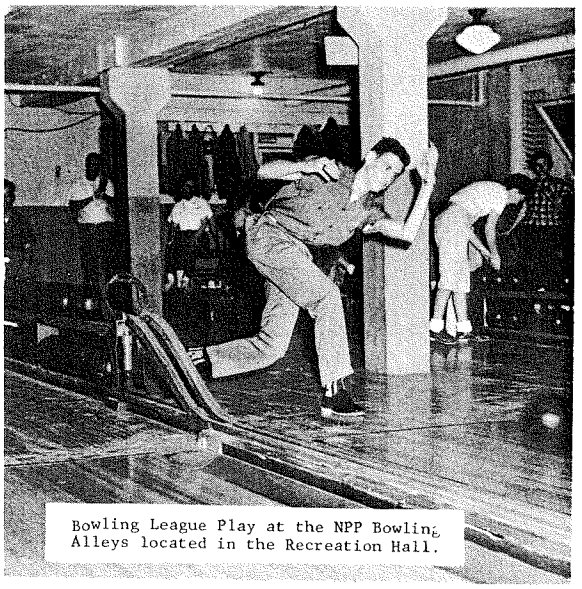
Boating on the Potomac River off the shores of the Naval Propellant Plant.

Member of NPP Golf Club drives "one" down the fairway.

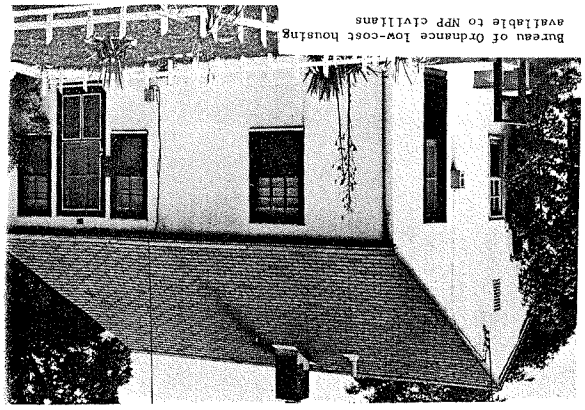
Annual occasion - Awarding of trophies at the Fire Prevention Parade on the school baseball diamond.



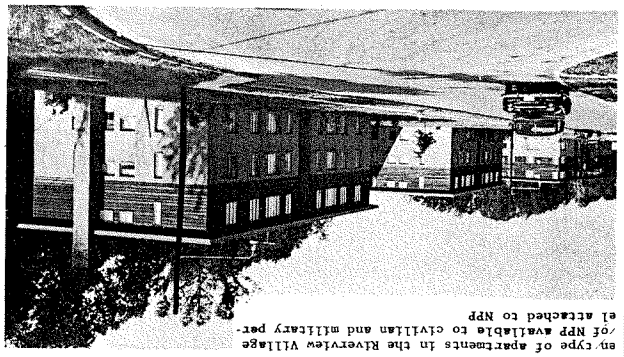
Swimming Classes - NPP Swimming Pool, available to all civilian and military personnel and their dependents.



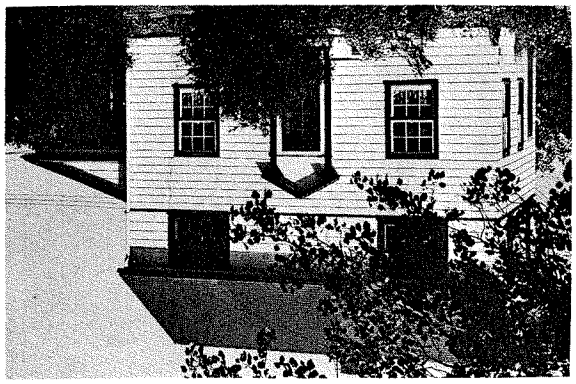
Bowling League Play at the NPP Bowling Alleys located in the Recreation Hall.



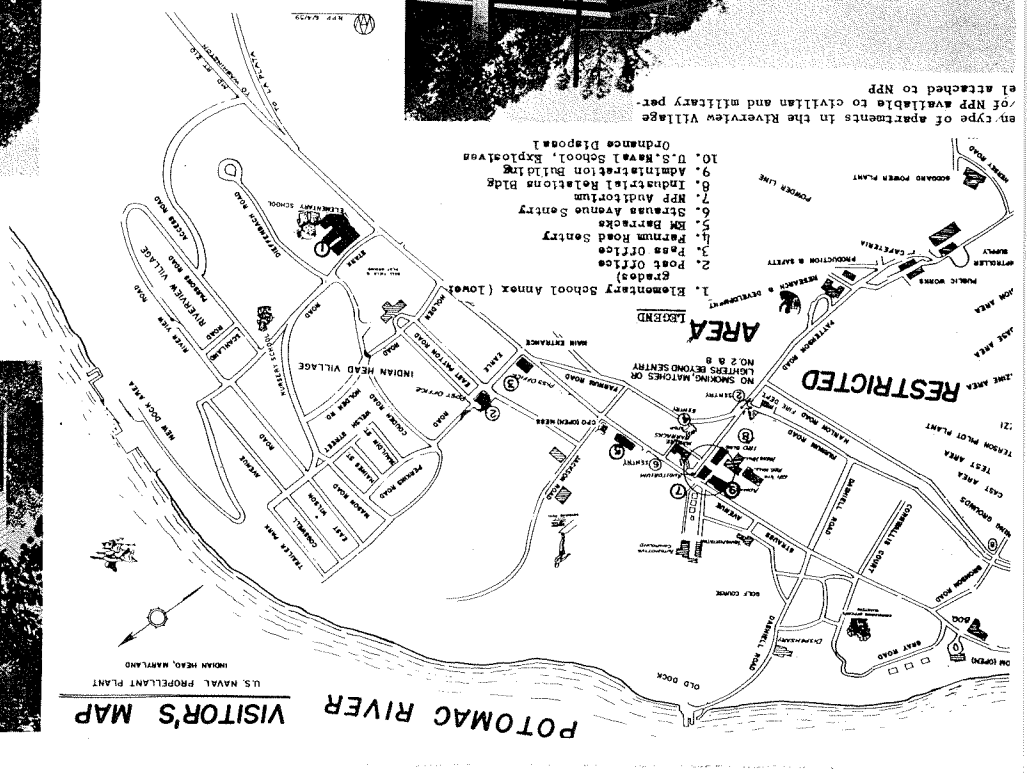
Bureau of Ordnance low-cost housing available to NPP civilians



Type of apartments in the Riverview Village of NPP available to civilian and military personnel attached to NPP



Bureau of Ordnance rental housing available to NPP civilians



NPP MISSION

1. Manufacture, reprocess, rework, inspect and test propellants and high explosives, including intermediate products used therein;

2. Conduct research and development in the field of propellants, related components, and explosives, including fundamental research;

3. Conduct process and production engineering and standardize manufacturing procedures for mass production of propellants and explosives;

4. Conduct explosives safety surveillance program to predict the storage safe life and the ballistic safe life of ordnance items such as propellants, loaded propulsion and explosives.

5. Conduct quality surveillance program to ensure operability of explosives, propellants and propulsion units.

6. Provide logistic support to attached activities.

HISTORY

The Station was first established in 1890, when the proving ground at Annapolis, Maryland, was moved to the present site of NPP. The site consisted of 880 acres and construction work was started in September 1890. In February 1891, the first gun was tested.

When need for a plant to develop smokeless powder was required, the Proving Ground at Indian Head was selected and the plant started in 1898. Powder was first manufactured in June 1900.

Since that time, keeping abreast of the times, and serving through World Wars I, II and the Korean War, the Plant has grown to include facilities for the production of solid propellants for providing grains for guided missiles and is now being further enlarged to provide modern facilities for the production of fine-grain, high-energy powder, which, when cast, becomes the propellant for the second stage POLARIS missile.

The original acreage of 880 acres has increased to over 3,000 (including land housing the Explosives Ordnance Disposal Technical Center at the Stump Neck Annex, across Mattawoman Creek from NPP.

In 1946, the U. S. School, Explosives Ordnance Disposal was established as a sub-activity and was moved into new quarters in 1958 to carry on its mission of training members of all branches of the services in ordnance disposal.

Since August 1958, the Plant has been renamed U.S. Naval Propellant Plant, which more accurately reflects the modern tasks now being performed.

Technical/Regulatory Guidelines

Characterization and Remediation of Soils at Closed Small Arms Firing Ranges

January 2003

Prepared by
Interstate Technology and Regulatory Council
Small Arms Firing Range Team

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ABOUT ITRC

Established in 1995, the Interstate Technology & Regulatory Council (ITRC) is a state-led, national coalition of personnel from the environmental regulatory agencies of some 40 states and the District of Columbia; three federal agencies; tribes; and public and industry stakeholders. The organization is devoted to reducing barriers to, and speeding interstate deployment of, better, more cost-effective, innovative environmental techniques. ITRC operates as a committee of the Environmental Research Institute of the States (ERIS), a Section 501(c)(3) public charity that supports the Environmental Council of the States (ECOS) through its educational and research activities aimed at improving the environment in the United States and providing a forum for state environmental policy makers. More information about ITRC and its available products and services can be found on the Internet at **www.itrcweb.org.**

DISCLAIMER

This document is designed to help regulators and others develop a consistent approach to their evaluation, regulatory approval, and deployment of specific technologies at specific sites. Although the information in this document is believed to be reliable and accurate, this document and all material set forth herein are provided without warranties of any kind, either express or implied, including but not limited to warranties of the accuracy or completeness of information contained in the document. The technical implications of any information or guidance contained in this document may vary widely based on the specific facts involved and should not be used as a substitute for consultation with professional and competent advisors. Although this document attempts to address what the authors believe to be all relevant points, it is not intended to be an exhaustive treatise on the subject. Interested readers should do their own research, and a list of references may be provided as a starting point. This document does not necessarily address all applicable heath and safety risks and precautions with respect to particular materials, conditions, or procedures in specific applications of any technology. Consequently, ITRC recommends also consulting applicable standards, laws, regulations, suppliers of materials, and material safety data sheets for information concerning safety and health risks and precautions and compliance with then-applicable laws and regulations. The use of this document and the materials set forth herein is at the user's own risk. ECOS, ERIS, and ITRC shall not be liable for any direct, indirect, incidental, special, consequential, or punitive damages arising out of the use of any information, apparatus, method, or process discussed in this document. This document may be revised or withdrawn at any time without prior notice.

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Characterization and Remediation of Soils at Closed Small Arms Firing Ranges

January 2003

Prepared by
Interstate Technology and Regulatory Council
Small Arms Firing Range Team

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ACKNOWLEDGMENTS

The members of the Interstate Technology and Regulatory Council (ITRC) Small Arms Firing Range Team wish to acknowledge the individuals, organizations, and agencies that contributed to this technical/regulatory guidance document.

The Small Arms Firing Range Team effort, as part of the broader ITRC effort, is funded primarily by the U.S. Department of Energy (DOE), the U.S. Department of Defense (DoD), and the U.S. Environmental Protection Agency (USEPA). Administrative support for grants is provided by the Environmental Research Institute of the States (ERIS), a nonprofit educational subsidiary of the Environmental Council of the States (ECOS). The Western Governors' Association (WGA) and the Southern States Energy Board (SSEB), who previously held secretariat duties for ITRC, remain involved.

The team recognizes the following states' support of team leadership and guidance preparation:

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Lastly, without the leadership, common sense, and coordination of Bob Mueller and Dib Goswami, co-team leaders, this guidance would not have been prepared. They spent many hours of their own time researching, reviewing drafts, and planning conference calls and meetings. They are the cohesive force of the team, and the substance of the guidance is much better due to their efforts.

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EXECUTIVE SUMMARY

Small arms firing ranges (SAFRs) include government, commercial, and recreational rifle, pistol, trap, skeet, and sporting clay ranges. Small arms firing ranges are those ranges accepting 50 caliber or smaller ammunition. This definition is meant to include shotgun ammunition used on trap- and skeet-type ranges. SAFRs may contain lead, antimony, copper, zinc, arsenic, and polycyclic aromatic hydrocarbons (PAHs) from nonexploding (nonenergetic) bullets and fragments, bullet jackets, and related sporting material (e.g., clay targets); however, lead is the primary risk driver and is thereby the focus of this guidance.

Lead has documented impacts on human health, particularly for children. There are many mechanisms for exposure to lead, including drinking lead-contaminated groundwater, ingesting lead-contaminated soil or sediment, or inhaling airborne particles of lead. Lead dissolution and migration to groundwater or through aerially (windblown) or hydraulically (erosion and deposition) dispersed particles can cause exposure and result in elevated levels of lead in the blood of humans and wildlife and may ultimately impact beneficial future land use.

The U.S. Department of Defense (DoD) oversees more than 3,000 active SAFRs as well as the closure, or pending closure, of 200 more. In all, DoD expends more than 2 million pounds of lead annually. In addition to DoD facilities, there are an estimated 9,000 nonmilitary outdoor ranges in the United States (USEPA, January 2001). USEPA also estimates that 4% of the 80,000 tons of lead produced in the United States during the late 1990s was made into bullets and shot.

This guidance is designed to display a logical and easy-to-follow decision diagram for determining how best to remediate lead and lead-contaminated soils at closed small arms firing ranges. A decision diagram is included to assist the practitioner in formulating a proper strategy for removing the threat that metal, particularly lead, presents at small arms firing ranges. This decision diagram and accompanying documentation is valuable for planning, evaluating, and approving lead soil remediation systems. It defines site parameters and appropriate ranges of criteria necessary for characterizing, testing, designing, and monitoring lead soil remediation technologies. Contaminants, associated chemicals of concern, and contaminant distribution may differ among small arms firing ranges; however, many characteristics of a site, necessary to determine the efficacy of lead remediation technologies, are similar. Once a site has been characterized and the postremediation land use of the site established, engineered approaches can be designed, tested, and deployed. The decision diagram defines the primary decision points and provides characteristics used to evaluate various lead soil remediation strategies. The flow diagram references the sections where each element is more thoroughly discussed in the body of the document. When viewing the flow diagram electronically, simply click on the box in the flow diagram to proceed directly to that section for additional information. This approach is useful to state and federal regulators, environmental consultants, responsible parties/owners, and community stakeholders.

Site owners and operators have only recently become familiar with the environmental consequences of their practice. Their industry has since developed Best Management Practices (BMPs) for environmental management and maintenance of their range and, consequently,

operators are incorporating these into their operating procedures. Federal agencies, specifically DoD, and commercial sporting range operators are proactively developing a greater understanding of lead management and remediation. There are a number of remediation technologies as well as sampling and analysis techniques that, if appropriately applied, can adequately characterize and remediate lead contamination at any SAFR.

Because of the increased scrutiny being paid to SAFRs, the U.S. Department of Navy, USEPA Region 2, and the state of Florida have developed BMP documents to provide guidance on the operation of active SAFRs. These documents closely follow the guidance provided by the National Shooting Sports Foundation (www.rangeinfo.org).

While researching and compiling information for this guidance, the team identified a number of regulatory and technical issues encountered while remediating a SAFR. Through this guidance, the team seeks to clarify these issues and make recommendations, which in the team's view enhance the use of the techniques discussed in the guidance. Following are some of the more significant issues identified by the team. See Section 6.0 of this guidance for further discussion:

- At some ranges, it may be possible and desirable to reuse the soil from the backstop of a range that is being closed to construct a new berm or rebuild an existing berm located in another area of the same property or facility. It is USEPA's position that ranges that reclaim and recycle lead bullets or lead shot may place the soil that is generated during the reclamation process back onto an active range on the same property or facility or a property adjacent to and under the same ownership as the property where the soils originated without testing the soil for hazardous waste characteristics.

- It has been suggested that range soil from a former backstop may also be reused, following lead reclamation, for constructing or rebuilding a backstop at a location that is not on the range property. The same environmental benefits from berm reuse as described later in this document could be realized, but extra oversight may be needed. Since individual states may not permit this action, or may impose additional requirements for transportation, documentation, and approvals, state regulations and regulatory agencies should be consulted prior to transporting range soils to a property that is not the same as or adjacent to and under the same ownership as the property where the soils originated.

- While many current analytical methods rely on using only soil that has been passed uncrushed through a 30-mesh sieve as the source for analytical tests, some controversy exists in the field as to the best method(s). Other sample preparation protocols have been proposed and approved by governing regulatory bodies. Differences in sample preparation protocols include the designation of the size of sieve or whether to use a sieve at all and on the degree of disaggregation prior to sieving. Therefore, to recommend a specific sample preparation method may be misleading. No matter which method is selected, however, it should result in a sample that is representative of the site and its environment and is agreeable to the regulatory community and the other parties involved in the evaluation.

Other recommendations on relevant issues can be found throughout this document. Please refer to Section 6.0 for a comprehensive listing of all issues contained in this document.

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TABLE OF CONTENTS

ACKNOWLEDGEMENTS i

EXECUTIVE SUMMARY iii

1.0 INTRODUCTION 1
- 1.1 Problem Statement 2
- 1.2 Purpose 3

2.0 SITE CHARACTERIZATION 5
- 2.1 Range History and Records 5
- 2.2 Range Design Considerations 6
- 2.3 Rifle/Handgun Firing Range Layouts 7
- 2.4 Shotgun Range Layouts 10
- 2.5 Fate and Transport Considerations 11
- 2.6 Sample Collection and Analysis 13
- 2.7 Risk Assessment 17

3.0 TECHNOLOGY OVERVIEW AND APPLICATION 28
- 3.1 Dig and Haul 28
- 3.2 Soil Washing/Particle Separation 29
- 3.3 Soil Stabilization 31
- 3.4 Chemical Extraction 37
- 3.5 Asphalt Emulsion Batching-Encapsulation 38
- 3.6 Phytoextraction and Stabilization Approaches 39

4.0 REGULATORY REQUIREMENTS, BARRIERS, AND FLEXIBILITIES 40
- 4.1 Classification of Spent Ammunition 40
- 4.2 Federal Regulations and Guidance 40
- 4.3 State Regulations and Guidance 41
- 4.4 Remediation /Future Use Issues 42
- 4.5 Lead Recycling 43
- 4.6 Live Rounds/UXO 44
- 4.7 Soil Recycling 44
- 4.8 Transporting or Relocating Range Soil for Reuse as a Backstop on Range Property 45
- 4.9 Disposal of Range Soil 46

5.0 TECHNOLOGIES AND TECHNICAL CONCERNS 47
- 5.1 Treatability Study 47
- 5.2 Data Needs 48
- 5.3 Soil Washing 49
- 5.4 Soil Stabilization 53
- 5.5 Chemical Extraction 55
- 5.6 Asphalt Emulsion Batching-Encapsulation 56
- 5.7 Phytoextraction and Stabilization Approaches (Constructed Wetlands) 57

6.0 ISSUES, CONCERNS, AND RECOMMENDATIONS....58
6.1 Risk Assessment....58
6.2 Site Identification....58
6.3 Berm Reuse....58
6.4 Cleanup Criteria....59
6.5 Sample Preparation....59
6.6 Technologies....59

7.0 REFERENCES....63

LIST OF TABLES

Table 1-1. Contaminants Potentially Found at Small Arms Firing Ranges....1
Table 2-1. Potential Bioavailability of Various Lead Minerals....26
Table 3-1. RCRA Regulatory Concentrations for TCLP Testing....29
Table 3-2. Treatment of a TCLP-Hazardous Metal Processing Waste....35
Table 5-1. Comparison of Various Types of Metals Remediation Technologies....52

LIST OF FIGURES

Figure 1-1. Decision Tree for Characterizing and Remediating Closed Small Arms Firing Range Soils....4
Figure 2-1. Cross Section of a Typical Static Rifle and Handgun Range....7
Figure 2-2. Cross Section and Plan View of Shotgun Range Layout and General Shotfall Zone....9
Figure 2-3. Schematic Drawing of a Trap Range Layout....10
Figure 2-4. Schematic Drawing of a Skeet Range Layout....11
Figure 2-5. Example Firing Range Conceptual Exposure Model (Terrestrial Site)....20
Figure 3-1. Solubility of Various Lead Compounds as a Function of pH....33

APPENDICES

APPENDIX A. Case Studies
APPENDIX B. Mining-Based Sampling Overview
APPENDIX C. Template: Scoping Document for Soil Washing Treatability Study and Engineering Report
APPENDIX D. Template: Scoping Document for Treatability Testing and Asphalt Emulsion Mix Design
APPENDIX E. White Paper on Created Wetlands for Range Runoff Control
APPENDIX F. Baseline Risk Assessment
APPENDIX G. Acronyms
APPENDIX H. ITRC Small Arms Firing Range Team Response to Comments from the POC Preconcurrence Review and the U.S. Army Environmental Center
APPENDIX I. ITRC Contacts, ITRC Fact Sheet, and ITRC Product List

CHARACTERIZATION AND REMEDIATION OF SOILS AT CLOSED SMALL ARMS FIRING RANGES

1.0 INTRODUCTION

Small arms firing ranges (SAFRs) include government, commercial, and recreational rifle, pistol, trap, skeet, and sporting clay ranges. Small arms firing ranges are those ranges accepting 50 caliber or smaller nonexploding ammunition. This definition is meant to include shotgun ammunition used on trap- and skeet-type ranges. Small arms firing ranges may contain lead, antimony, copper, zinc, arsenic, and polycyclic aromatic hydrocarbons (PAHs) that may leach from bullets and fragments, bullet jackets, and related sporting material (e.g., clay targets), thereby contaminating soils and possibly surface and groundwater (NFESC, 1997). Table 1-1 lists components used to manufacture ammunition and clay targets.

Constituent	Comment
Lead	Primary constituent of a projectile
Lead Styphnate/Lead Azide	Primary constituent
Antimony	Increases hardness
Arsenic	Present in lead. A small amount is necessary in the production of small shot since it increases the surface tension of dropped lead, thereby improving lead shot roundness.
Copper bullet core alloy	Increases hardness
Tin	Increases hardness
Copper	Jacket alloy metal
Zinc	Jacket alloy metal
Iron	Iron tips on penetrator rounds
PAHs (Polycyclic Aromatic Hydrocarbons)	Concentration of PAHs in clay targets varies from one manufacturer to the next but may be as high as 1000mg/kg. Existing studies show that PAHs are bound within the limestone matrix of the target and are, therefore, not bioavailable.

Table 1-1. Contaminants Potentially Found at Small Arms Firing Ranges
(Information obtained from Tables 2-1 & 2-2 in NFESC, 1997)

Lead accounts for more than 85% of the weight of the projectile and constitutes the greatest environmental concern. If the projectile fragments upon impact, it creates lead dust, which can be carried off site by either wind or water erosion. The heat of firing bullet projectiles can also atomize lead in a sort of lead vapor, which can precipitate or condense on soil particles at the firing line.

Lead has documented impacts on human health, particularly for children. There are many mechanisms for exposure to lead, including drinking lead-contaminated groundwater, ingesting lead-contaminated soil or sediment, or inhaling airborne particles of lead. Lead dissolution and migration to groundwater or through aerially (windblown) or hydraulically (erosion and deposition) dispersed particles can cause exposure to lead and result in elevated levels of lead in the blood of humans and wildlife and may ultimately impact future land use. Remediation of soils at small arms firing ranges presents unique challenges because lead and associated co-contaminants (see Table 1-1) exist as both discrete particles and as sorbed compounds dispersed within the soil matrix. The form and distribution of particulate lead varies based on range use, size and impact velocity of the round, soil characteristics, and past range maintenance practices.

For rifle and pistol ranges, most training is done with fixed or stationary targets at known distances, resulting in the formation of "bullet pockets" on the face of the berm. The high-impact energy of these high-speed rounds with the rounds accumulated in the bullet pockets results in significant fragmentation and ricochet. To mitigate ricochet, standard range maintenance practices include "refacing" and/or turning the berm soil over to bury the projectiles below the impact depths of incoming rounds. As a result, particulate lead can be found at depths below traditional impact depths; and the particles range from whole, relatively intact projectiles to microscopic metal particles. This heavy accumulation of lead in a relatively small soil volume coupled with the fine lead present results in range soils high in total lead, which can fail standard leachability tests such as the RCRA Toxicity Characteristic Leaching Procedure (TCLP) and the Synthetic Precipitation Leaching Procedure (SPLP).

Shotgun ranges (skeet, trap, and sporting clays), on the other hand, typically involve widely dispersed lead particles that fall to the ground with little impact energy. Remediation of these ranges involves large soil volumes with relatively low particulate lead concentrations. However, based on the age of the range and soil chemistry, lead shot can corrode into a wide range of various particle sizes. Since the pellets have little impact energy, fragmentation is not an issue. However, Craig, et al. (2002) reports evidence of fragmentation associated with short-range, low-angle shotgun shots.

The disk-like, flying targets used at shotgun ranges contain PAHs. However, Baer (1995) found that the targets did not exhibit the characteristics of toxicity as determined by an USEPA toxicity test even though they contained high levels of PAHs. The state of Connecticut accepted these findings and treated the targets at the site as solid rather than hazardous wastes.

1.1 Problem Statement

The U.S. Department of Defense (DoD) oversees more than 3,000 active SAFRs as well as the closure, or pending closure, of 200 more. In all, DoD expends more than 2 million pounds of lead annually. In addition to DoD facilities, there are an estimated 9,000 nonmilitary outdoor ranges in the United States (USEPA, January 2001). USEPA also estimates that 4% of the 80,000 tons of lead produced in the United States in the late 1990s was made into bullets and shot. Several existing environmental regulations can apply to shooting ranges. Developing and implementing an Environmental Stewardship Plan or Best Management Practices as outlined by

the firearms industry (www.rangeinfo.org), USEPA, or the Florida Department of Environmental Protection is an important range management activity to prevent environmental and/or regulatory problems. Federal agencies, specifically DoD, and commercial sporting range operators are proactively developing a greater understanding of lead management and remediation. There are a number of remediation technologies as well as sampling and analysis techniques that, if appropriately applied, can adequately characterize and remediate lead contamination at any SAFR.

1.2 Purpose

This guidance is designed to display a logical and easy-to-follow decision diagram for determining the best remediation alternative for lead at closed small arms firing ranges (SAFRs). The decision diagram, Figure 1-1, contains the general decision points when considering soils remediation at closed SAFRs. How to best manage lead at active and inactive small arms firing ranges is the subject of a follow-on ITRC project scheduled for completion in 2003.

The decision diagram (Figure 1-1) is included to assist the practitioner while formulating a proper strategy for removing the threat that metal, particularly lead, presents at small arms firing ranges. This decision diagram and accompanying documentation is valuable for planning, evaluating, and approving lead soil remediation systems. It defines site parameters and appropriate ranges of criteria necessary for characterizing, testing, designing, and monitoring lead soil remediation technologies. Contaminants, associated chemicals of concern (CoCs), and contaminant distribution may differ among small arms firing ranges; however, many characteristics of a site necessary to determine the efficacy of lead remediation technologies are similar. Once a site has been characterized and the postremediation land use of the site established, engineered approaches can be designed, tested, and deployed. The decision diagram defines the primary decision points and provides characteristics used to evaluate various lead soil remediation strategies. The flow diagram references sections where each element is more thoroughly discussed in the body of the document. When viewing the flow diagram electronically, simply click on the box in the flow diagram to proceed directly to that section for additional information. This approach is useful to state and federal regulators, environmental consultants, responsible parties/owners, and community stakeholders.

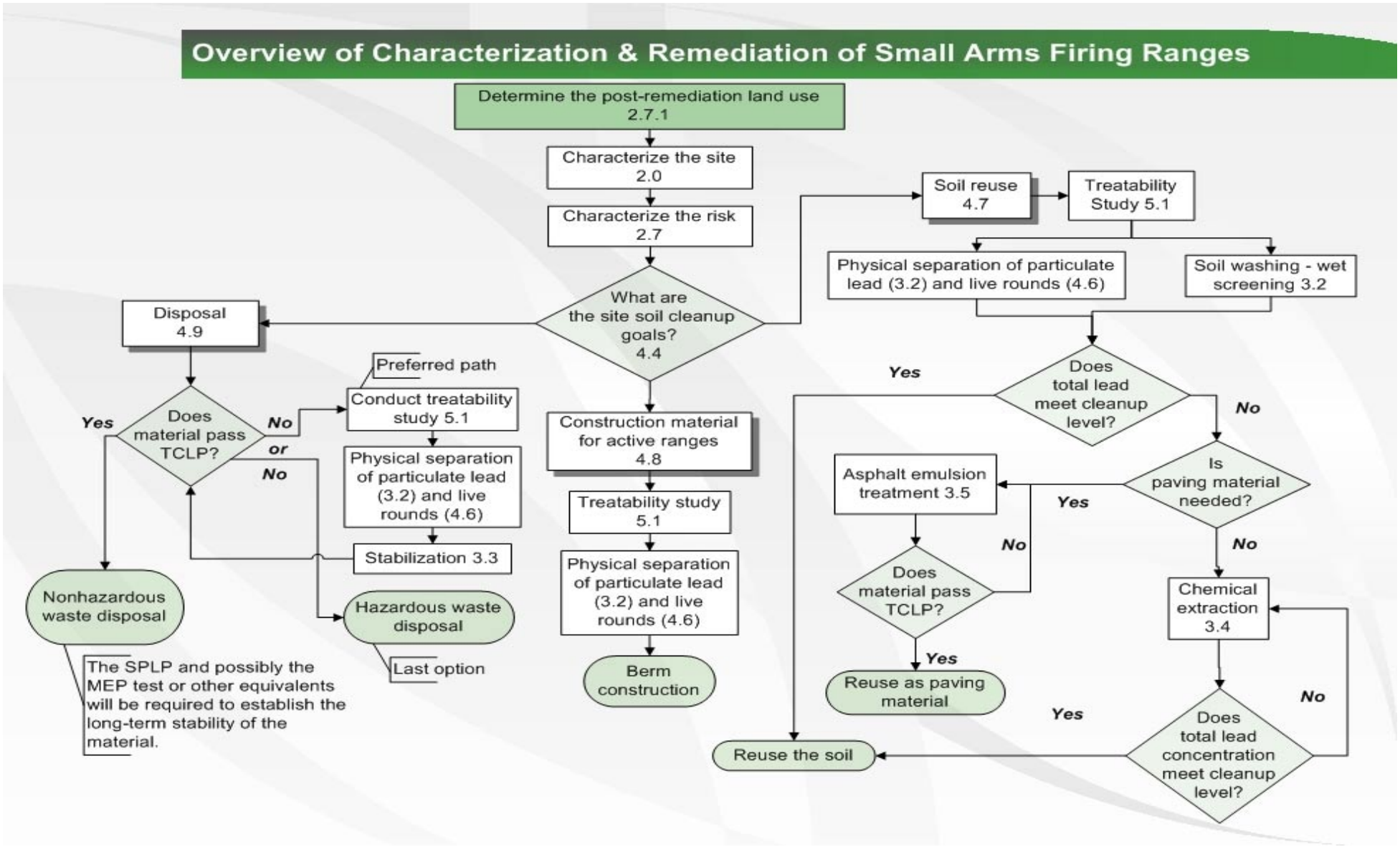

Figure 1-1. Decision Tree: Characterization and Remediation of Closed Small Arms Firing Range Soils

2.0 SITE CHARACTERIZATION

Site characterization assesses the extent and nature of the contaminants of concern as an initial step in the cleanup of a small arms firing range. The general approach for a small arms firing range site characterization is identical to that used in the assessment of any site where metals or other regulated hazardous chemical constituents have been released to the environment. Site characterization should answer the following questions:

- What are the contaminants of concern (CoCs) in addition to lead at the subject ranges?
- What is the vertical and horizontal extent of the lead and other CoCs in the environment?
- What are the concentrations of these contaminants across the affected area?
- What environmental media are impacted (i.e., soil, surface water, groundwater, air, sediment)?
- Are the impacted areas limited to locations where bullets and shot were initially deposited or has there been vertical/horizontal migration of the contaminants of concern?
- If migration has occurred, what are the likely routes of migration?
- What are existing or potential human or environmental exposure pathways?
- Is there a potential UXO present?

Before any actual sampling is conducted at a range to answer these questions, one should gather available records and accounts of the range history, use, and layout. These aspects of the site characterization are discussed below.

2.1 Range History and Records

To determine where lead and any other contaminants associated with the deposition of bullets and/or lead shot pellets are present in the environment, information should be gathered regarding the location of all current ranges that are subject to cleanup, as well as any abandoned ranges. This information can be obtained from written records, plans, photographs, etc. kept by the facility and/or through interviews with persons familiar with past operations. Current and historical aerial photographs are often excellent sources of information on range layout.

Information should also be gathered on the period of time during which each range was in use, the estimated amount of shooting done during that time, the type of ammunition used, and the reclaiming and recycling history of the site. For trap and skeet ranges, the amount of lead shot pellets deposited at a range may be estimated based on the number of targets used annually by the facility. Additionally, information should be obtained regarding any removal and relocation of soils from ranges to other locations at the range or off site. Areas that received soil that was likely contaminated with lead should be included in the site characterization.

Available surveys and property maps of the facility and ranges should be obtained. An examination of property boundaries with respect to range layout and areas where ammunition is deposited should be performed to determine whether any off-property impacts exist.

2.2 Range Design Considerations

The design and use of a shooting range will have a direct impact on where the lead will be deposited. Researching the range design(s) and past use(s) will help you identify where the lead will be found and help focus the remediation efforts. There are four different types of outdoor ranges: shotgun ranges, static ranges, dynamic ranges, and interactive ranges. Confusing the issue is the possibility that over the years a range may actually consist of several different ranges—one overlaid on top of another.

Users of a shotgun range shoot at airborne discs using ammunition that typically consists of between 1 ounce and 1-1/8 ounces of lead pellets. The pellets are very small in diameter (from .08 to .095 inches), which means the ammunition contains a large number of pellets (from 350 to 650 pellets per cartridge). These pellets have a maximum distance of between 660 feet and 770 feet from the shooter. Shotgun ranges are primarily used for recreation; however, the Army Air Corps used shotgun ranges for initial training in the skills needed to shoot down enemy airplanes. These ranges are not always over dry land. The impact areas for some of these ranges may be over wetlands or even open water. The National Association of Shooting Ranges, a division of the National Sports Shooting Foundation (NSSF), has published *Environmental Aspects of Construction and Management of Outdoor Shooting Ranges*, which describes the standard designs of trap (Figure 4-2), skeet (Figure 4-3), and conceptual design of sporting clays (Figure 4-4) www.rangeinfo.org.

Static ranges, dynamic ranges, and interactive ranges are used with rifles and handguns but can also include shotguns using large projectiles (known as "buckshot" and "slugs"). The static range is one where a stationary shooter fires at a known target located at a known distance. Most military basic training as well as recreational shooting is static. The dynamic range is one where there is movement on the part of the shooter firing at a known target. Finally, the interactive range is where there is movement on the part of the shooter, who is firing at targets that may also be moving, are randomly located, or are a surprise to the shooter. Interactive ranges are used primarily in law enforcement and military training but can also be part of advanced self-defense training.

There are different site characterization and environmental management implications for each of these four types of ranges. The shotgun range will have a widely scattered deposition of very small pellets (of a consistent size and shape) within an area no more than 770 feet from the shooting position, with the majority of the lead being deposited at a distance between 375 feet and 600 feet from the shooter. The shape and size of the area of shot deposition, or "shotfall zone," depends on the kind of recreational shooting done at the range (i.e., trap, skeet, or sporting clays) and the number of fields (single or multiple) (NSSF, 1997, pp. 4.1–4.7). The pellets will typically be found within inches of the surface, unless tilling or digging has physically disturbed the area.

The static range has lead very concentrated in a very small area directly behind each target. The lead may be found up to two feet into a primary impact berm. Lead from static ranges can also migrate due to erosion from the berm material, through surface water runon and runoff. The

targets are typically set between 5 feet and 8 feet apart in a straight line parallel to the firing line. Dynamic ranges also have small and identifiable lead deposits behind each target, but the targets are more randomly and widely dispersed. This layout results in specific areas of lead deposition in moderate concentration dispersed over a larger area.

2.3 Rifle/Handgun Firing Range Layouts

To effectively characterize the soil in each area for various range layouts, it is necessary to understand how the depth and aerial extent of particulate lead distribution varies with each type of range layout. The traditional layout of training areas can involve a central impact area for large munitions, ringed by SAFRs on the perimeter for firing toward the center. As a result, the safety fans and projectile flight paths can overlap, resulting in unexploded ordnance (UXO) unexpectedly turning up in SAFR soils and small arms projectiles in impact area soil. In addition to the safety issues associated with UXO (www.itrcweb.org, see the ITRC UXO guidance document), there are also contaminant issues with unburned propellants and explosives, which are present as microscopic discrete particles dispersed over a wide area, not unlike the dispersion of lead shot at a skeet range.

A rifle/handgun firing range has the following major areas (see Figure 2-1):

- Primary Impact Berm
- Range Floor
- Lateral or Side Berms
- Safety Fan, or Fallout Area

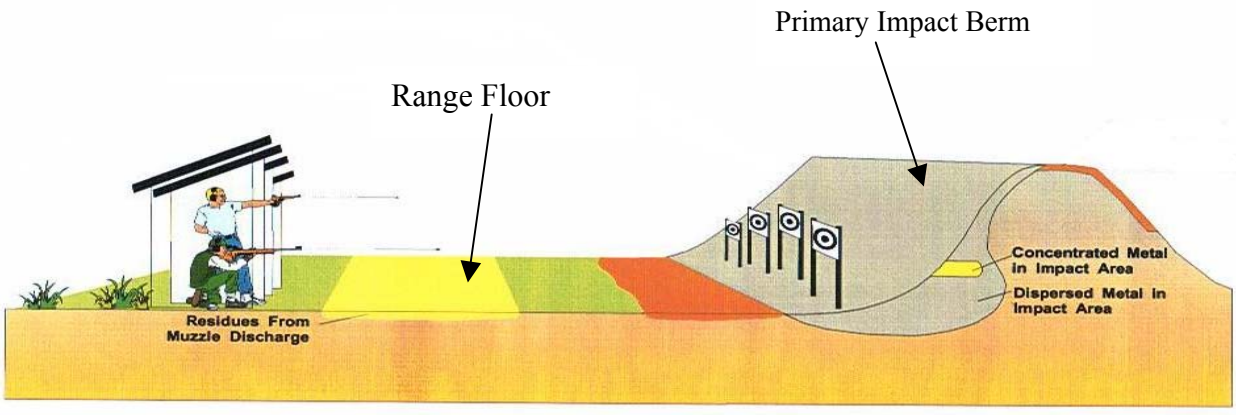

Figure 2-1. Cross Section of a Typical Static Rifle and Handgun Range
(Modified from Figure 1.1 in AFCEE, 2000)

2.3.1 Primary Impact Berm

The primary impact berm faces the shooter and takes the bullet head on. As such, the full force of impact is absorbed by the berm. Two mechanisms at work to scrub energy and stop the bullet are displacement of soil particles and fragmentation of the lead projectile. In sandier soils, displacement of the soil particles allows the bullet to penetrate a foot or more into the berm, with soil resistance increasing with depth. Eventually, all of the energy is scrubbed, and the bullet comes to rest basically intact and buried within the soil matrix. Hard-packed berm soil, surfacial lead buildup, or the presence of rocks causes the lead to fragment upon impact. Fragmentation also scrubs energy but creates undesirable byproducts—the generation of lead dust and fragments that increase the aerial extent of remedial efforts. Ricochet, which can present serious threats to shooters, bystanders, and neighboring properties, further expands the area that needs to be addressed by cleanup efforts.

2.3.2 Range Floor

The range floor is defined as the ground between the firing line and the primary impact berm, with a width equal to the width of the range lanes. This surface rarely receives direct fire and as such the particulates are shallow as compared to the primary impact berm. Rounds that impact the range floor are typically a flat trajectory that fell short of the berm or those that result from ricochet. The resulting projectiles/fragments are typically found lying on the surface or embedded in the root mass of the range floor vegetation, usually within the top 6 inches of soil. Live rounds are also found on a regular basis in this area, as there are misfires that were ejected and lost or dropped rounds that were not picked up. Empty brass is also common in this area, and casings also represent a potential source of lead because the initiators, or primers, use shock-sensitive lead compounds with residuals left in the casing after firing. The muzzle blast deposits these same lead compounds, as well as lead dust resulting from the rifling on the barrel of the weapon cutting into the projectile as it leaves the barrel. Typical depths of penetration on the range floor are 1 foot or less.

2.3.3 Lateral, or Side, Berms

Lateral berms separate contiguous ranges within a complex or provide containment at the perimeter. Like the range floor, they rarely receive direct fire and typically collect ricochets and the occasional stray round, which results from cross fire across lanes. The typical penetration depth is 1 foot. These berms may also be used on shotgun ranges.

2.3.4 Safety Fan/Fallout Area

On most range types, the rounds/fragments found in the safety fan/fallout area are almost exclusively the result of ricochet. Unless earthmoving is performed, the fragments lie on the surface. The exception to this rule is trap and skeet ranges, where distance is used to collect projectiles and the fallout area is the part of the range receiving most impact. If sampling is required, it should be conducted on the range floor, where most times fragments can be vacuumed up without any excavation.

Schematic Cross Sectional View

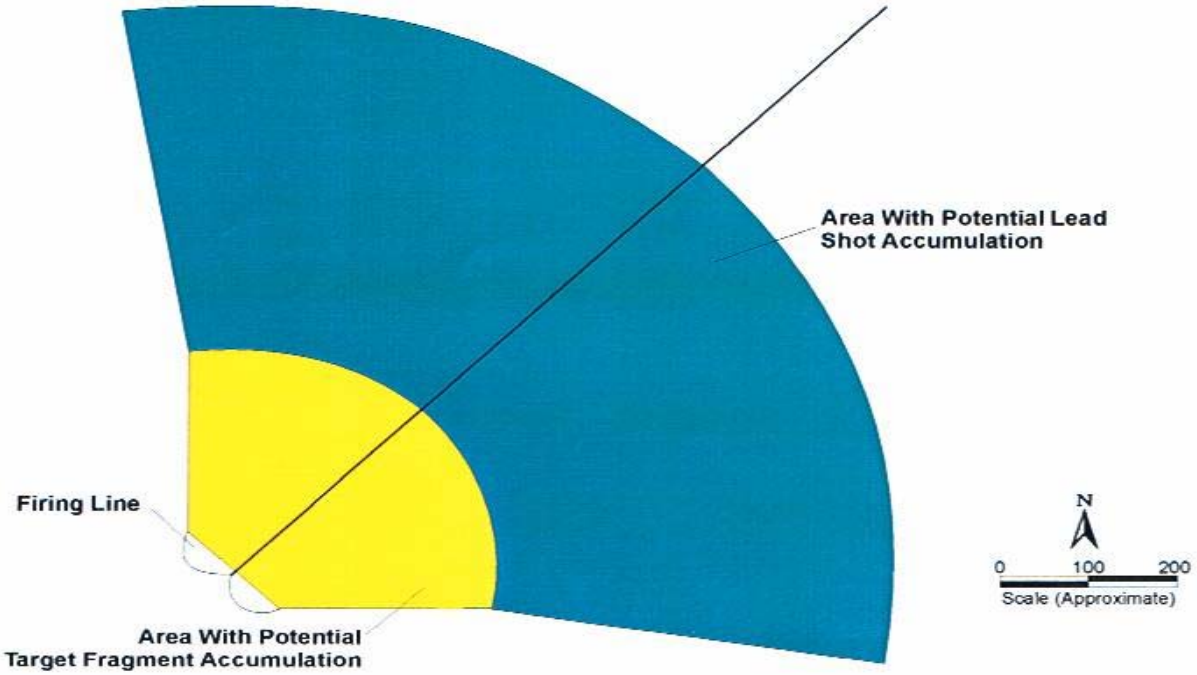

Figure 2-2. Cross Section and Plan View of Shotgun Range Layout and General Shotfall Zone (Modified from Figure 2-1 in AFCEE, 2000)

2.4 Shotgun Range Layouts

The primary characteristic of all shotgun ranges from an environmental perspective is the wide distribution of shot. This results in a relatively large area in which there might be a concern. The full extent of the total shotfall zone must be known before effective lead management practices can be implemented. Because clay targets are thrown at different angles for each of the different shotgun shooting venues, the type of venue will determine the dispersion of the spent shot.

2.4.1 Trap Range Layout (NSF, 1997)

The positions of the shooters and the angles at which trap targets are thrown result in a funnel-shaped shotfall zone. Depending on the load, the angle at which the shot was fired, and wind direction, typical lead trap loads can reach nearly 770 feet from the shooter. The theoretical shotfall zone and the area of maximum shotfall are illustrated in Figure 2-3. Note the overlap of the shotfall zone from adjacent fields, resulting in areas with increased amounts of lead.

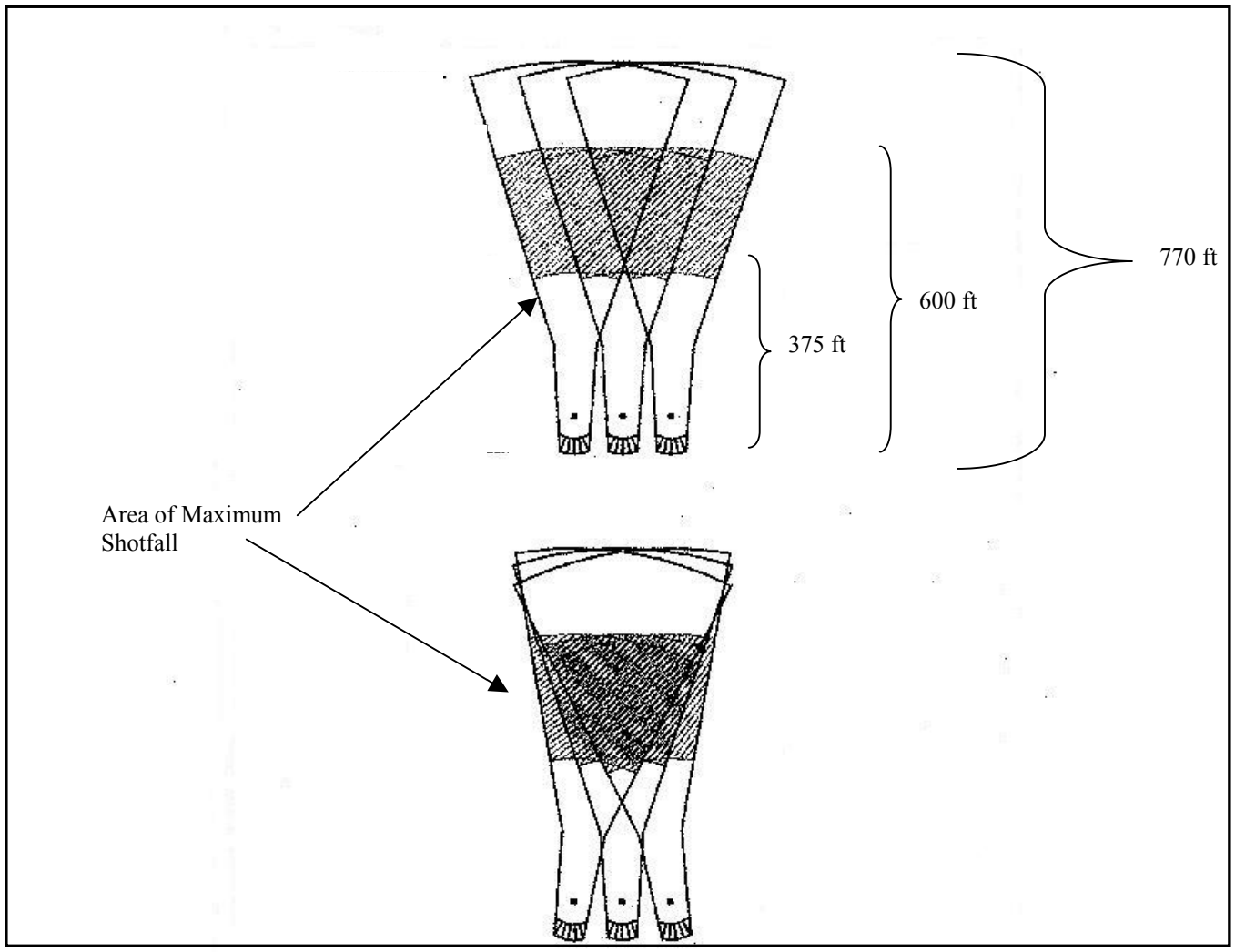

Figure 2-3. Schematic Drawing of Trap Range Layout (Modified from NSSF, 1997)

2.4.2 Skeet Range Layout

The positions of the shooters and the angles at which skeet targets are thrown results in a "fan-shaped shotfall zone. Depending on the load, the angle at which the shot was fired, and the wind direction, typical lead skeet loads can reach about 680 feet from the shooter (see Figure 2-4).

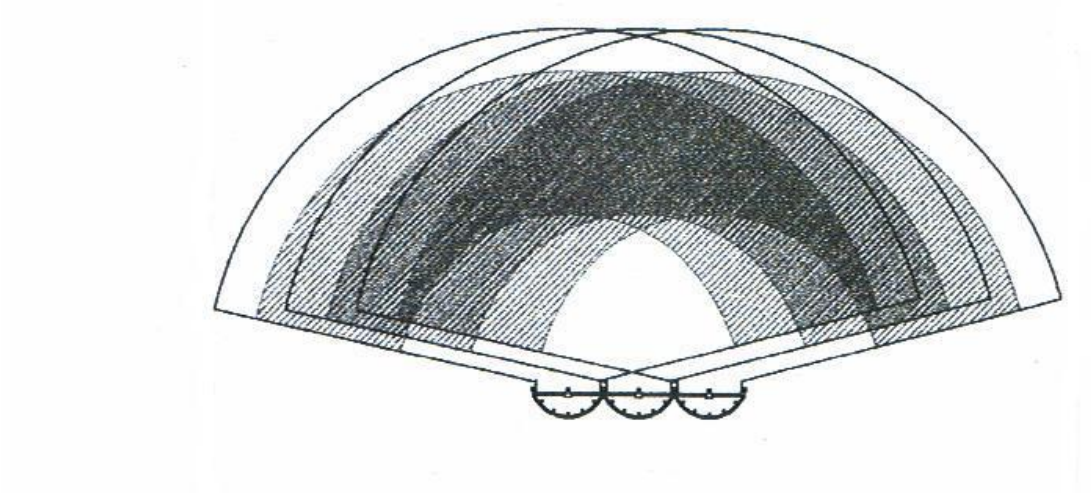

Figure 2-4. Schematic Drawing of Skeet Range Layout
(NSSF, 1997)

2.4.3 Sporting Clays Range Layout (NSSF, 1997)

The defining feature of sporting clays courses is the complete flexibility in target angles and shooting directions. Because there is no "standard" layout for sporting clays courses, it is impossible to illustrate a "standard" shotfall zone or area of maximum shotfall. When investigating closed facilities, efforts need to focus on identifying the locations of shooting stations and the target launcher in order to estimate where the shooter engaged the target. Unlike most shotgun ranges, stations at some sporting clays may involve low-angle, short-distance shotgun shots. Craig et al. (2002) has reported at the Winter Workshop and Meeting of the Virginia Chapter of the Wildlife Society that fragmentation may be more evident in these types of situations.

2.5 Fate and Transport Considerations

Sources of lead on military and civilian small arms firing ranges include spent bullets and residues of lead compounds used in small-caliber bullet primer and igniter formulations. Small-caliber military bullets (5.56mm and 7.62mm) have spent bullets composed of antimony-hardened lead in a copper jacket. The copper in a jacketed bullet remains in close proximity to the lead core. When the metals are exposed to moisture, an electrical connection between two

dissimilar metals is established, and the electron flow between them may result in galvanic corrosion.

Bullet masses range from 32 to 86 grams per bullet, of which 96.4% by weight is lead (MIDAS, 2002). Common military primer formulations (FA-956 and FA-70), igniters, and propellants include organolead compounds (lead thiocyanate, lead styphnate, lead stearate, lead salicylate) at approximately 0.1 to 0.2 grams per bullet (MIDAS, 2002). Lead carbonate also is added to inhibit corrosion of gun barrels. The primary sources of lead at training ranges are spent bullet projectiles and shot pellets. However, given the multiple uses of military ranges, residues from unignited propellant and explosives from artillery, rockets, etc. may also exist.

Site characterization at small arms firing ranges involves soil and water analyses to determine the spatial distribution of contaminants. However, it is important to understand the physical processes and chemical reactions that affect lead distribution in the environment so that the potential for contaminant migration can be assessed. The following subsections will describe the important physical processes and geochemical reactions that govern lead mobility.

2.5.1 Physical Processes

Elemental lead from fragmented bullet slugs and shot can be transported as a particulate by the action of surface water, groundwater, and wind. Typically, the greatest lead concentrations are measured near impact sources (impact and lateral berms and shotfall zones). The action of water and wind could distribute lead particulates and lead-enriched soil down slope or along the prevailing wind direction.

When slugs and pellets are exposed to the atmosphere and precipitation, elemental lead will tend to oxidize (or corrode) over time. Oxidation products consist primarily of lead hydroxide and lead carbonate. As pure solids, these oxidized compounds are nearly insoluble; however, physical abrasion of lead-rich metal fragments during erosion will release the oxidation products as dust into the environment and create particles yielding a larger surface area prone to breakdown and leaching.

2.5.2 Geochemical Reactions

The major reaction classes that govern lead transport and fate are

- dissolution-precipitation as a function of pH,
- dissolution-precipitation as a function of redox environment, and
- sorption-desorption reactions.

The extent to which these reactions occur depends somewhat on site conditions such as soil composition, extent of soil saturation, and soil organic content.

Lead compounds show the greatest aqueous solubility at the acidic (pH <4) and alkaline (pH >11) ranges. Under acidic conditions, elemental lead will dissolve, releasing a hydrated cation Pb^{2+}. Under alkaline conditions, elemental lead will dissolve, theoretically forming the dissolved

hydroxide complex $Pb(OH)_3^-$ and ion-pair $Pb(OH)_{2\ (aqueous)}$. Water and soil with high carbonate alkalinity form the dissolved ion-pair $PbCO_{3\ (aqueous)}$. The scenario of lead transport as a dissolved hydroxide or carbonate ion occurs most frequently in contaminated calcic soils, carbonate sediments, or aqueous environments characterized by high dissolved carbon dioxide gas concentration. Also, as discussed under soil stabilization in Section 3, certain treatment approaches can contribute to this increased solubility.

When lead exists in a dissolved state, it can sorb to charged clay particle surfaces. In most natural sedimentary environments, clays carry a net negative surface charge. In a solution having neutral pH, dissolved cations are sorbed preferentially. Therefore, when dissolved lead exists as Pb^{2+} in dilute solution, transport can be attenuated by sorption to clays. These conditions occur in anoxic subsurface environments characterized by neutral to acidic pH, low dissolved solids concentrations, and low carbonate alkalinity. In contrast, when dissolved lead exists preferentially as an uncharged ion pair or negatively charged hydroxyl complex, transport can be enhanced because sorption is negligible (presence of two negatively charged surfaces). These conditions can occur over a range of redox conditions but require alkaline pH or high total dissolved solids or carbonate alkalinity concentrations.

2.6 Sample Collection and Analysis

After gathering and reviewing information on the past and current use of a SAFR subject to closure and the layout of the ranges, the next step in the site characterization is to develop a plan for sample collection and analysis to determine the vertical and horizontal extent and concentrations of the chemical constituents of concern in the environment. The site use and history will provide information regarding the type(s) and volume of ammunition used at the range. This information will indicate what the likely chemical constituents of concern are at the range and, consequently, what sampling procedures and analytical methods should be used to determine the concentrations of these constituents in the collected samples.

Decisions regarding where to gather samples will be based on the current and historical range layout and actual observation of where the bullets and/or shot pellets have been deposited. When formulating a sampling plan, one should walk the ranges and note where lead is deposited. Observations should be made of where the lead bullets or shot appear to be most concentrated and the rough vertical and horizontal limits of the area(s) where the bullets or shot are present. At trap, skeet, and sporting clay ranges, markings on trees and vegetation on the ranges may indicate the shot flight path.

During the walkover of the ranges, observations should also be made of any surface water bodies or wetlands that may be impacted directly by shot or bullets landing in these areas. Nearby surface waters or wetlands that could be receiving runoff from the areas of the ranges where shot or bullets are deposited should also be noted, and the sampling and analytical plan should investigate this possibility.

In situations where the area impacted by the lead shot or bullets may extend off the property owned and/or managed by the facility, property boundaries should also be identified during the

site walkover, and the investigation of possible off-property impacts should be incorporated into the scope of the sampling and analytical plan.

2.6.1 Environmental Media of Concern

A SAFR site characterization should *initially* investigate all impacted or potentially impacted environmental media. While the focus of this document is the remediation of soils at SAFRs, a comprehensive site characterization requires the investigation of all affected or potentially affected environmental media of concern. For all ranges, the environmental media of concern in the initial phase of investigation include soil where the bullets or shot pellets are deposited and groundwater in these deposition areas. At those ranges where the bullets or shot are impacting surface waters or wetlands, either directly or potentially via surface water runoff/migration, the initial sampling should also assess these impacts through the sampling of sediment and surface water. Additionally, soil outside the areas directly impacted by bullets and shot should be assessed to determine whether lead or other chemical constituents have migrated as the result of runoff or windblown movement of soil particles. If the results of the initial investigation reveal that the chemical constituents of concern are limited to soil, then the sampling and analyses in subsequent phases of the investigation can be limited to assessing soil concentrations.

2.6.2 Sampling and Analytical Plan Objectives

Once a review of the range history and layout is completed and a walkover of the range to observe areas of bullets/shot deposition, a sampling plan can be developed. A sampling plan should present the objectives of the sampling and the approximate number, type (soil, groundwater, surface water, sediment) location, depth, etc. of the samples to be gathered. A sampling plan provides a guide for the assessment but is also subject to adjustments as the investigation proceeds and more is learned about range conditions.

Sampling objectives include

- identifying affected environmental media,
- determining the vertical and horizontal extent of contamination,
- determining background concentrations of the chemical constituents of concern (i.e., the concentrations that would be present in the absence of the range),
- defining areas where constituents of concern are concentrated (i.e., “hot spots”), and
- determining exposure point concentrations for the assessment of human and environmental risk.

Use of Field Screening

During the initial phase of the site characterization, field screening may be an effective way to define the boundaries of the area affected by the chemical constituents of concern, identify “hot spots” or source areas, and focus the scope of the investigation and sampling plan. Portable multi-element x-ray fluorescence (XRF) analysis, in particular, may be used

to approximate[1] lead, arsenic, and other metallic elements *in situ* to establish contamination profiles and identify locations for collecting confirmatory samples for laboratory analysis. Since contamination patterns tend to be heterogeneous, the large number of data points gathered with *in situ* field screening can be a time- and cost-saving means of delineating contamination patterns.

Depending on the data quality objectives, an XRF instrument may be used to screen samples for subsequent laboratory analysis or may be used with USEPA Method 6200 to achieve the necessary precision and accuracy to quantify metal concentrations for use in risk characterization and remedial decision making.

Soil Sampling

The single most important step in any soil characterization or treatability study is sample collection and preparation. As such, it is not necessarily the size of the sample submitted, but rather the accuracy and representativeness of the sample compared to the whole volume of soil to be treated. This is difficult to achieve as lead contamination at small arms firing ranges presents the following unique challenges:

- Metal contaminants are present mostly as discrete particles ranging in size from intact bullets or shot to bullet fragments.
- Lead bullets striking the impact berms at high speed can actually vitrify on impact, forming "melts" on individual soil particles.
- Lead bullets at ranges that don't have an active environmental stewardship plan or lead management plan may corrode over time. During rainfall, the surface corrosion may dissolve.

2.6.3 Sample Collection

Soil sampling procedures begin with appropriate sample collection. Soil samples from firing ranges are usually a heterogeneous mixture of matrix materials and contaminants. Individual granules of soil samples can be significant relative to the size of a subsample taken for analysis. Consequently, the analytical results can vary considerably depending on the particular group of granules selected in the subsample. Sample collection strategies should, therefore, be site-specific and a function of particulate metal distribution and soil gradation.

Several approaches for addressing the inherent variability of particulate metal distribution and soil gradation, as well as the vertical and horizontal distribution of contaminants between different types of firing ranges (e.g., rifle and pistol versus trap and skeet), have been developed (see Appendix B).

In soils where the distribution of contaminants is widespread and not easily predicted, a composite approach has been developed by Jenkins and others from the U.S. Army Cold

[1] XRF, used for *in situ* analysis, is sensitive to particle size and distribution. XRF analysis should be confirmed with laboratory analysis.

Regions Research and Engineering Laboratory (USACRREL). This approach was initially developed for use in characterizing training range soils that had received indirect fire, with subsequent explosion of the rounds resulting in a heterogeneous distribution of explosives in the form of small particulates. The typical small arms firing range floor is similar in nature in that it receives indirect fire, and the particulates that are present are generally fragments from high-energy impacts and are dispersed in a heterogeneous manner.

Since 1999, this approach has been successfully implemented at numerous small arms firing ranges. At Camp Edwards, located on the Massachusetts Military Reservation, this approach was used for both training ranges and small arms firing range floors. Collection began with dividing the area of interest into grids measuring 22 x 22 feet. Five subsamples were spaced in an "X" pattern. Each of the four corner subsamples was spaced 5.5 feet from the nearest grid edges. The center subsample was located at the center of the grid. Sampling intervals may vary but are usually 0–6, 6–12, 12–24, or 24–36 inches below ground surface (bgs), based on the location within the range and anticipated depth of penetration by projectiles.

The subsamples were then composited. Each composited sample was placed in a clean cement mixer and mixed for 5 minutes to maximize homogenization. Alternatively, the composited sample may be rolled on a plastic high-density polyethylene tarpaulin from each of the corners to the middle of the tarp, repeating the rolling process three times. In either case, homogenization equipment is decontaminated between samples.

For berm areas, however, the particles are concentrated in bullet pockets and can be found at depths exceeding several feet. In these areas, trenching through the berm will provide a more appropriate sample, with the added benefit of being able to visually inspect the berm core at depth. Samples are collected from the trench walls in this case and composited as outlined above.

2.6.4 Preparation of Soil Samples for Analysis

Preparation of soil samples must address the range of materials that can be found in a sample. Various plant parts, insects, rocks, and other materials are found in soil and must be addressed in collecting any soil sample. Soil is composed of a mixture of sand, silt, and clay, along with humified organic materials. Fauna, flora, and anything large enough to be identified by the naked eye are usually excluded in taking a sample. Engineering, agriculture, and the environmental fields have long recommended removing extraneous materials from a sample before submitting the soil to laboratory analysis. Removal is often accomplished visually, but many disciplines have adopted the use of a #10 sieve to separate soil from other materials.

The variability of measured chemical concentrations in soil has been noted in many professional fields. Some of the variability is due to the nature of collecting soil samples, but most variability is an inherent property of the soil itself. Each soil grain-size fraction exhibits its own range of physical and chemical properties, which causes different amounts of interaction with substances in the soil pore water. Differences in surface area and surface charge can cause significant differences in the chemical concentrations found in various soil-size fractions. Previous work

indicates that measured metal contamination, for example, can vary by over two orders of magnitude between the silt-clay fraction (minus 200-mesh) and medium sand (10-mesh by 40-mesh) alone. Consequently, one sample that contains more minus 200-mesh will generate a higher total metal result than a sample containing more 10-mesh by 40-mesh soil and so forth. Please refer to the Air Force Center for Environmental Excellence's *Technical Protocol for Determining the Remedial Requirements for Soils at Small Arms Firing Ranges* (2000) for additional detail.

While many current analytical methods rely on using only soil that has passed uncrushed through a 30-mesh sieve as the source for analytical tests, some controversy exists in the field as to the best method(s). Differences in sample preparation protocols include the designation of the size of sieve to use or whether to use a sieve at all; and on the degree of disaggregation prior to sieving. Therefore, the recommendation of a specific sample preparation method may be misleading. The choice of a method should result in a sample that is representative of the site and its environment, addresses the concerns that led to the need for sampling, and is agreeable to the regulatory community and other parties involved in the evaluation. (If you want to make sure a treatment meets the regulatory requirements for average concentrations in soil, you may want to get as much homogeneity as possible in your sample. However, if you want to make sure a treatment process is degrading/removing the contaminant, you may NOT want to disaggregate your sample but instead get more samples to see if there are any "particle" hits.)

2.6.5 Soil Sample Analysis

Standard USEPA SW-846 Method 3051 is used for digestion of samples for total metals analysis. The digestates can then be analyzed by flame AA or by ICP (SW-846 Standard Method 6010).

2.7 Risk Assessment

Risk assessment provides an evaluation of the potential threat to human health and the environment from contaminants in environmental media and can provide a basis for determining the necessity for, and extent of, remedial action.

Detailed guidance on evaluating potential human health impacts are provided in:

- USEPA's *Risk Assessment Guidance for Superfund* (RAGS), EPA/540/1-89/002 (December 1989)
- American Society for Testing and Material's (ASTM) *Risk-Based Corrective Action* (RBCA) (ASTM, 1995)

Detailed guidance on evaluating potential ecological impacts is provided in:

- USEPA's *Ecological Risk Assessment Guidance for Superfund* (ERAGS), EPA/540-R-97-006 (August, 1997)

In addition, many states have developed their own guidance, which should be consulted when conducting human health and ecological risk assessments.

In general, a risk assessment is composed of the following components:

Conceptual Site Model: The conceptual site model (CSM) identifies potential sources of constituents of interest, potential migration routes for constituents, and potential receptors and exposure pathways. The CSM provides the foundation for the human health or ecological risk assessment.

Identification of Constituents of Interest: Constituents detected in surface water, sediment, and fish tissue are compared to background concentrations and conservative, default risk-based screening values to determine which constituents should be retained for quantitative risk characterization.

Calculation of Constituent Intakes: For all receptors with complete exposure pathways, constituent intakes (i.e., doses) are estimated. Intakes are calculated for noncarcinogenic and carcinogenic effects for applicable routes of exposure.

Calculation of Exposure Point Concentrations: To determine constituent intakes for each receptor, exposure point concentrations are calculated for each constituent of interest in each medium. Exposure point concentrations may be calculated directly from measured concentrations or estimated using fate and transport models.

Constituent-Specific Parameters: Constituent-specific toxicological parameters (cancer slope factors and reference doses) must be identified in order to calculate risk. For human health risk, these values are obtained from the Integrated Risk Information System (USEPA, 2000) or the Health Effects Assessment Summary Tables (USEPA, 1997a). Additional constituent-specific parameters (e.g., absorption factors) may also be required. Constituent-specific toxicological parameters for ecological receptors may be obtained through dose-response experiments or from various literature sources.

Risk Characterization: The calculated intakes are combined with chemical-specific toxicological parameters to determine cancer risks and/or hazard indices for each receptor and exposure pathway.

Uncertainty Analysis: The uncertainty analysis reviews the key assumptions that were incorporated in the risk assessment and the potential effect that these assumptions may have on the results.

Risk assessment frameworks allow for the incorporation of site-specific inputs by adopting a tiered system of evaluating risk. Earlier tiers of the risk assessment process (i.e., screening level) compare contaminant concentrations to background concentrations and/or generic risk-based concentrations, which represent a conservative estimate of risk. Subsequent tiers in the process (i.e., baseline risk assessment) allow the use of more site-specific information to fine-tune the risk evaluation.

While RAGS, RBCA, and state risk assessment guidance are used to evaluate potential risks to humans posed by most contaminants at SAFRs (i.e., metals and polycyclic aromatic hydrocarbons, or PAHs), the evaluation of risk to humans from lead is accomplished by two separate methodologies that have been created by USEPA's Technical Review Workgroup for Lead (TRW):

- Integrated Exposure Uptake Biokinetic Model for Lead in Children (IEUBK) for residential exposures (*Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for Lead in Children.* February 1994), and

- Adult Lead Model for nonresidential exposures (*Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Risks Associated with Adult Exposures to Lead in Soil*. December 1996).

TRW is an interoffice workgroup convened by the USEPA Office of Solid Waste and Emergency Response/Office of Emergency and Remedial Response. The two lead models, and information pertaining to them, can be found on the TRW Web site (www.epa.gov/superfund/programs/lead).

The IEUBK model relates soil-lead concentrations to blood-lead concentrations in children for long-term exposure to lead in a residential setting and can be used to determine target cleanup levels for residential use. The Adult Lead Model relates soil-lead concentrations to blood-lead concentrations in the developing fetus of an adult woman who has potential exposure to the site and can be used to determine target cleanup levels at nonresidential (i.e., commercial and industrial) sites.

Based on these models, the generic screening level for lead in soil is 400 mg/kg for residential sites and 1000 mg/kg for industrial sites. USEPA and some states have developed generic screening levels for other contaminants at small arms firing ranges. For example, USEPA Region 3 Risk-Based Concentration Tables (USEPA, 2002a) and USEPA Region 9 Preliminary Remediation Goals (USEPA, 2002b) are often used as sources of generic screening levels.

2.7.1 Application of the Human Health Risk Assessment Process to Small Arms Firing Ranges

While most of the general risk assessment process applies directly to small arms firing ranges, a few of the steps can be modified to address the special circumstances of these sites.

Conceptual Site Model

Figure 2-5 presents an example conceptual site model developed by the Air Force Center for Environmental Excellence (AFCEE) to focus the risk assessment at small arms firing ranges. Once the source(s) and release mechanisms have been identified, an analysis of the environmental fate and transport of the chemicals can be conducted. This analysis considers the potential migration, transformation, and transfer mechanisms to provide information on the potential magnitude and extent of contamination. From this information, the actual or potential

exposure points for receptors can be identified. The focus of this effort should be on those locations where actual contact with the compounds of potential concern (CoPC) will occur or are likely to occur. Last, potential exposure routes that describe the potential for the CoPC to enter the receptor's body are identified and described.

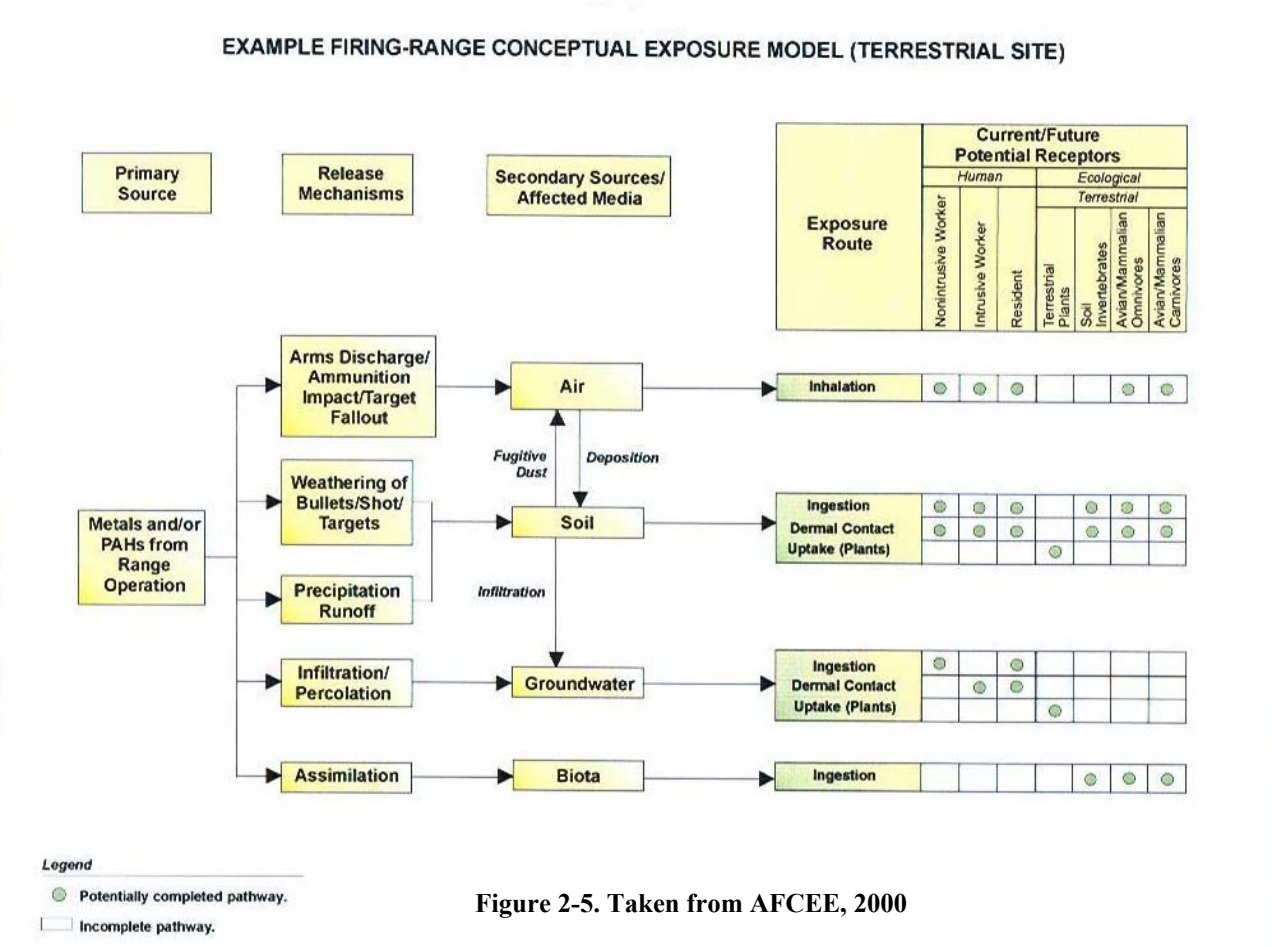

Figure 2-5. Taken from AFCEE, 2000

Contaminant Identification

While the evaluation of a hazardous waste site involves consideration of a full target analyte list of chemical parameters, the focused nature of a small arms firing range provides some opportunity to focus on a few selected constituents. Unless otherwise indicated in the site history, the use of small arms firing ranges is limited to projectiles of small caliber (less than 0.50 caliber). These projectiles are overwhelmingly lead or copper-jacketed lead with a few being composed of some other metal, usually steel, or a polymer. Other CoPCs include antimony, arsenic, copper, iron, tin, zinc, and PAHs (see Table 1-1 for a complete list of CoPCs and sources at SAFRs). However, the primary CoPC at theses sites is usually lead with potential contribution from copper or arsenic. Peddicord and LaKind (2000) found no adverse effects to human receptors due to PAHs at a SAFR.

The primer is generally composed of a metallic fulminate, styphnate, or azide compound (usually lead) and a propellant (granular, smokeless powder or black powder). Modern propellants are composed of nitrocellulose or nitrocellulose and nitroglycerine mixtures. Both the propellants and the primer are rapidly burning materials that leave little residue as either decomposition products or uncombusted compounds. Additionally, both the original compounds and the decomposition products are mostly analyzed as common soil compounds, which are difficult to evaluate (organic carbon, CO_2, nitrates, etc.).

Exposure Assessment

The exposure assessment is highly dependent on the current and future land use expected for the site. When a small arms firing range is to continue its operation, the risk assessment should be based on the range's impact on groundwater with no quantitative ecological risk assessment, unless a migratory pathway away from the range can be established. The reasons for this type of assessment are not obvious. If the range is to continue in use, metallic deposition in the backstop/berm area will continue. The only human receptors will be site workers, who are covered by the exposure standards of the Occupational Safety and Health Administration (OSHA). For safety, site visitors are not allowed near the backstop/berm area, thus eliminating their exposure. Ecological concerns are addressed by the nature of the range operation (i.e., a commercial operation, which does not support wildlife).

However, for small arms firing ranges that will be discontinued and the site re-used for other purposes, the identification of future land use (i.e., residential, commercial/industrial, or park/ recreation area) needs to be identified, and the appropriate receptors should be evaluated for potential risk (i.e., child or adult residents, adult workers, construction/utility workers, recreational users, or ecological receptors).

2.7.2 Ecological Risk Assessment

During the development of the risk assessment, it may be necessary to evaluate the potential for impacts to ecological receptors from exposure to metals and organics through preparation of an ecological risk assessment (ERA). In certain circumstances, the focus of potential remedial actions at a range may be either substantially or solely driven by the results of the ERA. As opposed to a human health risk assessment with its single receptor and limited number of exposure scenarios, the preparation of an ERA requires a more complex assessment of multiple receptors of different taxa and a variety of potential exposure mechanisms.

An ERA is an iterative process for evaluating the likelihood that adverse impacts may occur, or are occurring, as a result of exposure to one or more stressors. Ecological impacts may occur if the stressor has the inherent ability to cause one or more adverse effects, and the stressor co-occurs with or contacts ecological components that include diverse organisms within a population or community. The ecological communities that may potentially be affected include terrestrial ecosystems exposed to contaminated soils and aquatic and wetland ecosystems exposed to contaminated surface water and sediments. The ERA process is designed to help

identify environmental problems, establish priorities for resolving those problems, and provide a scientific basis for possible actions.

ERAs most commonly conform to the framework described in USEPA's *Framework for Ecological Risk Assessment* (EPA/630/R-92/001) and *The Guidelines for Ecological Risk Assessments* (Federal Register, Vol. 63, No. 93, p. 26846), which divide ERAs into three stages: problem formulation, analysis, and risk characterization. In addition, several states have developed their own ecological risk assessment guidance.

Problem formulation is the process by which a preliminary hypothesis about why ecological effects may be occurring is developed. During the problem formulation stage, a scope of work for conducting the risk assessment is defined, usually through the completion of a conceptual site model. The analysis phase is the technical evaluation of data to reach conclusions about ecological exposure and the relationships between the stressor and ecological effects. The risk characterization phase uses the results of the analysis phase to estimate risk to the receptor endpoints identified in the problem formulation phase.

While the term "risk" is used in this section, the risk characterization mathematically calculates a level of concern to be taken into account in any remedial decisions. This numerical value is not an absolute determination of the risk of adverse effects to the receptor. It is a relative comparison of an estimate of the exposure to the receptor in the field with a safe laboratory-derived reference dose for the same or different species. Risk to an ecological receptor or receptor community can only be established by direct measurements of detrimental effects in the field.

For ERAs completed at SAFRs, more detailed guidance can be found in USEPA's *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments* (EPA 540-R-97-006). This guidance expands this framework into a multistep process by which a greater level of ecological scrutiny is placed, as needed, at each of the steps.

For the majority of sites, an ERA will not need to proceed beyond a screening-level assessment. The screening-level assessment can narrow the scope of possible subsequent assessment activities by focusing on those aspects of the site that constitute realistic potential risks. Additionally, screening-level assessments serve to identify data gaps in both the evaluation of chemicals and in the identification of matrices of concern. Screening-level assessments will generally consist of a straightforward comparison of concentrations of metals and organics in surface soils, surface water, and sediments (as appropriate) to relevant benchmarks for the determination of potential risks. Site specificity is included with respect to potential receptors and potential exposure pathways. Additional steps in an ERA are pursued only if potential risks are noted and it is necessary to refine those risk estimates for purposes of remediation. An example of an ecological risk assessment at a SAFR can be found in Peddicord and LaKind (2000).

2.7.3 Ecological Risk Assessment State Survey

Interdependent risk assessments often are conducted for human and ecological receptors potentially exposed to contaminants in range media. While differences in methods and assumptions justify separate analyses, several considerations are common to both types of risk assessments. Aside from the federal requirements under RCRA and Superfund, many states have variations under authorization programs such as RCRA or state-developed remediation cleanup or mitigation programs. In an attempt to understand the potential variability, ITRC states were asked the following survey question:

> "When permitting remediation of a small arms firing range, do you require an ecological risk assessment in addition to a human health risk assessment? Please comment and explain your answer."

The following states replied to the survey question as follows:

Florida — "Florida has not required an ecological risk assessment for a small arms range remediation. They will evaluate a site before deciding if an ecological risk assessment is required. The Florida Center for Solid and Hazardous Waste Management has also developed *Best Management Practices for Lead at Outdoor Shooting Ranges*."

Kansas — "Kansas has no specific requirements for an ecological risk assessment under state guidance; however, small arms ranges under CERCLA within the state are required to have an ecological risk assessment performed."

New York — "New York does not generally use ecological risk assessments. For range sites (as well as other sites that have potential eco impact), we start with a Fish and Wildlife Impact Analysis. If the findings of this analysis are positive, we then go further and require additional work such as tissue analysis. When selecting remedies, consideration is given to whether the alternatives will cause more harm than good."

New Jersey — "New Jersey has cleanup standards that are health-based. As such, they do not require risk assessments. For ecological concern, the consultants for the RP are required to assess the need (for an ecological risk assessment) based on the following three criteria:

- What are the contaminants? Are they mobile, and could they present a threat?
- What are the potential receptors in the vicinity of the site? Could they potentially be impacted?
- What are the transport mechanisms? Is there a general pathway that could potentially result in impact?

Based on the answers to these questions, the RP must determine if there is a reasonable potential for ecological impact to occur. NJDEP reviews the results of the survey and either concurs or requires further work."

Oklahoma — "Oklahoma has no experience permitting remediation activities at small arms firing ranges; however, they make site-specific determinations on the need for an ecological risk assessment after the initial request is made."

Oregon — "Oregon environmental cleanup rules require that all removal and remedial actions be protective of human health and the environment. 'Acceptable risk levels' are defined in the rules for both individual ecological receptors and for populations of ecological receptors. Thus, for any site requiring remediation, some level of ecological risk assessment must be performed. However, Oregon's rules provide for a four-tiered approach to ecological risk assessments as follows:

- Level I Scoping
- Level II Screening
- Level III Baseline
- Level IV Field baseline

"At many sites, only a level I assessment is required. A level I assessment is a conservative, qualitative determination of whether or not there is any reason to believe that ecological receptors and/or exposure pathways are present, or potentially present, at or in the locality of the facility (i.e., the area where contamination exists and is reasonably likely to migrate, in the absence of any remedial action). Scoping is intended to identify, and eliminate from further study, sites that are obviously devoid of ecologically important species or habitats and/or where exposure pathways are obviously incomplete."

Pennsylvania — "Remediation of a small arms range would follow the Pennsylvania Act 2 regulations if any kind of liability relief is being sought. With respect to the standard chosen, ecological receptors would need to be addressed in some way. Under the statewide Health Standard Generic Numeric cleanup values for anywhere in the state, the ecological screen exists. If the site does not pass the screen, a more involved assessment is required. Under the site-specific standard, ecological risk assessment is required. There is no ecological screen under the site-specific standard. We actually have no requirements specific to regulation of small arms ranges; however, we are going to prepare 'guidance' primarily citing USEPA's Best Management Practices Manual."

Tennessee — "Tennessee has not dealt with remediation of small arms ranges. Most likely they would not require an ecological risk assessment unless there are strong indications that a wetland or other area is being, or potentially could be, impacted."

2.7.4 Measuring Bioavailability for Determining Risk

Metals and organic compounds at SAFRs may come into contact with human and other receptors through the ingestion, dermal contact, or inhalation of soils exposure pathways. The amount of these compounds in soils that is used to assess risk and determine cleanup levels is determined from analytical methods that extract the total concentration in soil. However, in reality only a fraction of these compounds will generally be "available" to the relevant receptors. This fraction is termed the bioavailable amount of the compound. USEPA defines bioavailability as "the

fraction of the total amount of material in contact with body portal-of-entry (lung, gut, skin) that enters the blood" (USEPA, 1999). Bioavailability can further be defined as absolute or relative, where

- Relative bioavailability is the amount of a substance entering the blood via a particular route of exposure (e.g., gastrointestinal) divided by the total amount administered (e.g., soil lead ingested).

- Absolute bioavailability is the comparative bioavailability of different forms of a chemical or for different exposure media containing the chemical relative to the bioavailability of a standardized reference material (e.g., bioavailability of soil lead relative to its bioavailability from soluble lead acetate).

Absolute bioavailability can be incorporated within the risk assessment process by adjusting the fractional relative absorption factor (RAF) in the chronic daily intake (CDI) calculations of the exposure assessment. A good review of the bioavailability of metals in soils can be found in the National Environmental Policy Institute's (NEPI) document entitled *Assessing the Bioavailability of Metals in Soil for Use in Human Health Risk Assessments* (NEPI, 2000; www.nepi.org). Since lead is generally the CoPC at SAFRs, lead bioavailability is discussed below.

Lead Bioavailability

Lead is generally the compound of most concern at SAFRs. Studies conducted on SAFR sites indicate that lead from ammunition may contribute to soil in any of three forms: metallic lead, Pb^{+2} (dissolved from the crust of the ammunition), and as a variety of oxidized compounds (largely hydroxycarbonates, carbonates, and sulfates). Ingestion of fragments of lead ammunition may be the cause of children exhibiting pica behavior, although metallic lead is largely insoluble (USEPA, 2000b). Lead speciation within the soil matrix, soil type, mineralogy, and soil particle-size have been shown to affect soil-lead bioavailability (USEPA, 2000a).

Bioavailability of metallic lead has been shown to decrease with increasing particle size (Barltrop & Meek, 1979). There also is evidence to suggest that smaller soil particles (e.g., <100 – 250 μm) are more likely to be incidentally ingested than larger particles because the particles adhere more readily to the skin (Druggan, et al., 1985; Bornshire, et al., 1987; Driver, et al., 1989; Shepard and Everden, 1994; Duff and Kissel, 1996; and Kissel, et al., 1996a). Studies conducted on 20 soil-lead samples found varying levels of bioavailability, as shown in Table 2-1. Therefore, lead bioavailability at SAFR sites may differ depending on the interaction of the ammunition with chemical reactants in the soil.

Generally, soils should be sieved to < 250 um (60-mesh) prior to measuring bioavailability and also as a recommended input to the IEUBK and Adult Lead Models (USEPA, 2000a). Even though 60-mesh may yield the most representative results, the AFCEE studies show no measurable difference in results screened at 10-mesh at the time of sample collection (AFCEE, 2000). Bioavailability of lead from soils is currently utilized in the IEUBK and Adult Lead risk

assessment methods that have been created by USEPA's Technical Review Workgroup for Lead (TRW).

The IEUBK Model relates soil-lead concentrations to blood-lead concentrations in children for long-term exposure to lead in a residential setting and can be used to determine target cleanup levels for residential use. Bioavailability within the IEUBK Model is set at a default estimate of 30% as an absolute value. This number is derived from the estimation of 50% bioavailability of soluble lead in water and food and presumes that the relative bioavailability of lead in soil is 60%. The absolute bioavailability of soil lead is therefore 50% x 60% = 30% (USEPA, 1999).

The Adult Lead Model relates soil-lead concentrations to blood-lead concentrations in the developing fetus of an adult woman who has potential exposure to the site and can be used to determine target cleanup levels at nonresidential (i.e., commercial and industrial) sites. The default estimate of bioavailability of lead in the Adult Lead Model is 12%, based on an absorption factor for soluble lead in adults of 20% and the relative bioavailability of lead in soil compared to soluble lead of 60% (20% x 60% = 12%, USEPA, 1996).

Potentially Lower Bioavailability (RBA < 25%)	**Intermediate Bioavailability (RBA = 25% to 75%)**	**Potentially Higher Bioavailability (RBA > 75%)**
Galena (PbS) Anglesite ($PbSO_4$) Pb (M) Oxides Pb Fe (M) Sulfates Native Pb	Pb Oxide Pb Fe (M) Oxides Pb Phosphate Slags	Cerrusite = $PbCO_3$ Pb Mn (M) Oxides

Table 2-1. Potential Bioavailability of Various Lead Minerals

RBA = relative bioavailability, M = Metals
(From USEPA, 1999)

Site-Specific Measurement of Bioavailability

Animal dosing studies (i.e., *in vivo* bioassays) are the only approved methods to measure soil-lead bioavailability for application to a site-specific risk assessment. Currently, USEPA indicates that the juvenile swine model may be the best method for determining site-specific bioavailability of lead; however, other *in vivo* studies using different species may be accepted on a case-by-case basis (USEPA, 1999). These studies have currently not been applied to SAFRs to determine site-specific bioavailability (personal communication with the Technical Review Workgroup for Lead).

A lead bioavailability test using juvenile swine has been developed to evaluate relative lead bioavailability (Casteel, et al., 1997). In the juvenile swine model, swine are dosed with differing

amounts of either lead in soil or lead acetate. The swine are dosed twice daily to mimic childhood lead exposure. Blood samples are collected and analyzed for lead during the study; and at the end of the study, samples of blood, bone, and liver and kidney tissue are collected and analyzed for lead. The resulting data are used to estimate relative lead bioavailability by comparing lead in blood and tissues from the swine receiving soil lead relative to the swine receiving lead acetate. Studies conducted using the juvenile swine test indicate relative lead bioavailability estimates from soil between less than 0.01 and 0.90. These studies support USEPA's use of 30% lead absorption (relative bioavailability of 60%) from soil as a default assumption for child lead ingestion in the IEUBK Model (NEPI, 2000).

To determine bioavailability from lead ingestion in adults, a stable lead-isotope technique was utilized on adult humans. Results indicate that between 8.1% and 26.2% of the administered dose of lead was absorbed. When the lead was ingested after eating, the absolute lead bioavailability was reduced to between 1.7% and 2.5% (Maddaloni, et al., 1998). These results support the lower lead bioavailability value seen in USEPA's Adult Lead Model.

In vivo tests to determine lead bioavailability are time-consuming and expensive and may create ethical concerns. Therefore, *in vitro* methods are being developed to measure metal bioavailability as a function of the dissolution of lead and other metals within a simulated gastrointestinal tract environment (Ruby, et al., 1996). In these methods, metal salts or soil metal are incubated in a low-pH solution to mimic residence time in the stomach. The pH is then increased to a neutral range to mimic residence time in the small intestine. The fraction of lead that dissolves during these incubation phases is the bioaccessible fraction (i.e., the amount that is soluble and available for absorption). A correlation between the juvenile swine model and the stomach phase of the *in vitro* test indicated that lead dissolution in the acidic stomach environment of the *in vitro* test is predictive of relative lead bioavailability in the juvenile swine test (NEPI, 2000).

A refined *in vitro* test, called the physiologically based extraction test (PBET), has been developed by the Solubility/Bioavailability Research Consortium (SBRC), based on stomach and intestinal dissolution of lead. Lead bioaccessibility from soil as determined by the PBET has been shown to be well correlated with lead bioavailability from soil as determined by a rat model and a swine model (NEPI, 2000). A formal validation of the PBET is currently ongoing; however, USEPA currently considers that there is insufficient evidence for using these tests to quantify lead bioavailability (USEPA, 1999).

The dermal and pulmonary bioavailability of lead is generally not utilized in risk assessments. It is assumed that absorption of inorganic lead compounds through the skin is negligible in comparison to the oral or inhalation routes (ATDSR, 1993). The bioavailability of lead from inhalation exposure is very dependent on particle size, where smaller particle sizes appear to contribute a greater fraction of inhaled lead deposition within the lungs (NEPI, 2000).

Arsenic Bioavailability

In vivo studies on arsenic bioavailability from soil indicate a reduced absorption of arsenic compared to soluble forms and suggest a relative bioavailability between 0.1 and 0.5 (NEPI, 2000). Soil arsenic bioaccessibility has been shown to correlate well with soil arsenic bioavailability using a monkey model, a rabbit model, and a swine model (NEPI, 2000). However, the correlations between *in vitro* and *in vivo* studies for arsenic are generally not as good as those demonstrated for lead.

Research and Development – Future Needs

Several areas of research and development have been identified by the In-Place Inactivation and Natural Ecological Restoration Technologies (IINERT) Soil-Metals Action Team, part of the Remediation Technologies Development Forum (RTDF, www.rtdf.org):

- Develop a more thorough understanding of the factors that control soil-metal bioavailability to humans, which should include the biological, chemical, and physical factors that affect bioavailability.

- Develop and validate simple *in vitro* techniques that can be used to assess soil-metal bioavailability to humans. These simple techniques should be well correlated to appropriate human or animal (e.g., pigs and rats) model surrogates.

- Develop correlations between soil components (i.e., metal species, nonmetal-containing components) and the soil-metal bioavailability for determining the short- and long-term stabilities of soil-metal components.

- Develop treatment technologies and processes for adding materials to metal-contaminated soils that induce the formation of less bioavailable metal forms, providing a practical approach to in-place inactivation.

3.0 TECHNOLOGY OVERVIEW AND APPLICATION

A variety of technologies are appropriate for remediating lead contamination at small arms firing ranges. The choices are dependent upon characteristics of the site, costs, length of time allowed for remediation, land availability, and, foremost, future land use. The technologies all have proven records of success. With proper design of the appropriate technology or system of technologies, successful remediation can be achieved.

3.1 Dig and Haul

The baseline approach on closure of firing ranges is to excavate the soil, load the soil onto over-the-road trucks with end dumps, and transport the soil to an appropriate landfill. Before the approach is selected, the contractor/owner will need to confirm whether the soil is RCRA

hazardous by testing appropriate constituents using the Toxicity Characteristic Leaching Procedure (TCLP) method. The soil is RCRA hazardous waste according to the following criteria:

Element	RCRA TCLP Requirements
As	≥ 5.0 mg/l
Ba	≥ 100 mg/l
Pb	≥ 5.0 mg/l

Table 3-1. RCRA Regulatory Concentrations for TCLP Testing

As shown, if any of the listed metals fall within the stated RCRA concentration criteria for specified metals, then the soil is considered hazardous and must be managed as a hazardous waste. Furthermore, the soil can be considered characteristically (reactivity) hazardous if it contains live rounds. An actual site remediation may generate both hazardous and nonhazardous wastes and, thus, use both landfill types.

However, with the technologies described in the following sections, the owner/operator has alternatives for closure of their firing range containing hazardous soil. These technologies have been implemented on other site closures and may reduce liability for the generator/owner because the soil will no longer have hazardous waste characteristics.

3.2 Soil Washing/Particle Separation

The soil-washing process uses mineral processing techniques and procedures to recover particulate contaminants as refined "products." The operation is dust-free, and in the case of ranges, the recovered metal is considered "scrap metal" per 40 CFR 261.1(c)(6). Under this citation, scrap metal is classified as a "recyclable material," which is not regulated or manifested. As a rule, the site and the excavated material is surveyed for live UXO prior to treatment, and live small arms rounds are segregated from other recovered metals as part of the soil-washing process, prior to shipment of metal for recycling.

Soil washing also classifies soil fractions by both size and density. Through their affinity for soil fines and organic matter, sorbed contaminants, if present, can be partitioned, and the concentrated contaminant-bearing material then segregated from the clean soil fractions for subsequent treatment or disposal. Hence, the volume reduction of material requiring further treatment is a function of the organic/fines content of the soil.

For sandy soils, a dry-screening step can possibly be substituted for the wet-screening techniques for physical sizing. While this is not a dust-free operation, simple misting can help minimize the dust. Dry processing can offer potential savings over wet-screening steps if the soil is amenable to dry processing, and this needs to be evaluated as part of a treatability study.

3.2.1 Process Description

While the concept of soil washing is over 100 years old, its application in remediating metals-impacted soils began in the early 1990s. Since that time, the process has been refined and the equipment streamlined to provide higher throughputs from a physically smaller plant as described in subsequent sections. The results are more efficient operations with reduced processing costs. Following is a description of major unit operations. These operations are selected and/or configured on an as-needed unit-operations basis as determined by the treatability study.

3.2.2 Physical Sizing

The physical-sizing process uses sequential wet-screening steps, the first of which is deagglomeration. Wet screening provides dust-free operation and sharp particle-size fraction cuts. For each screening step, "plus" and "minus" fractions are generated, with actual cut points based on the treatability study data. The goal of wet screening is to partition the particulate metal contamination into narrow-size fractions to facilitate effective gravity separation and to partition soil particles containing organic contaminants into the smallest size fraction for subsequent classification.

For free-flowing sandy soils with little oversize material other than spent projectiles, simple dry screening may be sufficient to recover the bullets in a condition suitable for recycling. The practical lower limit for screen size is 3/8 to 1/4 inch. For soils containing a measurable clay content, significant volumes of soil in the screen reject or plus-size fraction, or for soils requiring particulate removal below 1/4 inch, dry screening is generally not feasible.

3.2.3 Soil Classification

Sand screws and/or hydrocyclones are used to classify soil through segregation of the contaminant-bearing material from the clean sand and gravel fractions. With sand screws, water flow coupled with screw rotational speed are used to set the actual cut points. For hydro-cyclones, flow rates coupled with apex size determine the cut points. The goal of classification is to minimize the volume of soil requiring subsequent treatment while maximizing the output of clean sand and gravel.

3.2.4 Gravity Separation

When particulate contaminants are the same size as the surrounding soil particles, gravity separation is used to remove the particulates from the same-sized soil matrix. Elutriation and jigging are used for soil fines removal and gross particulate removal, respectively. Elutriation uses water flow over weirs to separate soil fines from larger sand particles. Jigging uses differential settling in water to separate heavy, metal particles from same-size but lighter sand/gravel particles. This approach has seen successful use in both commercial mineral processing and range remediation.

3.2.5 Magnetic Separation

To recover tramp iron and other spent ferrous metal debris, self-cleaning magnets are suspended over the intermediate product conveyors to automatically remove tramp iron and other ferrous metals from the product stream after the initial high-pressure wash. The iron is then deposited in a bin for subsequent recycling.

3.2.6 Dewatering and Water Treatment

To close the loop on water consumption, process water is recycled within the plant. A clarifier and dewatering screen may be used in series to segregate/dewater heavy humates and condition the fines-slurry for subsequent dewatering using a belt filter press. Sand and carbon filtration follows as a polishing step for final rinse spray bars, if required. This enables the counter-current reuse of process waters while minimizing water consumption and associated disposal costs.

3.2.7 Humate Removal

A static organic removal screen is incorporated after each elutriation/classification step to recover the "floatable" humates in the aqueous stream. In addition, a high-frequency vibratory screen may be used after the initial fines dewatering step to remove the "heavy" humates from the fines stream prior to belt filter press dewatering. All of the recovered humates are containerized for subsequent treatment and/or disposal.

3.3 Soil Stabilization

Stabilization/solidification has often been used to change the hazardous characteristic of firing range soil prior to long-term management or to control the solubility of metals in range soil for groundwater protection. Stabilization/solidification has historically been used to describe several unique processes by which metal-bearing waste can be treated to remove hazardous characteristics. More recently, those active in the remediation field have recognized that there is an important distinction between the two terms.

Solidification generally refers to adding pozzolanic material to a waste to reduce permeability and surface area. These pozzolans are usually alkaline materials, which can often increase the solubility of metals in many disposal environments.

The most common form of solidification is a cement process. It simply involves the addition of cement or a cement-based mixture, which thereby limits the solubility or mobility of the waste constituents. These techniques are accomplished *in situ* by either injecting a cement-based agent into the contaminated materials or *ex situ* by excavating the materials, machine-mixing them with a cement-based agent, and depositing the solidified mass in a designated area. The goal of this process is to limit the spread of contaminated material via leaching. The end product resulting from the solidification process is a monolithic block of waste with high structural integrity. Types of solidifying/stabilizing agents include Portland; gypsum; modified sulfur cement, consisting of elemental sulfur and hydrocarbon polymers; and grout, consisting of

cement and other dry materials such as acceptable fly ash or blast furnace slag. Processes utilizing modified sulfur cement are typically performed *ex situ*.

Stabilization, or chemical treatment as it is often referred to, is different in that the reagents added to the contaminated soils form less soluble compounds while controlling pH in a range of minimum solubility. Because less soluble compounds are formed, stabilized waste is often considered more protective of groundwater.

Heavy-metal contamination in soils is widespread in the United States and other parts of the world. The most common remedy for lead- (Pb) contaminated soils has been to mix the soils with chemical binders such as Portland cement and to relocate them to landfills, safely away from receptors. Portland cement works by increasing particle size and imparting the resulting material with a high buffering capacity in the alkaline pH range. The large particles and alkaline pH buffering capacity that result from the stabilization process reduce the amount of contaminant that is extracted by laboratory leaching methods, including regulatory tests such as the Toxicity Characteristic Leaching Procedure (TCLP) and the Synthetic Precipitation Leaching Procedure (SPLP). But this stabilization process can increase leaching in "real-world" disposal environments when the acid from leaching tests is not present to moderate the pH of the treated matrix.

The chemical form of heavy metals in soils is an important consideration in determining the hazard to human health and the environment. Some chemical forms of some heavy metals are very toxic.

3.3.1 Theoretical Basis for Soil Stabilization

Stabilization of hazardous wastes was developed as a treatment alternative to conventional solidification processes. Common stabilization compounds include phosphates, sulfates, hydroxides, and carbonates. The theoretical basis for metals treatment using a stabilization approach can be explained by studying the solubility of the metals of concern as a function of pH.

Figure 3-1 shows the solubilities of various lead species versus pH, for a system containing sulfate, phosphate, carbonate, and hydroxide ions. At low values of pH, free lead ion and cationic hydroxide complexes are the predominant soluble species. In the mid-pH range (6–9), the solubility of lead reaches a minimum. At high pH (pH > 11), the solubilities of the tri- and tetrahydroxy complexes [$Pb(OH)_3^-$ and $Pb(OH)_4^{-2}$] govern the soluble lead concentration. Under both low-pH conditions (pH<4) and high-pH conditions (pH>11), lead may be soluble at environmentally significant concentrations.

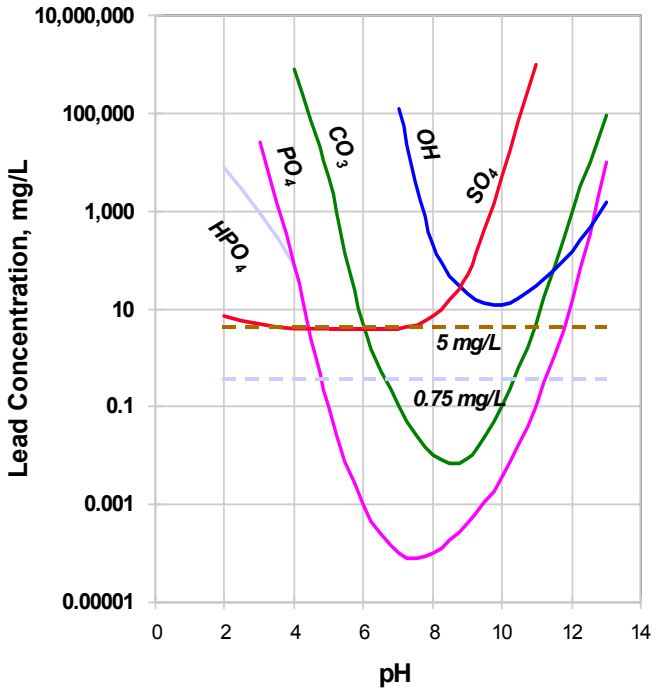

Figure 3-1. Solubility of Various Lead Compounds as a Function of pH

In regard to Figure 3-1, the concentrations associated with the horizontal dotted lines correspond to the current threshold toxicity characteristic concentration for lead (5.0 mg/L) and the universal treatment standard (UTS) for lead. Clearly, wastes treated with phosphate, and possibly carbonate and sulfate, can meet both of these criteria, although lead carbonates tend to form over long periods of time. The performance of either treatment system can be enhanced by including a buffering compound to maintain the pH of the treated waste in the range of 6 to 10. A buffering compound reduces the leachability of the lead immediately and also increases the waste's resistance to attacks by acids. For example, waste or soils buffered with as little as 1% magnesium oxide can theoretically resist leaching by acid rain for more than 1,000 years. This assumes an acid rain pH of 5, forty inches of rain per year, a waste depth of 10 feet, and a waste porosity of 30%.

Recent studies conducted by Ma, et al., funded by USEPA, have shown phosphate amendment to be a preferred method of stabilizing lead-impacted wastes. The results of leaching tests, electron microscopy, and various other investigations support this conclusion. Stabilization of wastes with the buffered phosphate system has been demonstrated to result in effective long-term treatment. USEPA's Multiple Extraction Procedure (MEP) has been used to test the long-term stability of treated wastes. The MEP, according to USEPA scientists, was designed to simulate 1,000 years of leaching with acid rain. It consists of an initial TCLP, with the leached solids being subjected to nine successive SPLPs. The TCLP lead in the untreated material was 50 mg/L, and the TCLP cadmium was initially 6 mg/L. Clearly, the leachability of the treated waste decreased with time.

Barring some environmental incident in which strong acid or alkali spills onto the treated material, future dissolution is highly unlikely. Furthermore, there is ample evidence that very stable lead phosphate compounds, specifically from the pyromorphite mineral group, form over time from the initial reaction products, such as amorphous lead phosphate and lead orthophosphate. Nriagu established the theoretical basis for this statement in his classic 1974 work.

3.3.2 Reducing Solubility through Soil Stabilization

Technologies are evaluated using only the Toxicity Characteristic Leaching Procedure (TCLP) or its predecessor, the EP toxicity test. The TCLP is designed to mimic conditions over an extended period in an actively decomposing municipal landfill, since the high-acid concentrations that can assault a waste over years are often not present immediately after disposal. The results of these tests are compared with the RCRA standards for characteristically hazardous material. When USEPA developed the Synthetic Precipitation Leaching Procedure (SPLP) and the Multiple Extraction Procedure (MEP), some regulatory bodies incorporated these tests as part of their evaluation regimen. The SPLP is designed to simulate 100 years of leaching with a worst-case acid rain containing nitric and sulfuric acids. The MEP, which consists of a TCLP followed by nine SPLPs, is designed to simulate 1,000 years of leaching. Many of those active in the remediation industry have felt that these tests, along with the TCLP, can more accurately predict immediate and long-term leaching behavior.

It is important to note that the TCLP solution contains about 1,000 times more acidity than the SPLP solution. Even though nitric and sulfuric acids used in the SPLP are “stronger” acids than acetic acid (the TCLP acid), strength refers only to the degree to which the acids are ionized. In a leaching test, the SPLP solution can be neutralized with milligram levels of alkalinity, whereas it takes several grams of alkalinity to neutralize the TCLP solution. So, even though the TCLP has flaws, it is a very rigorous test.

Sample quantities of soils should be obtained and tested at the bench scale to establish the proper mixing and mass of amendment required to stabilize the sample to pass previously described test(s). Results from these tests are transferred to the field scale, where climatic variables and heterogeneities of the soil are added to a field-scale test. Again, performance is based on the previously identified testing procedures.

Since the introduction of the TCLP, a variety of methods for stabilizing hazardous wastes have been commercially available. Some approaches simply use manipulation of the pH of the waste, so that the final pH in the TCLP will correspond to the minimum solubility conditions of the waste. Many solidification methods currently used for treating heavy metals, especially lead, involve mixing a high-pH, lime-based stabilization or solidification agent, such as Portland cement, cement kiln dust (CKD), or lime kiln dust (LKD) with the waste.

During the TCLP, the lime added to the waste neutralizes the TCLP’s acidic leaching solution, and the resulting pH limits leaching of lead in the test. However, this added lime could produce leachate having rather high pH (11–12) when the waste is contacted with groundwater,

precipitation, or surface water. Under such conditions, amphoteric metals, such as lead, can reach unacceptable concentrations in leachate, whether in laboratory water leaching tests or in the environment. Therefore, lime-based treatments may enable wastes to pass the regulatory TCLP requirement but can create severe environmental problems under actual leaching conditions.

Table 3-2 presents actual leaching data that demonstrate the increased leachability of lead from a waste treated with three different solidification/stabilization approaches. The benefit of using a TCLP and a SPLP to detect potential problems related to inappropriate treatments is apparent. All three treatments (buffered phosphate, lime, and Portland cement) are capable of rendering the waste nonhazardous with respect to the TCLP lead leaching. However, solidification with either lime or Portland cement (a lime-based material) substantially increases the leaching of lead in the SPLP. In other words, the alkaline materials used in the solidification process enable the waste to pass the TCLP but can actually create problems in a disposal situation where high concentrations of acid do not exist. Examples might be an industrial monofill, a municipal landfill with freshly disposed waste where the decomposition process has yet to start, or a natural setting such as a shooting range berm. It is possible that the high-pH levels being observed in several Subtitle D landfills (and concomitant aggravated leaching of metals) could have been caused by the practice of solidifying wastes with alkaline materials in order to pass the TCLP.

	TCLP (Acid)		TCLP Threshold (mg/L)	SPLP (Water)	
	Lead (mg/L)	Final pH		Lead (mg/L)	Final pH
Untreated	600	6.0	5.0	<0.003	8.2
Lime (Calcium Hydroxide) (% by weight)					
+5%	76	6.5	5.0	290	12.2
+10%	0.2	8.6	5.0	540	12.5
+15%	6.2	10.4	5.0	510	12.5
Portland Cement (% by weight)					
+5%	450	5.3	5.0	19	11.5
+15%	< 0.2	10.4	5.0	11	11.9
+25%	1.2	11.6	5.0	12	11.9
Buffered Phosphate (% by weight)					
+4%	2.4	5.8	5.0	<0.003	10.6
+6%	0.4	5.5	5.0	<0.003	10.3
+8%	< 0.2	5.6	5.0	<0.003	8.5
Note: All samples were crushed to pass a 9.5-mm sieve per the Method 1311 Toxicity Characteristic Leaching Procedure, 40 CFR, Part 261, Appendix II					

Table 3-2. Treatment of a TCLP-Hazardous Metal Processing Waste

3.3.3 Reducing Lead Bioavailability through Soil Stabilization

There are several approaches that can be used to immobilize lead in soil. In general, lead can be immobilized or made less bioavailable by reducing the solubility of Pb-bearing minerals through a change in pH, converting lead to a chemically more stable form, or solidification of the soil matrix. However, converting lead to a chemically more stable form appears to be the most effective way to reduce mobility and bioavailability in lead-contaminated soils. To accomplish this, lead-contaminated soil is treated with various types of amendments. These amendments are applied to the soil in a variety of ways, including wet or dry forms and *in situ* or *ex situ* applications. The reduction in solubility following the addition of amendments reduces the potential for leaching to groundwater and may result in a lower bioavailability.

The effectiveness of the immobilization process has generally been ascertained by two methods: sequential extraction and the physiologically based extraction test (PBET). The most common sequential extraction procedure assesses the exchangeable lead, lead carbonates, lead associated with Fe and Mn oxides, Pb associated with organic matter and sulfides, and residual lead (Rapin, et al., 1986). A shift in lead distribution toward the residual fraction is used to indicate immobilization after treatment with phosphates. The lead extracted in the PBET is indicative of that which is available for uptake through the gastrointestinal system (Ruby, et al., 1996).

Research studies have been conducted to investigate the effectiveness of adding amendments to stabilize lead-contaminated soil. Some of these research studies are summarized below.

- Preliminary results of a swine soil dosing study at the University of Missouri (Drs. Stan Casteel and Robert Blanchar, personal communications) and a Sprague-Dawley rat dosing study at the U.S. Department of Agriculture–Agricultural Research Service (USDA–ARS) (Dr. Sally Brown and Rufus Chaney, personal communications) indicate a significant reduction in soil Pb bioavailability as a result of adding phosphorus alone or in combination with FeOOH to lead-contaminated soil (total soil-Pb about 4000 mg/kg).

- Studies by the Remediation Technologies Development Forum's (RTDF) IINEERT Soil-Metals Action Team have shown that commercially available stabilization agents have been effective in reducing bioavailability by as much as 83% in lead-impacted soil.

- Soil-borne lead was converted to pyromorphite by evaluating the reaction of lead-contaminated soil with hydroxyapatite during sequential extraction (Ryan, et al., 2001). The results of the experiments indicated that the addition of hydroxyapatite caused a decrease in each of the first four (i.e., most soluble) fractions of sequential extractable lead and a 35% increase in recalcitrant extraction residue. A 240-day incubation at field moist conditions resulted in further increase in the recalcitrant extraction residue fraction to 45%.

- The transformation of soil-borne lead to pyromorphite by soil treatment with phosphoric acid on a smelter-contaminated urban residential soil was investigated (Yang, et al., 2001). The results indicated that increasing the amount of phosphoric acid and elevating the temperature significantly decreased bioaccessble lead by 60% using the PBET method.

- In a study by Sauve, et al. (1998), the solubility of lead phosphate in water and soil suspensions was addressed. The study also investigated the stability of lead phosphate mixed with soil to determine the pH-dependent solubility of lead in the presence of excess phosphate in soils. The study concluded that phosphate amendments and lime are effective ways to reduce the solubility, mobility, and bioavailability of lead, with the optimum pH to reduce solubility in the range of 5.5 to 6.5.

- Laperche, et al. (1997) investigated the effect of apatite amendments, specifically synthetic hydroxyapatite, on plant uptake from lead-contaminated soil. The results of the study, along with other previous studies, indicated that addition of phosphate to lead-contaminated soil could immobilize lead as an identifiable stable form such as pyromorphite. Also, the study showed that by amending synthetic hydroxyapatite and phosphate rock to lead-contaminated soil, bioavailability (as indicated by plant uptake) can be reduced.

- Lead-contaminated soil was amended with triple super phosphate (TSP), rock phosphate, or manganese oxide (cryptomelane) (Ganga, et al., 2000). The addition of a combination of a phosphate source and the Mn oxide resulted in lower bioavailability (23%–67% reduction) as measured with the PBET test than with either amendment alone (14%–41% reduction).

3.4 Chemical Extraction

Chemical treatment is a proven technology when combined with a physical treatment/soil-washing approach. It involves introducing a leachant (for lead, this is generally a strong acid) into the water used in a physical separation or into a soil-washing process to promote the dissolution of residual metals into solution after particulate metal removal. While weak acid (acetic) has been used in the field, the nuisance odors and relative low strength limit its efficiency. As such, hydrochloric acid is most often used for chemical leaching. Acid addition aims to solubilize metals from the soil by changing the pH. Adding acid lowers the pH and increases the supply of H^+ ions. The H^+ ions generated are consumed in a multitude of reactions that increase soluble metal concentrations.

Chemical treatment is a continuous process with the following steps:

- Bringing acid and soil into contact in a leach tank
- Separating the leached soil from spent leachant
- Regenerating the spent leachant by precipitating the dissolved metals

Once in solution, the dissolved metals are recovered through a co-precipitation step involving the addition of a polymer to adjust pH. The settled soil fines go through a series of rinse and dewatering steps for reuse on the site, while the settled precipitants are dewatered for subsequent recycling with the recovered particulate metals.

Equipment additions to the base soil-washing plant include acid storage tanks, dispensing pumps, and pH meters, as well as systems for recovering metals from solution and dewatering/ discharging recovered metals (precipitant).

Two important range soil material characteristics for designing an appropriate separation/ leaching scheme are the particle sizes of the material and the metals distribution by fraction. Other than the mechanical aspects of treatment, clay soils tend to bind metals better than sandy soils and tend to be more difficult to treat. These limitations are discussed in more detail in Section 5.5.

3.5 Asphalt Emulsion Batching–Encapsulation

Tall oil pitch and asphalt-based emulsions have been used extensively in the commercial construction industry to stabilize soils for dust control, thereby minimizing their mechanical migration through wind or water erosion. These same emulsions have been modified (and the modifications patented) to encapsulate heavy metals (such as lead, uranium, arsenic, and chromium), rendering them resistant to leaching to groundwater and creating a material that reduces infiltration and is resistant to wind and water erosive forces. Chemical theory indicates the technology would also work on heavy organics (PCBs, DDT, etc.).

In July 2000, USEPA issued a determination that use of encapsulation technologies qualifies as recycling for RCRA characteristic wastes, in that permanent chemical bonding is achieved in a commercially useable end product. Treated soils exhibit increased soil strength and can be used as an asphalt base material. The technology is especially applicable for military ranges (lead and DU contamination), military base reuse sites (where treated soils can be used to construct new roads), and other applications. The emulsions can be mixed into the soil and/or applied topically.

The objective of the technology is to provide permanent encapsulation of contaminated soils, where the resultant treated soil exhibits reduced leachability of the contaminant, reduced permeability of the soil surface, and increased soil strength to withstand wind and water erosion. In most cases, the end product can be used as a nonhazardous construction material, road base, or structural fills. On military firing ranges, the soil can be topically treated or, in the absence of UXO, mixed and compacted. Resultant compacted treated soils typically exhibit high strength and low permeability characteristics.

The objective of site-specific demonstration testing would be to refine emulsion designs for specific application sites, evaluate and compare application methods, and implement rigorous postapplication monitoring to evaluate key performance data. Proposed testing would also evaluate the technology's efficacy on residual explosives in soil.

This patented technology includes improvements over other stabilization technologies. Most previous stabilization technologies do not exhibit "permanent" treatment and are subject to loss of effectiveness under changing physical or chemical (pH) conditions. Additionally, most stabilization technologies do not work well on a range of inorganic and organic contaminants.

The use of specially modified organic emulsions has proven effective as permanent treatment on lead-contaminated soils in full-scale implementation and on depleted uranium, arsenic, and chromium in laboratory treatability tests. The technology has been used to improve road foundation soils at Ft. Hunter Liggett and to treat lead-affected soils for a Caltrans highway project in Richmond, Calif. Once soil-specific emulsion design testing is completed, implementation of this technology in the field can be done with normal road construction equipment and crews.

Laboratory testing for the U.S. Army indicates that the technology is extremely effective at stabilizing depleted uranium from munitions. Full-scale field testing is proposed to compare field application techniques and evaluate its performance in the presence of possible unexploded ordnance. Additional testing also indicates a high potential for success in stabilizing residual uranium daughter products (cesium) from atomic weapons testing.

3.6 Phytoextraction and Stabilization Approaches

While phytoextraction is proven to remove lead from soils, the relatively high levels of lead at SAFRs and the time required for effective phytoextraction render this technique impractical as a range remediation tool. However, other phytoremediation techniques such as phytostabilization and use of constructed wetlands can complement the overall remedial approach and prevent migration of lead particulates through prevention of erosion and storm water management, respectively.

In-place inactivation has been recently coined to describe this process of chemically and physically inactivating contaminants, both in soil and other materials found at the earth's surface. Other names for this strategy include *phytostabilization*, *agronomic stabilization*, and *phytorestoration*. In this process, no actual reduction in pollutant concentration occurs. The risk reduction is provided by chemical and physical processes that allow the soil to remain in place. Chemicals and materials that appear to be most promising for in-place inactivation include phosphates, mineral fertilizers, iron oxyhydroxides, other minerals, biosolids, and limestone. Conversion of Pb to less toxic forms has been demonstrated in soils amended with safe additives using common agricultural techniques.

To complement the use of soil amendments, a rich plant growth in treated areas will help hold soil in place by preventing erosion, reducing rain impact, and providing an effective barrier against direct contact with soil. In some cases, plant roots may absorb contaminants to further prevent off-site migration or leaching. Incorporating soil amendments and growing plants using existing agronomic techniques are more natural ways of restoring the ecology of soil in comparison to many other remediation technologies. Importantly, this agriculturally based technique should be less likely to impair the soil's potential for sustaining plant growth after treatment and be relatively environmentally benign when compared to many conventional remediation practices

Please refer to www.itrcweb.org for technical and regulatory requirements for phytotechnologies.

4.0 REGULATORY REQUIREMENTS, BARRIERS, AND FLEXIBILITIES

Remediation of shooting ranges is an increasing concern for both owners/operators of closed ranges and environmental regulators. It has become evident that lead management practices are inconsistent, and owners/operators of closed ranges are often unaware of the appropriate path forward. While understanding the regulatory flexibilities is imperative to range cleanup, it is also important to understand the regulatory barriers. Of particular note is the need to understand both the state and federal regulatory requirements. The sections below outline the regulatory requirements that should be considered during the cleanup of small arms firing ranges.

4.1 Classification of Spent Ammunition

A key issue to be resolved is whether spent ammunition is classified as a solid waste or a contaminant. Partially for this reason, no state or federal laws or regulations exist that set specific environmental standards for operation of firing ranges. For instance, the Clean Air Act under Section 112(b) 3 (7) excludes elemental lead as a hazardous air pollutant. Furthermore, under CERCLA, releases of lead particles with a mean diameter of over 100 microns are exempted from being reported. If the site is not listed on the National Priorities List under Superfund, state equivalents of the Clean Water Act or the Solid Waste Disposal Act are the most likely vehicles for development of comprehensive environmental standards at shooting ranges.

USEPA has defined "scrap metal" as "bits and pieces of metal parts or pieces that may be combined together with bolt or soldering, which when worn can be recycled" (40 C.F.R. 261.1). Since lead shot is a product made of recyclable metal, it falls within the definition of scrap metal. In accordance with 40 CFR 261.6(a)(3)(ii), scrap metal is a solid waste but is exempt from the regulatory requirements of RCRA Subpart C. Additionally, as outlined in the Federal Register (62 Federal Register 25998, May 12, 1997), processed scrap metal is exempted from RCRA regulation (i.e., is not a RCRA solid waste) when it is being recycled (40 CFR 261.4(a)(13). Therefore, as long as the selected remediation technology (e.g., soil washing) meets the definition of processed scrap metal, the technology is exempt from regulation under RCRA.

4.2 Federal Regulations and Guidance

The management of soil from shooting ranges is evolving and likely will continue to do so. The current management of active shooting ranges is being shaped primarily by two lawsuits: *Connecticut Coastal Fisherman's Assoc. v. Remington Arms Co*., 989 F.2d 1305 (2d Cir.1993); and *Long Island Soundkeeper Fund v. New York Athletic Club,* 1996 WL 131863 (S.D.N.Y.). USEPA published the RCRA Subtitle C Military Munitions Rule (MMR) in the Federal Register (62 Fed Reg. 6621). USEPA has also published a guidance document entitled *Best Management Practices for Lead at Outdoor Shooting Ranges*. The subsequent resolution of these suits and their associated range cleanups prompted USEPA to develop its guidance document. Part of the impetus to develop this guidance was the realization that, because of its relative high volume and

low risk, the management of shooting range soil may benefit from approaches that differed from those typically used at normally encountered hazardous waste-type facilities.
The management of closed military ranges is being shaped by the RCRA Subtitle C Military Munitions Rule (MMR). It was then adopted in September 1998 (40 CFR 266 Subpart M). However, the MMR is incomplete in that a large section, the "Range Rule," was never completed. USEPA is moving forward to complete that section, but it is unknown when it will be finalized.

Though originally intended to apply to federal facilities, USEPA has taken the position that the MMR also applies to nonmilitary ranges. The MMR excludes munitions used for their intended purposes from the definition of a solid waste and, therefore, excludes munitions from regulation as a hazardous waste. This exclusion applies to training, research, development, recovery, collection, and on-range destruction of unexploded ordnance (UXO). The Military Munitions Rule considers range management to be a necessary part of the safe use of munitions for their intended purpose. The exclusion for range clearance applies to the separation of lead and bullets from soil and the redeposition of soil on the range.

If spent lead at a shooting range is abandoned (or is determined to be abandoned), it then becomes solid waste. If the solid waste accumulates on ground surface and, therefore, causes lead leaching, it may be considered a hazardous waste. At that point, the lead contamination could be subject to RCRA Subtitle C.

States adopting this rule may set more stringent requirements for determining when military munitions are solid waste; or using this rule as a precedent, state agencies may elect to implement a regulatory scheme that is protective without requiring a full RCRA permit. The rule does not exempt ranges from Clean Water Act requirements.

4.3 State Regulations and Guidance

Storm water collected and conveyed in ditches or pipes prior to discharge is potentially subject to permit requirements. Some shooting ranges may operate without discernable conveyances; however, contaminated leachate from these ranges could be considered a nonpoint source as it moves laterally into surface waters. Some states, like Florida, are recommending that small arms firing ranges develop and implement a site-specific best management practice (BMP) instead of developing rules for small arms firing ranges. The main goal of the BMP is to have a good storm water management plan that includes routine maintenance to minimize off-site migration of lead and other contaminants. The key components include

- monitoring and adjusting pH in soils,
- controlling and containing lead bullet fragments,
- controlling storm water runoff,
- bullet containment devices,
- removing and recycling lead,
- using alternate ammunition (lead shot alternatives),
- minimizing shooting area (reducing shotfall zone),
- documenting activities and keeping records, and

- determining the frequency of lead removal and pH adjustment in soils.

While the consensus to date has been that shooting ranges should not be subject to hazardous waste regulations, some states have authority to regulate any discharge from a facility with the potential to contaminate groundwater. For example, Florida has unique geology and relies heavily upon groundwater as a source of drinking water, which needs to be considered when evaluating potential contamination from shooting ranges. This consideration is in addition to the widely accepted guideline that lead shot and bullets should not be deposited in surface water or wetlands. A public shooting range in Naperville, Illinois became the first site for which a state agency issued a NPDES permit for a shooting range discharging to a wetland.

In Florida, an "installation" is defined as "any structure, equipment, facility, or appurtenances thereto, or operation which may emit air or water contaminants in quantities prohibited by the Department of Environmental Protection [DEP]." Specific types of "installations" such as landfills and wastewater treatment plants may be further defined as "stationary installations." State environmental agencies may, therefore, claim authority to require permits prior to construction of new shooting ranges based upon several issues:

- Shooting ranges are both "installations" and "stationary installations."
- Shooting ranges are known to discharge pollutants into the environment.
- Several shooting ranges in Florida have violated state groundwater and surface water protection requirements.
- Several shooting ranges have degraded wetlands and caused harm to wildlife.

Other states have similar antidegradation policies and laws. In general terms, these laws prohibit the discharge of contaminants into the environment without permit(s) from the state environmental agency. This policy applies to releases to the soil, groundwater, surface water, and air. State and local agencies may have permitting requirements or remedial performance standards in addition to, or more stringent than, federal requirements (e.g., strict cleanup standards, transportation permits, permits for working near wetlands, etc.).

4.4 Remediation/Future Use Issues

Some state agencies are informally collecting information on the location of outdoor shooting ranges. Owners of closed ranges should be required to notify state agencies if they become aware of soils on site that are present in amounts that pose a risk based on current or reasonably anticipated future land use or if exceedances of groundwater quality standards are detected.

For closed shooting ranges, policy should be developed in the following areas:

- How will the agency locate operating and closed shooting ranges?
- Will the state require all closed ranges to conduct site cleanups? If not, will they be required to do so under new ownership or land use?
- What mechanism will be used to require cleanups?
- Will self-certification be accepted? How will it be verified?
- What state agency program will have primary responsibility to oversee cleanups?

"The City of Tampa and the Hillsborough County School Board worked with the [FDEP] District [office] to remediate a pistol range site in order to build a new school. Because of liability concerns, the Board needed assurance that the site was safe for residential use before they would accept the property. However, at the same time, the owner of a private shotgun range in Hillsborough County declared his property 'clean' by using a limited biased sampling plan and sold the property for residential development. The owner's consultant took 20 soil samples from 1 to 2 feet below land surface throughout the range, rather than 0 to 2 feet, thus excluding the most suspect soils from his samples. Conversations with management at [the land developer] confirmed that they were aware that the property had been used as a range and that no soils were removed prior to development. Management said that a large amount of fill was brought in to raise the grade of the residential lots. However, these lots will be sold to unsuspecting homeowners who will not know that their property may be lead-contaminated. There is no assurance that contaminated soil will not be excavated, as for a swimming pool installation, and then disposed elsewhere on the surface."

This scenario, in which "capping" was the selected remedial alternative, presents an example of why state environmental regulators need to become involved early in the process and why future land use considerations are important factors when crafting appropriate and enforceable deed restrictions.

4.5 Lead Recycling

During remediation activities, recovery of bullets and bullet fragments from firing range sands or soils via physical treatment constitutes "reclamation" per 40 CFR 261.1(c)(4). Metal concentrates reclaimed from firing range berms via size classification and density concentration contain more than 50% lead on a dry weight basis. The other metals included in the concentrate are predominantly copper and antimony. The concentrate reclaimed from the firing range material is "scrap metal" per 40 CFR 261.1(c)(6).

However, scrap metal is not regulated as solid waste or as hazardous waste when recycled. Under 40 CFR 261.6(a)(3)(ii), recycled scrap metal is classified as a "recyclable material" that is not subject to the requirements for generators, transporters, and storage facilities of hazardous wastes specified in paragraphs (b) and (c) of 40 CFR 261.6. Therefore, the scrap metal reclaimed from the firing range sand, or soil, does not need to be regulated or manifested as a hazardous waste during generation or transport to a smelter for recycling.

When scrap metals reclaimed from remediation activities are recycled using a smelter, the generator is paid for the value of the reclaimed metals minus any smelter handling fees. All material recovered should be shipped under bills of lading for recycling. Some of the recycling processes automatically bag all recovered metals in DOT-compliant super sacks, which are palletized for ease of handling and shipment.

4.6 Live Rounds/UXO

A potential hazard at Department of Defense small arms firing ranges is "live rounds," referred to as unexploded ordinance, or UXO, from nearby previously conducted large arms range activities. Additionally, all small arms firing ranges may contain live small arms rounds. Quite often these items are overlooked in treatability testing or site characterization. Both are addressed in more detail below.

UXO

UXO presents significant safety hazards in the form of unintended or spontaneous detonation, as well as a potential contaminant source through the dispersion of propellants and explosives through cracked casings and/or low order detonation. These issues are addressed by the ITRC UXO Team and their related guidance documents.

The intent of this section is to emphasize that while the focus of this document is dealing with small arms firing ranges, experience has shown that unexpected UXO is occasionally present even if there are no historic records indicating large arms use or storage at the site. If physical evidence or historical records indicate the presence of UXO, an appropriate response should be conducted by an explosives or munitions response specialist prior to conducting any required intrusive activities at a closed range. If UXO is present, a second sweep/clearance should be performed in the feed pile just prior to treatment. The process plant operators should also be trained in UXO recognition, with appropriate shutdown and notification procedures in place in the unlikely event UXO makes its way into the treatment plant.

Small Arms Rounds

Experience has also shown that hundreds of pounds of live small arms rounds, along with "duds," end up in range soil as they are recovered during range soil processing operations. The wet screening and water-based density separation process (soil washing) is well suited to deal with these issues, as all operations are under water in steel tanks, and the density separation step isolates the live rounds for recovery and subsequent destruction as part of the process.

Once removed and containerized, live rounds are typically classified as ORM-D materials for shipping to a DoD-approved facility for subsequent destruction. For bases with an active Explosives Ordnance Disposal (EOD) group, the ORM-D materials could be transferred to the base EOD group for ultimate disposition.

4.7 Soil Recycling

Under current regulations, waste that is recycled and "used in a manner constituting disposal" is exempt from RCRA regulation if the resulting product is produced for the general public's use, contains recyclable materials that have undergone a chemical reaction so as to become inseparable by physical means, and meets Land Disposal Restriction (LDR) treatment standards (see 40 CFR 266.20 (b)).

USEPA has recognized a process utilizing asphaltic and/or plant-based organic emulsions, modified with proprietary and patented chemical formulations, to enhance the structural characteristics of contaminated soil and to chemically fixate hydrocarbon and metal contaminants found therein. The resulting product meets structural specifications for commercial granular and asphaltic road base materials.

This recycling process for RCRA waste satisfies the criteria set forth in 40 CFR 266.20 (b):

- The resulting product meets engineering and regulatory standards for commercial roadway construction materials. The process was recently used on a California State Highway project involving "Cal-Only" waste material. Thus, it is produced for public use as a construction product.
- The resulting product uses the contaminated soil as a necessary and integral part of the finished structural material. The process produces chemical fixation or stabilization of the waste material. Further, waste-derived cement and asphalt products were deemed to have satisfied the "chemical reaction" requirement when the final rule was issued in 1985 (see, Federal Register, Vol. 50, No. 3, p. 646).

To be allowed under 40 CFR 266.20(b), the resulting product must satisfy the LDR treatment standards pursuant to the appropriate test procedure. The resulting product has been proven to pass these tests.

4.8 Transporting or Relocating Range Soil for Reuse as a Backstop on Range Property

At some ranges, it may be possible and desirable to reuse the soil from the backstop of a range that is being closed to construct a new berm or rebuild an existing berm located in another area of the same property or facility. It is USEPA's position that ranges that reclaim and recycle lead bullets or lead shot may place the soil that is generated during the reclamation process back onto an active range on the same property or facility or a property adjacent to and under the same ownership as the property where the soils originated, without testing the soil for hazardous waste characteristics. In many situations, range soil has proven to be high volume but relatively low risk.

Consistent with this approach, range soil that has been processed to reclaim lead for recycling is considered a construction material if it is used to construct or rebuild a backstop on the same site. Defining the "site" in such a manner to allow the soil to be reused to construct another shooting range component on the same range property or on an adjacent range property, under the same ownership and control as the property where the material originated, is an option that deserves consideration. Range soil includes soil from a former backstop or from other parts of the range. As a construction material, range soil after reclamation is not considered as either a solid or hazardous waste.

If there is a need for backstop construction material elsewhere on the property at which a range is being closed, then the option of reusing the range soils after reclamation should be considered. The potential environmental benefits of this approach include reusing a "manmade structure," i.e., berm, in a manner that is consistent with reusing other construction material; avoiding use of

new soil on a new or existing backstop, thus preventing the new soil's ultimate future contamination from small arms ammunition; consolidating several berms containing contaminated material into fewer berms; and avoiding costs associated with testing and disposing of the soils from the former backstop as hazardous waste. Reusing this material is also consistent with the trend to look for creative ways to recycle and reuse material rather than disposing of it. The cost of the reclamation process is a function of the time, labor, equipment used to segregate the lead bullet fragments or shot from the former backstop, and transportation to a recycling facility/smelter. These costs are offset to some extent (depending on the amount of lead that has accumulated in the backstop and the efficiency of the reclamation process) by the price received from the scrap metal recycler/smelter for the recovered lead. In addition, there is a cost savings related to the construction material for the new or rebuilt backstop.

It is important to note that lead reclamation and recycling is required for the soil to be considered a construction material. If lead reclamation is not conducted prior to moving the backstop, then pursuant to RCRA, the movement of the backstop may be considered illegal disposal of hazardous waste.

It has been suggested that range soil from a former backstop may also be reused, following lead reclamation, for constructing or rebuilding a backstop at a location that is not on the range property. The same environmental benefits mentioned above could be realized, but extra oversight may be needed. Since individual states may not permit this action, or may impose additional requirements for transportation, documentation, and approvals, state regulators should be consulted prior to transporting range soils to a property that is not the same as or adjacent to and under the same ownership as the property where the soils originated.

Finally, once range soils have been removed and relocated for use in a backstop at another range, assessment of the area under and surrounding the former backstop should be conducted as part of the site characterization as described elsewhere in this document.

4.9 Disposal of Range Soil

Disposal of soil containing a hazardous waste is addressed by USEPA's "contained-in" policy. Under this policy, soil can be classified as either hazardous (listed or characteristic) or nonhazardous, based on key parameters. For range soils, the relevant parameter is toxicity. The soil that is removed from a closed range for treatment or disposal may be considered to contain hazardous waste and classified as "characteristically hazardous" if it exhibits the characteristics of toxicity.

However, the soil can be considered to no longer contain a hazardous waste through removal of the live rounds and particulate lead, with residual stabilization, if required, to meet the regulatory TCLP level of 5 mg/l. Once the soil is viewed as not containing lead, the soil may be able to be disposed of at a Subtitle D (nonhazardous) facility. Any applicable land disposal restrictions should be consulted. It should be noted that individual states may not utilize the contained-in policy (and, thus, these soils would be regulated under RCRA) or may have additional, more stringent disposal requirements.

5.0 TECHNOLOGIES AND TECHNICAL CONCERNS

For DoD, small arms firing ranges may present significant environmental concerns because the soil on a closed range contains lead. The soils on a closed range may exceed hazardous waste criteria and require either treatment or removal. The approach outlined herein uses soil washing as the first step to remove particulate metals. In many documented cases, this step alone has been sufficient to render the soils nontoxic and suitable for reuse. If treated soils do not meet reuse criteria after soil washing, then additional treatment can be selectively performed on only those fractions that caused the soil matrix to fail.

5.1 Treatability Study

A treatability study using representative site soils is imperative to determine appropriate treatment methods at any site, as well as to predict actual scaleup and field performance of the selected approach. Experience has shown that firing range soils vary significantly from site to site and even at different locations within a given site. Variations in soil that affect treatment procedures include grain-size distribution, clay content, physical characteristics, mineralogy, aggregate hardness, soil pH, and the form and distribution of contaminants.

Samples collected for treatability testing must be representative of the anticipated soils for treatment. A compositing approach as described in Appendix B is useful for range floors and lateral berms where the depth of contaminants is relatively shallow. For the primary berm, face trenching is often a preferred approach, as it allows for visual inspection of the berm cross section to help determine if additional soil was added or if the berm face was "turned over" as part of maintenance and, thus, indicates the potential depth for ultimate remediation.

In the case of test trenches, grab samples should be collected from the trench walls and floor at different depth intervals through the cross section, allowing equal contribution from each grab sample collected. These grab samples are then composited in a cement mixer, and a representative sample is drawn for subsequent treatability testing. A five-gallon sample is typically the minimum size required for testing, but one should confirm with one's proposed treatability lab prior to collecting samples.

The initial step of the treatability study should include a step-wise evaluation of density separation for particulate metals consisting of

- grain-size analysis/containment by fraction,
- contaminant removal by size segregation and gravimetric techniques,
- oversize fragment removal by size segregation and screening, and
- post-treatment and TCLP metal results for each individual size fraction.

The treatability study will focus first on material characterization of the sample, followed by optimizing treatment of specific fractions using physical treatment methods. Recoverable quantities of metals will be estimated in the treatability study to quantify the amount requiring recycling.

Density separation/soil-washing techniques evaluated during this treatability study should include the following:

- deagglomeration steps to separate sod/vegetative material from soil fractions,
- physical treatment employing a wet screen for particulate partitioning, and
- density treatment to further separate geologic material from same-sized metal particulates.

Results of the treatability study will reveal the appropriate treatment approach for implementing the full-scale remediation. In the event site cleanup goals are not met after initial particulate lead removal, fractions failing cleanup goals should undergo further treatment to supplement the initial soil-washing process. Further treatment may include

- stabilization,
- chemical treatment,
- emulsion stabilization of both organic and residual metal compounds, or
- phytoremediation.

Only the soil fraction(s) failing reuse criteria need to undergo these additional treatment steps. This approach yields cost savings through volume reduction, as soil washing generally partitions sorbed organic and metal contaminants into the finer soil fractions while rendering sand and coarser fractions suitable for reuse after particulate removal. Results of the treatability study dictate the appropriate treatment approach for implementing the full-scale remediation. Treatment effectiveness and implementability are presented in the treatability study report. The report also includes the most appropriate means of handling the recovered metal. A sample scoping document for treatability testing is included as Appendix C.

5.2 Data Needs

For any remedy to be effective, accurate soil information must be available prior to process selection. Factors that influence performance include but are not limited to

- grain-size distribution,
- organic content (humates),
- contaminant form and distribution,
- clay content/ plasticity,
- mineralogy,
- soil pH,
- aggregate hardness,
- type and level of use of the range in question,
- past range use and maintenance records, and
- climatology records.

This information is best collected through a review of historical records and any existing soil characterization, supplemented by a treatability study and additional characterization as deemed necessary to fill data gaps.

5.3 Soil Washing

Soil washing is a source removal technology that physically separates particulate metals from the soil matrix and refines them such that they have a commercial salvage value. The system treats SAFR soils by removing spent bullets and bullet fragments from the soil through a physical solids-separation technology and then treating the remaining soil, if required, with the appropriate secondary treatment approach.

In addition to metal recovery, soil washing can segregate a soil fraction that is ideal for use as ballistic-grade sand in berm reconstruction. By using ballistic sand that is free of stones, sticks, and excessive fines, bullet fragmentation is eliminated, and simple sifting is sufficient for subsequent maintenance activities. For closed ranges, the treated soil is suitable for reuse, thereby eliminating the need to purchase replacement soil for site restoration.

5.3.1 Treatment Efficiency

The efficiency of the technology is measured by the average total lead concentration in the feed soil compared to the average total lead concentration of the treated soil stockpile. For example, if 21 tons of metal is recovered via physical treatment and 84%, or 17.64 tons, was determined to be lead, the balance of the metal recovered for recycling would typically consist of copper, zinc, and antimony. Again, assuming that approximately 3,600 tons of range soil was processed, dividing 17.64 tons of lead by the total amount of material processed (3,600 tons) results in the average percentage of particulate lead for the feed soil of .49%. On an mg/kg basis, .49% is equivalent to 4,900 mg/kg, thus the feed soil contained an average particulate total lead concentration of 4,900 mg/kg. Adding the particulate lead concentration (4,900 mg/kg) and the residual total lead concentration in the treated soil (assume 300 mg/kg) results in the feed soil containing an average total lead concentration of 5,200 mg/kg.

Physical treatment would have reduced total lead levels in the soil from an average of 5,200 mg/kg to an average of 300 mg/kg, a lead reduction efficiency of almost 95%. These numbers are typical for this type of treatment arrangement and were taken from actual case studies. This technology has also been successfully used in soils with feed soil levels as high as 40% lead.

5.3.2 Technology Acceptance

Acceptance of the soil-washing technology has been very positive. This positive response is related to key elements in the application of this technology, as seen by the regulatory community, the client, and the general public.

Heavy-metal complexing agents are commonly used to stabilize soil contaminated with lead. With this approach, the complexing agents do not reduce total lead concentrations, and the stabilized soil is often shipped to a landfill for indefinite storage although on-site reuse is acceptable with some stabilization technologies. The overall benefit of the stabilization approach is that the soil can be shipped to a nonhazardous landfill with lower tipping fees than a landfill designed to receive hazardous waste.

With soil washing, lead contamination at small arms firing ranges can be dramatically reduced using physical treatment only, without the use of other expensive and long-term treatment technology. Also, case study work by the Army Environmental Center has shown that continued firing into berms that have been chemically stabilized with certain chemical agents can actually worsen the lead mobility issues. This is not necessarily a stabilization agent problem but rather a design problem. (MFW-3)

Of particular interest to the Department of Defense is the effectiveness of the technology for remediating soils at small arms firing ranges. Soil washing offers site closure or reuse within a very short time frame, without long-term environmental monitoring. This approach has the added benefit of recycling all of the reclaimed particulate lead. Thus, the client also gains a proactive public image with respect to resource recycling.

5.3.3 Public Acceptance

During a technology demonstration at Fort Dix, N.J., the general public perceived soil washing positively. Physical treatment of small arms firing ranges is a very effective pollution prevention measure. The dramatic reduction in total lead concentrations with physical treatment using water only and recycling the lead reclaimed from the soil was instrumental in generating this positive public image. The technology demonstration illustrated that effective soil treatment can be performed without relying on stabilizing the contaminants and landfilling the soil.

In addition, at one site standard control measures were successfully used to avoid generating excessive noise at the work site. The work site was maintained in an orderly fashion from site mobilization through processing and demobilization. Demonstrating the minimal aesthetic impact of this process is critical in gaining public acceptance for on-site treatment of contaminated sites in the vicinity of residential areas or within the boundaries of military facilities.

The general public is concerned with the following issues:

- The clean portion of separated soil must be analyzed for residual contamination before it is used as clean material. Sites using soil washing should have on-site capability to test samples of treated soil before it is released as clean.
- Soil contaminated with both metals and organic compounds make formulating a single suitable washing solution difficult. Sequential washing using different wash formulations may be required. Soil-washing processes for soil contaminated with volatile organic compounds (VOCs) may require emission controls.
- Wash water containing inorganics may require treatment before it can be discharged, as it is usually not completely free of smaller inorganic particles.
- Measures should be taken to prevent wind-borne particulates if dry screening is a step in the process.

5.3.4 Full-Scale Soil-Washing Costs

Treatment of small arms firing ranges utilizing soil-washing technology fits a mining-type economic model based on mass production. The volume of soil is the driving force behind treatment costs on a per-ton basis. Typical of a mass production model, cost elements such as mobilization/demobilization, labor, and capital outlay decrease with increased quantity in a nonlinear fashion on a per-ton basis.

Small arms firing ranges are highly variable with respect to soil and contaminant characteristics. Treatment goals and the quantity of soil requiring treatment are highly variable as well. A number of variables impact treatment costs when considering this technology for full-scale implementation at small arms firing ranges:

- mass of soil to be processed
- cleanup standards
- soil characterization (grain-size distribution and chemistry, including contaminant by fraction analysis
- site assessment risks
- split- or single-operations site
- throughput rate required
- weather conditions/time of year to operate
- level of personal protection equipment (PPE) required
- availability and cost of utilities
- sampling and sample preparation

Although sand, silt, and clay are the predominant soil matrices used in berm construction, one type of treatment process cannot be universally applied to all small arms firing ranges. The ideal treatment plant approach is to utilize unit components predetermined by the bench-scale treatability study as required for insertion in the overall treatment process. The typical price range for pile-to-pile processing varies from $30/ton to $80/ton, based on site-specific conditions/ requirements, as outlined in Table 5-1.

Option	Cost	Long-Term Liability	Land Use Restrictions	Perception Factor
Soil Washing	**$$$**	**L**	**R**	**Excellent**
• **Asphalt Batch**	**$**	**L**	**R**	**Good**
• **Chemical Extraction**	**$$**	**L**	**R**	**Fair**
Construction Material	**$**	**LL**	**RR**	**Fair**
Hazardous Disposal	**$$$$$**	**LLLLL**	**RRRRR**	**Poor**
Nonhazardous Disposal	**$$**	**LLLL**	**RRRR**	**Fair**
• **Stabilization**	**$$**	**LLLL**	**RRRR**	**Good**
• **Solidification**	**$$**	**LLLL**	**RRRR**	**Poor**

Table 5-1. Comparison of Various Types of Metals Remediation Technologies

Using this technology, soils can be treated and replaced on site, while recovered metals can be recycled. Recovered metals can be shipped as recyclable materials under bills of lading. Thus, no hazardous wastes are generated or shipped as a result of this process.

Public acceptance of this technology is high because it meets regulatory requirements without landfilling any contaminated soils and it reclaims hazardous contaminants for recycling in the process. In addition, because contaminants are removed and not just shifted to a landfill, potential long-term risks to human health and the environment are eliminated. These advantages must be balanced against the need to smelt the lead, which results in the generation of air containing solids and water, which may contain contaminants. The demonstration has shown that this technology can be implemented with minimal environmental or aesthetic impact to the processing area.

5.3.5 Recommendations for Future Applications

Based on the results and implementation of the treatability study findings for the design of the soil-washing plant, it is strongly recommended that every soil-washing solicitation include a vendor-conducted, bench-scale treatability study for effective costing and plant design. The bench-scale treatability study represents an effective method for fully defining a remediation problem, associated treatment parameters, and plant design.

Establishing physical treatment operations within the confines of the small arms firing range is ideal. Locating the treatment plant in the range facilitates the timely excavation and haulage of

soils destined for treatment, as well as the return and placement of the treated soil. When fieldwork is confined to one location, the project is more efficient and overall project costs are reduced.

5.4 Soil Stabilization

Prior to stabilizing soil, a bench-scale treatability study is typically performed to determine a dose rate and reagent mixture that successfully meets the performance standards. Representative samples of the waste material are obtained and characterized prior to trying potential technologies. The mix design includes the type of reagent to be used and the appropriate rate of addition. The treatability study should be formatted to address pertinent regulatory concerns and long-term liability issues.

Stabilization at firing ranges is performed either *in situ* or *ex situ*, often depending on the regulatory program under which the work is performed. *In situ* stabilization can be used to avoid regulatory approvals needed to treat hazardous waste by treating prior to the point of generation for the waste. In the case of soil, this is when the soil is excavated and "managed" or when it is moved from an area of concern (AoC).

In situ treatment can be performed in a variety of ways. Typical *in situ* methods include mixing with standard earth-moving equipment, such as a tracked excavator, a clam shell, or an end loader; mixing with agricultural equipment, such as tillers and discs, when the contamination is surficial; mixing with vertical augers; and injection grouting. With all of these methods, the stabilization reagent is typically added to the surface of the soil to be treated and blended or mixed into the soil with one of the above methods.

Ex situ methods are similar to *in situ* methods except that the soil is usually stockpiled prior to treatment. *Ex situ* methods also include the use of pug mills and specialized mixing equipment, such as road reclaimers. In most cases, *ex situ* treatment can be performed at a higher rate (tons per day) than *in situ* treatment. With either method, the goal is to create a homogeneous mix between the impacted soil and the stabilization agent.

Post-treatment performance verification testing will depend on the regulatory program. At a minimum, testing will include analyzing for TCLP-lead (and other metals present). Common testing frequencies vary from one for every 250 cubic yards of soil, to one for every 500 cubic yards. Optimally, the sampling frequency is based on the daily throughput of the operation of selected technologies. In addition, SPLP and other leaching tests should be performed based on the specific regulatory program. Following stabilization, samples for total metals analysis are collected to provide verification that the site-specific remediation goals are met.

5.4.1 Costs/Benefits of Stabilization

When comparing stabilization with other firing range remediation methods, several factors need to be considered:

- What is the long-term use of the firing range?

- Is cost-effective landfill space available?
- Can stabilized soil be disposed on site in an area that could be managed to prevent human contact with the material?

As described in previous sections, stabilization is more robust than solidification. Stabilization is also typically more cost-effective. Other technologies, including thermal extraction and chemical extraction (i.e., acid washing), also tend to be more costly. Table 5-1 on page 52 compares the costs for various types of metals remediation.

Table 5-1 indicates that stabilization can be a cost-effective approach to lead remediation. For comparison with other alternatives, transportation and disposal costs are also often added in. This may not be appropriate in all cases. As discussed in the next section, the bioavailability of stabilized soil is often less than that of soil that has not been amended. Also, stabilized soil has been shown not to be a threat to groundwater, and direct contact issues can be addressed through low-cost soil covers. Evaluation of on-site versus off-site disposal can be performed, based on the costs involved and the long-term plans for the firing range.

5.4.2 Public Acceptance of Soil Stabilization

The general public is concerned about the following issues:

- Environmental conditions may affect the long-term immobilization of contaminants, and there is concern that the process under certain circumstances could be reversed. Long-term monitoring is necessary to ensure that contaminants have not been remobilized.
- Future use of the site and environmental conditions may erode the materials used to stabilize contaminants, thus affecting their capacity to immobilize contaminants. Solidified material may also restrict future use of the site.
- Depth of contaminants may limit these processes.

Among the concerns regarding solidification are these:

- In general, stakeholders desire low-temperature, nonoffgas-producing stabilization technologies that generate no secondary wastes, minimize disposal volumes, and ensure long-term durability.
- Institutional controls provide little confidence in a remediation project from a stakeholder's point of view.
- It is well documented that inorganic salts affect the set rate, through either acceleration or retardation. End users need to know precisely how different salts individually and collectively affect basic Portland cement stabilization so that the proper additive can be used in the dry binder mix.
- Special concerns may be posed by other types of hazardous waste (e.g., organic chemicals) that may interfere with the solidification/stabilization process: inorganic acids that will decrease durability for Portland Type I cement; chlorinated organics that may increase set time and decrease durability of cement if concentration is too high; and oil and grease that will decrease unconfined compressive strength.
- Several soil characteristics influence whether the technology will contain the waste effectively. These characteristics include void volume, which determines how much grout

or cement can be injected into the site; soil pore size, which determines the size of the cement particles that can be injected; and permeability of the surrounding soil, which determines whether water will flow preferentially around the solidified mass.
- Some cementation (solidification) processes result in significant increase in volume (up to double the original volume).
- Certain wastes are incompatible with variations of this process. Treatability studies are generally required. Reagent delivery and effective mixing are more difficult than for *ex situ* applications.
- Cracks extending through the stabilized mass have been observed in some demonstrations, the cause of which is suspected to be the high temperature rise during curing.

5.5 Chemical Extraction

As with any treatment technology, soil parameters play a significant role in the success of the technology. For chemical treatment, these include but are not limited to the following:
- **Feed soil pH and buffering capacity** determine the volume of chemical addition to reach the pH required for efficient leaching.
- **Cation exchange capacity (CEC)** indicates the ability of the soil to bind lead in an exchangeable form. Generally, CEC is proportional to the clay content of the soil, making sandier soils easier to treat.
- **Total organic carbon** indicates the volume of organic material (humates) present in the soil on a weight-to-weight basis. Dissolved metals complexed with humates are difficult to remove and may require a separate humate-removal step prior to chemical leaching.
- **Iron and manganese levels** indicate the presence of iron and manganese oxides that can adsorb lead. These materials tend to bind lead very strongly and may leach out with other metals, increasing overall chemical consumption during leaching and precipitation steps.

These parameters provide some indication of difficulties that may be encountered during leaching. The leachant selection and optimization process can be further focused, if required, by determining heavy-metal speciation and binding mechanisms in the soil. These tend to be rather expensive analyses and may not be required at every site, as outlined in Table 5-1.

Heavy-metals speciation indicates the types of chemical compounds the metals are present as. At many SAFRs containing native alkalinity, lead is present predominantly as elemental lead and carbonate minerals. These lead carbonate formations are much easier to leach than elemental lead, which exists predominately as free particulates in the soil matrix. As such, any leaching steps should be performed only after the particulate lead has been removed using physical separation techniques. Lead oxides and lead sulfate are other lead compounds that may occur under certain conditions and are very difficult to leach. Soil containing a high percentage of these compounds may be more amenable to stabilization than chemical leaching.

All of these parameters should be evaluated in a thorough treatability study prior to field mobilization. Once treatability results have been determined, a sequential approach can be developed for coupling appropriate technologies to address site-specific conditions with an optimized approach.

5.5.1 Public Acceptance of Chemical Treatment Technologies

Public concerns include the following:

- While metals that are mixed and bound with organic contaminants can be extracted, the residuals may be restrictive of future land use.
- The toxicity of the solvent is an important consideration as traces may remain in the treated soil.
- After acid extraction, any residual acid in treated soil needs to be neutralized.
- In solvent extraction, impermeable membrane liners and covers should be used to reduce solvent evaporation and to protect against rain.

5.6 Asphalt Emulsion Batching–Encapsulation

The soil to be treated with emulsions is contaminated with metals and organic contaminants and will subsequently be used as an asphalt sub-base for paving projects. As such, the following parameters must be addressed:

- chemical fixation/treatment effectiveness
- physical properties of treated soil

Ultimately, the goal of the treatability study is to provide a mix design and procedures for field implementation that meet the site reuse goals for treated soils as well as the physical characteristics to support the soil's intended end use.

Since the treated soil is to be used as a product, particulate metals must be removed prior to emulsion treatment. This particulate-removal step is critical as encapsulated heavy-metal particles could be re-exposed during placement or subsequent work on the treated sub-base material. Also, certain metals like copper are detrimental to the asphalt matrix and must be removed to ensure the long-term structural integrity of the sub-base material.

To ensure effective particulate removal, all metal leachability testing will be done after the emulsion mix has cured, been strength tested, and the cured sample subsequently pulverized. The aliquot selected for leachability testing will be taken from the pulverized sample.

The initial required data includes

- grain-size analysis/containment by fraction,
- contaminant removal by size segregation and gravimetric techniques,
- oversize fragment removal by size segregation and screening, and
- post-treatment and TCLP metal results for each individual size fraction.

A treatability study as outlined in Appendix D is required to focus first on material characterization of the sample, followed by optimizing treatment of specific fractions using physical treatment methods. Recoverable quantities of metals will be estimated in the treatability study to quantify the amount requiring recycling. Once completed, residual soils free of

particulate metals will undergo subsequent emulsion treatability studies. This approach is favorable from a cost standpoint, as described in Table 5-1.

5.6.1 Public Acceptance of Asphalt Emulsion Chemical Treatment Technologies

Among the issues that affect public acceptance of this technology are the following:

- Future use of the site and environmental conditions may erode the material used to encapsulate contaminants, thus affecting their capacity to immobilize. Stabilized material may also restrict future use of the site.
- Certain waste streams are incompatible with variations of these processes, and each application must be carefully tested for long-term compatibility before it is used.
- Special concerns may be posed by other types of hazardous waste (e.g., organic chemicals) that may interfere with stabilization processes. Some factors include inorganic acids that will decrease durability of the emulsion, or chlorinated organics that may increase set time and decrease durability of the emulsion if the concentration is too high.

5.7 Phytoextraction and Stabilization Approaches (Constructed Wetlands)

A passive wetlands system could be designed to receive storm water runoff from small arms firing ranges. The constructed wetlands could be placed at either the toe of the berm slope so as to receive sheet flow runoff from the berms, or designed to receive storm water through channels that contain and direct storm water runoff. The wetlands could be designed in combination with biofilters (using the storm water channel as prefilters to remove large particles prior to polishing in the wetlands) and/or detention basins to allow the settling of large particle sediments prior to discharge of the storm water into the constructed wetlands. The designed slope for such systems should be between 1% and 5% (USEPA, 2000). In circumstances where the supporting water is acidic, anoxic limestone drains or other mechanisms can be installed between the berm and the wetlands to raise pH and allow for lead precipitation, thereby increasing retention in the wetlands.

As part of a conceptual constructed wetlands to address arsenic, chromium, and copper dissolved in storm water at a site in Florida, modifications to storm water channels and retention basins were proposed. The anticipated effect was to reduce storm water infiltration and increase storm water residence time through the installation of a low permeability liner to the channel and/or the basin, followed by the planting of wetlands vegetation to develop the organic base for retention of the metals. Initially, excavation and grading of the existing channel and basin would be performed to contour the subgrade. The channel and basin would be lined with a low permeability liner, consisting of a geosynthetic clay liner (GCL) or compacted low permeability soil (e.g., clay). Vegetative soil material (e.g., topsoil) would be placed above the liner and further covered with a layer of humic material (*Sphagnum* or peat moss) to facilitate organic binding of metals. Soils would be a sandy loam and contain approximately 8% to 10% organic matter. The channel basin would be planted with a combination of native emergent wetlands species that are known to remove metals from surface water.

5.7.1 Public Acceptance of Phytoextraction Technologies

Among the issues expected to affect public acceptance are the following:

- The long-term effectiveness of constructed treatment wetlands is not well known. Wetlands aging may contribute to a decrease in contaminant removal rates over time.
- Constructed wetlands do not destroy the metals; they restrict their mobility. Certain conditions such as pH, temperature, or other variables may lead to a reversal of the filtration process for metals.
- During operation of the constructed wetlands, wildlife may be adversely affected by the presence of metals that have accumulated in plants and sediment.
- The outlet of the constructed wetlands should be carefully monitored. Underlying aquifers must also be monitored to assure that the impermeable base has not leaked.

6.0 ISSUES, CONCERNS, AND RECOMMENDATIONS

6.1 Risk Assessment

Interdependent risk assessments often are conducted for human and ecological receptors potentially exposed to contaminants in shooting range media. While differences in methods and assumptions justify separate analyses, several considerations are common to both types of risk assessments. Aside from the federal requirements under RCRA and Superfund, many states have methodologies developed according to authorized programs such as RCRA and state-developed remediation, cleanup, or mitigation programs. The variability in risk assessment approaches, as identified by the ITRC Small Arms Firing Range Team, is quite high. ITRC has formed a 2003 team to address risk issues such as these.

6.2 Site Identification

Some state agencies are informally collecting information on the location of outdoor shooting ranges. Owners of closed ranges should be required to notify state agencies if they become aware of soils on site that are present in amounts that pose a risk based on current or reasonably anticipated future land use or if exceedances of groundwater quality standards are detected. See Section 4.4, Remediation/Future Use Issues.

6.3 Berm Reuse

At some ranges, it may be possible and desirable to reuse the soil from the backstop of a range that is being closed to construct a new berm or rebuild an existing berm located in another area of the same property or facility. It is USEPA's position that ranges that reclaim and recycle lead bullets or lead shot may place the soil that is generated during the reclamation process back onto an active range on the same property or facility or a property adjacent to and under the same ownership as the property where the soils originated, without testing the soil for hazardous waste characteristics.

It has been suggested that range soil from a former backstop may also be reused, following lead reclamation, for constructing or rebuilding a backstop at a location that is not on the range property. The same environmental benefits from berm reuse as described earlier in this document could be realized, but extra oversight may be needed. Since individual states may not permit this action or may impose additional requirements for transportation, documentation, and approvals, state regulators should be consulted prior to transporting range soils to a property that is not the same as or adjacent to and under the same ownership as the property where the soils originated.

6.4 Cleanup Criteria

Current models used to establish safe cleanup levels at SAFRs use either residential or industrial exposure as a basis. Many of the BRAC (Base Realignment and Closure) sites have become more dispersed recreational areas (i.e., wildlife refugees, open spaces, etc.) that have deed restrictions prohibiting development. None of the existing criteria take this type of restricted use into account when establishing cleanup criteria. The exposure pathways for dispersed recreation are much different, and exposure rates are lower than for residential or industrial exposure scenarios.

6.5 Sample Preparation

While many current analytical methods rely on using only soil that has passed uncrushed through a 30-mesh sieve as the source for analytical tests, some controversy exists in the field as to the best method(s). Other sample preparation protocols have been proposed and approved by governing regulatory bodies. Differences in sample preparation protocols include the designation of the size of sieve to use or whether to use a sieve at all and on the degree of disaggregation prior to sieving. Therefore, the recommendation of a specific sample preparation method may be misleading. The choice of a method should result in a sample that is representative of the site and its environment and is agreeable to the regulatory community and other parties involved in the evaluation.

6.6 Technologies

- Establishing physical treatment operations within the confines of the small arms firing range is ideal. Locating the treatment plant in the range facilitates the timely excavation and haulage of soils destined for treatment, as well as the return and placement of treated soil. When fieldwork is confined to one location, the project is more efficient and overall project costs are reduced.

- Long-term effectiveness has not been demonstrated for many contaminant/process combinations.
- Depth of contaminants may limit these processes.

- Institutional controls provide little confidence in a remediation project from a stakeholder's point of view.

6.6.1 Soil Washing

- The clean portion of separated soil must be analyzed for residual contamination before it is used as clean material. Sites using soil washing should have on-site capability to test samples of treated soil before it is released as clean. Some states may require certified labs to be used for these tests.

- Soil contaminated with both metals and organic compounds make formulating a single suitable washing solution difficult. Sequential washing using different wash formulations may be required. Soil-washing processes for soil contaminated with volatile organic compounds (VOCs) may require emission controls.

- Wash water containing inorganics may require treatment before it can be discharged, as it is usually not completely free of smaller organic particles.

- Measures should be taken to prevent wind-borne particulates if dry screening is a step in the process.

- Based on the results and implementation of the treatability study findings for the design of the soil-washing plant, it is strongly recommended that every soil-washing solicitation include a vendor-conducted, bench-scale treatability study for effective costing and plant design. The bench-scale treatability study represents an effective method for fully defining a remediation problem, associated treatment parameters, and plant design.

- Establishing physical treatment operations within the confines of the small arms firing range is ideal. Locating the treatment plant in the range facilitates the timely excavation and haulage of soils destined for treatment, as well as the return and placement of treated soil. When fieldwork is confined to one location, the project is more efficient and overall project costs are reduced.

6.6.2 Stabilization

- Environmental conditions may affect the long-term immobilization of contaminants, and there is concern that the process, under certain circumstances, could be reversed. Long-term monitoring is necessary to ensure that contaminants have not remobilized.

- Future use of the site and environmental conditions may erode the materials used to stabilize contaminants, thus affecting their capacity to immobilize contaminants. Solidified material may also restrict future use of the site.
- Certain waste streams are incompatible with variations of these processes, and each application must be carefully tested for long-term compatibility before it is used.

- Depth of contamination may limit this technology.

6.6.3 Solidification

- It is well documented that inorganic salts affect the set rate, through either acceleration or retardation. However, end users need to know precisely how different salts individually and collectively affect basic Portland cement stabilization so that the proper additive can be used in the dry binder mix.

- Special concerns may be posed by other types of hazardous waste (e.g., organic chemicals) that may interfere with the solidification process, including inorganic acids that will decrease durability for Portland Type I cement; chlorinated organics that may increase set time and decrease durability of cement if concentration is too high; and oil and grease that will decrease unconfined compressive strength.

- Several soil characteristics influence whether the technology will contain the waste effectively. These characteristics include void volume, which determines how much grout or cement can be injected into the site; soil pore size, which determines the size of the cement particles that can be injected; and permeability of the surrounding soil, which determines whether water will flow preferentially around the solidified mass.

- Some cementation processes result in significant increase in volume (up to double the original volume).

- Certain wastes are incompatible with variations of this process. Treatability studies are generally required. Reagent delivery and effective mixing are more difficult than for *ex situ* applications.

- Cracks extending through the stabilized mass have been observed in some demonstrations, the cause of which is suspected to be the high temperature rise during curing.

- In general, stakeholders desire low-temperature, nonoffgas-producing stabilization technologies that generate no secondary wastes, minimize disposal volumes, and ensure long-term durability.

- While metals that are mixed and bound with organic contaminants can be extracted, the residuals may restrict future land use.

- The solvent's toxicity is an important consideration as traces may remain in the treated soil.

6.6.4 Chemical Extraction

- After acid extraction, any residual acid in treated soil needs to be neutralized.

- In solvent extraction, impermeable membrane liners and covers should be used to reduce solvent evaporation and to protect against rain.

- While metals that are mixed and bound with organic contaminants can be extracted, the residuals may restrict future land use.

- Solvent toxicity is an important consideration as traces may remain in the treated soil.

6.6.5 Asphalt Emulsion Chemical Treatment Technologies

- Future use of the site and environmental conditions may erode the materials used to encapsulate contaminants, thus affecting the materials' capacity to immobilize. Stabilized material may also restrict future use of the site.

- Certain waste streams are incompatible with variations of these processes, and each application must be carefully tested for long-term compatibility before it is used.

- Special concerns may be posed by other types of hazardous waste (e.g., organic chemicals) that may interfere with stabilization processes, including inorganic acids that will decrease durability of the emulsion and chlorinated organics that may increase set time and decrease durability of the emulsion if the concentration is too high

6.6.6 Phytoextraction Stabilization Technologies

- The long-term effectiveness of constructed treatment wetlands is not well known. Wetlands aging may contribute to a decrease in contaminant removal rates over time.

- Constructed wetlands do not destroy metals; they restrict their mobility. Certain conditions such as pH, temperature, or other variables may lead to a reversal of the filtration process for metals.

- During operation of the constructed wetlands, wildlife may be adversely affected by the presence of metals that have accumulated in plants and sediment.

- The outlet of the constructed wetland should be carefully monitored. Underlying aquifers must also be monitored to assure that the impermeable base has not leaked.

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APPENDIX A

Case Studies

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Adapting Remedial Technologies to Meet Site-Specific Risk-Based Cleanup Goals
A Case Study of the MCA/GCC 29 Palms Range Soil Remediation Project

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Live-fire training is an integral part of our war fighters' training and is essential for maintaining mission readiness. In all, the Department of Defense expends over 2 million pounds of lead annually to maintain this vital, necessary training function. Unfortunately, environmentalists are continuing to press for cessation of live-fire training, using lead contamination as the reason. These issues are compounded by the fact that a replacement bullet trap must be retrofitted to existing berm areas with minimal impact to ongoing live-fire training.

At MCA/GCC, Brice Environmental Services Corporation is working in conjunction with Battelle Memorial Institute (Battelle) and the Naval Facilities Engineering Service Center (NFESC) to configure a soil-washing system to physically remove particulate lead from range soil and meet the risk-based cleanup requirements at the site. This approach was based on a comprehensive treatability study, which indicated the particulate contaminants could be isolated in a small fraction of the total range soil, enabling their effective removal using density separation techniques borrowed from the mining industry. This innovative approach allowed for successful completion of the project ahead of schedule and within budget, while rendering range soil suitable for reuse during subsequent berm construction and generating 230 tons of high-quality metals for recycling.

BACKGROUND

The overall scope of this proactive pollution prevention project included removing and processing contaminated soils from three small arms firing ranges to remove the lead, then installing bullet traps at those ranges as a pollution prevention measure. During the site assessment performed by Battelle, it was determined that surficial lead concentrations ranged from 27,000 mg/kg to 233,142 mg/kg, with concentrations rapidly decreasing with depth. Based on depth profile data and surface data, it was determined the lead at the small arms ranges is essentially immobile except when surface materials are carried away by wind and water erosion.

Battelle used site-specific data as input values to determine an acceptable soil concentration for an industrial worker (a Marine) exposed to the soil 8 hours/day, 5 days/week. To determine an acceptable soil-lead concentration, the Blood Lead Spreadsheet, Version 6 ("LeadSpread"), developed by the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC), was used. The LeadSpread model gave the value of 5,451 μg/g (mg/kg). This value was rounded down to 5,400 mg/kg to provide a conservative soil-processing goal.

Because this range maintenance and repair work was performed on an active range, USEPA's Military Munitions Rule (40 CFR, Part 260) applied, and the soils were not considered hazardous waste under the Resource Conservation and Recovery Act (RCRA). The local regulators were also in favor of adopting this position and did not apply the California hazardous waste regulations (CCR Title 22).

TECHNOLOGY SELECTION

To capitalize on the favorably negotiated risk-based cleanup goals, a technology to selectively remove particulate metal contaminants was required. Since the cleanup goal was a function of total lead levels, traditional stabilization methods were discounted, as they do not reduce total lead levels. Also, the all-or-nothing approach of off-site disposal was not used, as it did not mitigate the problem. Rather, it only transferred the liability associated with lead in soil to an off-site location and required replacement fill to be imported to use in subsequent berm construction.

The ideal technology for total lead reduction in soil is soil washing. The key to successful soil washing is to couple wet-screen sizing with gravity separation to selectively remove lead from only those fractions requiring it. The Brice soil-washing process is based on placer mining techniques that have been in use for over 100 years in the mineral dressing industry. Taking basic placer mining techniques and unit operations, Brice modifies and configures unit operations to provide both clean soil (traditional placer "tails") as well as refined lead concentrate suitable for recycling. A logic diagram outlining the technology selection process is detailed in Figure 1.

Physical Sizing

The physical sizing process uses sequential wet-screening steps, the first of which is deagglomeration. Wet screening provides dust-free operation and sharp particle-size fraction cuts. For each screening step, "plus" and "minus" fractions are generated, with actual cut points based on the treatability study data. The goal of wet screening is to partition the particulate metal contamination into narrow-size fractions to facilitate effective gravity separation and remove from the process plant those soil fractions not requiring any treatment.

The sand and gravel fractions typically represent the largest portion of range soils. These fractions also contain the majority of the lead (typically over 95%) as free particulates. This particulate lead is easily removed using mining-based techniques, which concentrate the lead into a refined product for recycling and renders the soil suitable for reuse.

The silt/clay fraction of range soils typically contains a small portion of the total lead in the form of surficial ionic metal coatings. In some cases, sizing and gravity separation of the sand and gravel fractions may remove sufficient lead to render the whole matrix suitable for reuse. In others, the surficial ionic coatings may have to be removed using additional physical/chemical treatment steps to meet cleanup goals.

Gravity Separation

When particulate contaminants are the same size as the surrounding soil particles, gravity separation is used to remove the particulate metal. Elutriation and jigging are typically used for soil fines removal and gross particulate lead removal, respectively. Elutriation uses water flow over weirs to separate soil fines from larger sand particles. Jigging uses differential settling in water to separate heavy bullet particles from same-size, but lighter, sand/gravel particles. This approach removes the particulate lead from the sand and gravel fractions.

Dewatering
To close the loop on water consumption, process water is recycled within the plant. A clarifier and mechanical dewatering equipment is used to aggressively dewater the fines and enable the reuse of process waters. Recycling the plant process water minimizes both water consumption and the ultimate volume of water requiring treatment, limiting it to just the static volume of the plant at project completion.

Acid Leaching
If physical/gravity treatment of the sand and gravel fractions is insufficient in meeting cleanup goals, the silt and clay fractions can be effectively treated with acid leaching. A dilute hydrochloric acid solution dissolves leachable ionic metals coatings from the soil fines (and sands if required), creating metal-chlorides in solution. The dissolved metals are precipitated out of solution, dewatered, and removed from the process for recycling at a smelter. The lixiviant is re-acidified and recirculated within the plant. The treated soil fractions are then dewatered, neutralized, and recombined with the rest of the treated soil matrix.

QA/QC Sampling and Sample Preparation Procedures
Proper sampling and sample preparation methods must be used when dealing with soils containing particulate metal ranging in size from intact bullets to very fine fragments. These methods are necessary to reduce sample variation and ensure adequate material representation in the aliquot being analyzed.

Sampling and sample preparation protocols developed by the mining industry are appropriate for soils from small arms shooting ranges. This involves taking samples sized according to the diameter of the largest piece in the material, followed by sample preparation according to the type of analysis to be performed, (i.e., total lead or TCLP lead). For range soils with particles as large as $3/8^{th}$ of an inch, sample sizes are typically 300 pounds or more.

Mining-based sampling and sample preparation adds costs to the project, but these costs are less than the costs associated with schedule impacts caused by reprocessing material as a result of data scatter and not achieving data quality objectives because of statistically unrepresentative samples.

Lead Recycling
During firing range maintenance or remediation activities, recovery of bullets and bullet fragments from firing range sands or soils via physical treatment constitutes “reclamation” per 40 CFR 261.1(c)(4). Metal concentrates reclaimed from firing range berms via size classification and density concentration contain more than 90% metal on a dry weight basis. The primary metal is lead, with small amounts of copper and antimony. The concentrate reclaimed from the firing range material is “scrap metal” per 40 CFR 261.1(c)(6). Under 40 CFR 261.6(a)(3)(iv), recycled scrap metal is classified as a “recyclable material” that is not subject to the requirements for generators, transporters, and storage facilities of hazardous wastes specified in paragraphs (b) and (c) of 40 CFR 261.6. Therefore, the scrap metal reclaimed from the firing range sand, or soil, does not need to be regulated or manifested as a hazardous waste during generation or transport to a smelter for recycling.

SITE OPERATIONS

Brice Environmental Services performed remedial operations as a first-tier subcontractor to Battelle, under their prime contract Number N47408-95-D-0730. The scope of work for Brice on this project included both a bench-scale treatability study and subsequent full-scale treatment of range soils. The project objectives were to meet the treatment goal of less than 5,400 mg/kg lead in the processed soil while recovering particulate metal from the soil at a purity level suitable for recycling.

The bench-scale treatability study test results indicated that the majority of the lead contamination ranged in size from large intact bullets and bullet fragments (¾-inch to ¼-inch) to sand-size (50-mesh) metal particles. The treatability study results further indicated that residual lead levels would average around 1,600 mg/kg in the treated soil after removal of free particulates in the ¾-inch by 50-mesh range. Since this level was considerably less than the treatment goal of 5,400 mg/kg, no further particulate recovery steps were required or deployed, reducing total project costs accordingly.

Deploying only the required unit operations is critical to project cost control, as incremental treatment costs follow the law of diminishing returns, with successively smaller contaminant removal increments costing increasingly more to attain. Figure 2 outlines soil-washing costs as a function of treatment goals for several completed projects.

The plant subsequently deployed at 29 Palms was based on the treatability study results and consisted of individual unit operations integrated into one continuous process. Since the treatability study results indicated that site soils were composed primarily of sands and rock, the process was designed to separate rock larger than ¾-inch and sand smaller than 50-mesh from the soil fraction containing the targeted particulate metals.

To accomplish this, a wet vibrating screen deck containing a ¾-inch screen (Step 1) was utilized to remove large particulate-free rock. A second smaller screen (4-mesh) on the vibrating screen deck was utilized to separate the larger particulate metal and rock from the fine soil fraction. Fine particulate metal and fine soil (minus 4-mesh), along with the wash water passed through the smaller screen deck.

The minus ¾-inch by plus 4-mesh metal and rock (Step 2) was subjected to density treatment. Following density treatment, the separated rock was discharged to a dewatering screw (Step 3) and discharged from the plant.

The slurry of material that passed through the second screen was pumped to a separate density treatment unit (Step 4) for fine particulate metal recovery. Refining the metal in this fraction was crucial to maximize the value of the material. Recovered metals from this step were thus discharged to two additional density recovery units to enhance the purity of the metal (Steps 5 and 6). The concentrates from these units, along with the concentrates from Step 2, were piped to a metal dewatering unit (Step 7). From this unit, the concentrate was dewatered and discharged into a “supersack” for subsequent recycling by the Base Defense Reutilization and Marketing Office (DRMO).

Soil fines discharging from Step 4 was split into clay and fine sands in another dewatering screw (Step 8). Density-treated sands from Step 5 and 6 were also discharged to the dewatering screw for dewatering. Soil clays exiting the screw overflow were pumped into a clarifier (Step 9), where a coagulant was added to accelerate the settling rate of the clays. The dewatered clay was then pumped to a centrifuge for additional dewatering (Step 10). All of the ¾-inch minus treated soil fractions were recombined and placed into a daily stockpile to await confirmation sample results and subsequent reuse in bullet-trap construction. The ¾-inch plus rock was stockpiled separately for reuse as erosion control or road base material in subsequent base civil engineering projects.

Approximately 11,700 tons of soil was processed, resulting in the generation of approximately 230 tons of recovered metal concentrates. Analysis of the concentrate showed it to average approximately 90% metal. Of the metal, approximately 85% was lead, 13% copper, 1% zinc, and 1% antimony. The average total lead in feed soils was 24,700 mg/kg lead. Processed soils were analyzed in daily batches with the average lead level in treated soil less than 1796 mg/kg, or just 33% of the risk-based cleanup goal.

SUMMARY

The objective of the 29 Palms project was to remove particulate metal from approximately 11,700 tons of range soil within a tight schedule, while attaining a cleanup standard of less than 5,400 mg/kg total lead. These objectives were met, with the average total lead in the treated soil less than 1,796 mg/kg and plant throughput averaging between 20 and 30 tons/hour.

This adaptation of mining-based technology for removing particulate metal is an inexpensive means of both reducing the threat of ricochets at active ranges and mitigating lead contamination at ranges to be closed. At 29 Palms, the total soil-processing cost for the project was approximately $66.30 per ton, which included all mobilization, processing, and demobilization costs. In all, 230 tons of particulate metal was recovered (with an approximate purity of 90%) and recycled by the base DRMO.

For this project, sizing and gravity separation as a stand-alone treatment process was all that was required to meet cleanup goals. Other sites may require additional gravity separation steps, aggressive deagglomeration, and/or residual chemical treatment to meet more stringent cleanup goals. Examples of completed projects where soil washing met more stringent goals for range soil treatment include Bergstrom Air Force Base, Fort Polk, Naval Weapons Station Earle, and the Twin Cities Army Ammunition Plant, where total lead reuse goals were 1,000, 500, 400, and 300 mg/kg respectively.

In these cases, the process was modified with additional treatment steps based on site-specific treatability study results. Ongoing projects with soil-washing operations similar to MCA/GCC 29 Palms include small arms ranges at Camp Edwards/MMR and Range 24 at Fort Dix.

The 29 Palms project was an unparalleled success for three important reasons:

- The solicitation required that a vendor-based, bench-scale treatability study be performed prior to mobilization. This was the best investment to ensure full-scale success because bench-scale treatability studies allow the vendor to evaluate site-specific process parameters for the purpose of delineating the process approach and costs. By conducting these studies, the vendor is placed in a position of decreased risk and can price the remediation with fewer contingencies.
- The design of the treatment train incorporated flexibility for changing components based on actual soil conditions. The plant was modified in the field to meet changing soil conditions, subsequently increasing both removal efficiency and production rate without impacting the project schedule.
- The project succeeded because of the willingness of all parties to work together as a team with a common objective—identifying and mitigating potential project impacts before they occurred.

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Figure 1: Treatment Train Decision Tree for Small Arms Firing Ranges

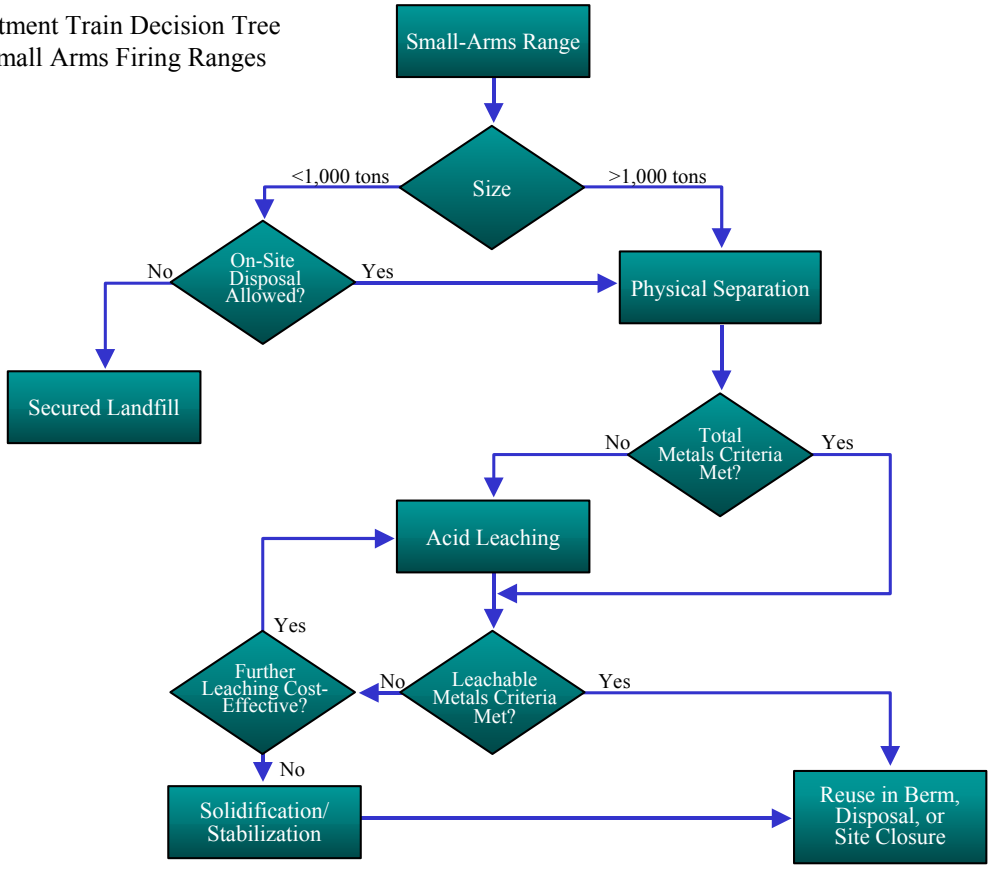
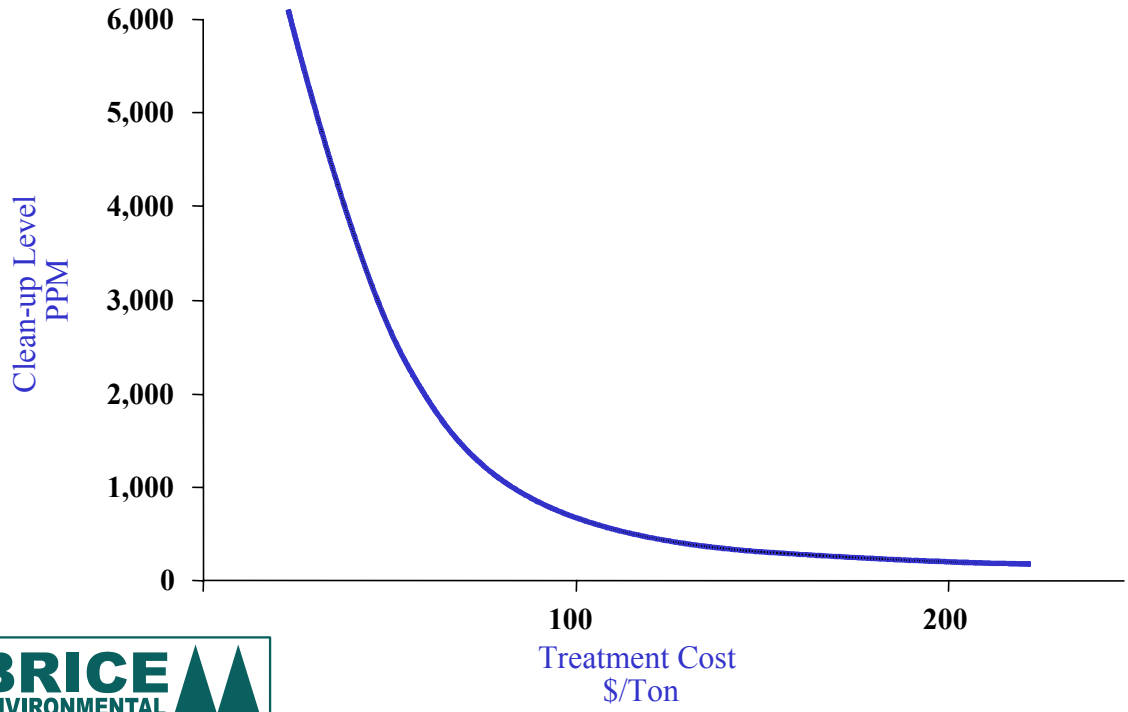


Figure 2: Relative Soil-Washing Cost as a Function of Cleanup Goal



BRICE ENVIRONMENTAL SERVICES CORPORATION

Fort Dix gets lead out at firing range

(Published in the *Asbury Park Press* 9/25/99)

By KIRK MOORE
STAFF WRITER

FORT DIX -- A crew of former Alaskan gold miners is using its know-how to dig up to 1,000 pounds of lead bullets a day from an Army firing range here in a demonstration project military engineers hope will show how to remove toxic lead contamination at nearly 3,000 ranges around the country.

At Fort Dix's Range 24, machinery originally designed for the gold fields is processing sand from the range berm, the sandy wall behind the target area that catches spent bullets. Engineers estimate the soil is 1 percent to 2 percent lead by weight. Lead is poisonous heavy metal that has to be cleaned up.

BOB BIELK photo

Joan Brice of Brice Environmental Co., Fairbanks, Alaska,

"We have trained over 3 million soldiers here in the last 82 years . . . from the First World War to World War II, Korea, and Vietnam," said Fort Dix commander Col. James Snyder.

With the Army Reserve, National Guard, and police training that continues today, that adds up to a lot of buried bullets.

Cleaning them up is a major step toward what the Army calls "greening the ammunition"—a complete phaseout of lead, the metal that's been used in bullets since American soldiers leveled flintlock muskets against the British 224 years ago.

Tungsten will replace lead in the first 1 million rounds of replacement ammunition being produced for the Army's M-16 rifles at the Lake City Army ammunition plant near Independence, Mo. this year, said Wade Bunting, program manager for the Green Bullet project at Picatinny Arsenal in Morris County.

"It's a direct replacement" for lead because tungsten is a slightly denser metal, Bunting said. The tungsten is lightened somewhat by the addition of tin or nylon plastic during the molding process, so the new ammunition will perform the same as the old bullets, he added.

The military's work on tungsten ammunition next year will expand to studying how to make tungsten shotgun pellets cheaply, which in time could give civilian shooters an affordable alternative to steel shot, said James Frankovic, manager of the RangeSafe cleanup program based at Picatinny.

The military's wakeup call on lead contamination came several years ago when the U.S. Environmental Protection Agency demanded a halt to training at the Massachusetts Military Reservation on Cape Cod, Frankovic said. Serious lead contamination and groundwater problems were traced to firing ranges at the Massachusetts base, and Bunting said those ranges are getting the first consignment of 125,000 tungsten bullets.

Meanwhile, Picatinny engineers have sought cheaper, more environmentally safe ways to clean up existing lead contamination and pave the way for new ammunition. The $1.7 million Fort Dix project is unique because it uses no harsh chemical or acid cleaning agents but only water and a polymer-based clarifying chemical that's also used to treat drinking water, said Michael Warminsky of Brice Environmental Services Corp., the Army's soil-washing contractor.

"There's all kinds of bullets—.45 wadcutter (target ammunition), .30 caliber, .223 (M-16 bullets), and even a lot of buckshot," Warminsky explained. "The bullets are easy. It's these little lead particles that are hard to pick out."

Some bullets break apart when they hit buried stones or spent bullets, Warminsky said. The lightweight, high-velocity M-16 bullet in particular "self-destructs. We found one place where they must have been doing machine gun practice, because there's nothing but lead foil," Warminsky said.

To sort it all out, the Brice crew digs soil from the berm with a front-end loader, carrying it to the first conveyor on their processing line. Washed with water, the soil passes through sorters that first eject any pebbles or other debris bigger than 3/4-inch, Warminsky said.

The screened soil is conveyed to a pulsing "density separator" that works on the same principle as panning for gold: Heavy metals sink faster than dirt.

"The pulsing momentarily suspends all the material . . . and lead, being heavier, sinks faster," Warminsky said. Water and suspended dirt flow out, leaving most of the bullets in the separator tub.

Finally, the water goes to a clarifier, where a polymer-based floccing compound congeals the remaining fine silt.

The end products: One-ton packages of spent bullets to be shipped to the makers of Exide car batteries in Reading, Pa., who pay 6 cents a pound for lead, and newly washed sand that will go back onto the range berm.

After the range becomes tungsten-only, that sand will absorb M-16 bullets without breaking them up, and it's possible the Army will start recycling bullets back to its munitions factories, Bunting said. The new bullets will cost about 1.5 cents more than lead at first, but over the years engineers estimate the real cost per cartridge will drop by 5 cents, he said.

Brice is a family-owned company, with roots in Alaskan bush construction and mining, and it applies mining techniques to soil decontamination around the country. The company has a contract to assess lead levels at the Monmouth County police academy range in Howell. “It’s just an assessment of the berm” and nearby perimeter road, said Leo Carling, county superintendent of buildings and grounds.

“We’ll see what they find and if we have to, we’ll clean it up.”

PROACTIVE Lead Removal AND POLLUTION PREVENTION

AT THREE SMALL ARMS RANGES

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BACKGROUND

The Marine Corps Air Ground Combat Center (MCAGCC), located in south central San Bernardino County, California, is an active military facility. In 1940, the Army began using the base to train glider crews and, beginning in 1943, fighter pilots. The Navy used the facility for bombing and gunnery ranges until the end of World War II. The base was not in use between 1945 and 1952 but has been occupied by the Marine Corps since 1952.

In support of the primary mission of MCAGCC, troops are trained and qualified in the firing of rifles and pistols. The small arms range complex trains over 10,000 active duty Marines each year for service rifle and service pistol requalification. In addition, approximately 1,500 reserve Marines, local law enforcement personnel, Junior Reserve Officers Training Corps cadets, and recreational shooters use the small arms ranges each year.

The overall scope of this proactive lead removal and pollution prevention project included removing and processing contaminated soils from three small arms ranges to remove the lead, then installing bullet traps at those ranges as a pollution prevention measure. The ranges were in active use supporting weapons practice and qualifications requirements at MCAGCC.
The following ranges were specified for this project:

- Range 1: Known-Distance Rifle Range ("Rifle Range")
- Range 1A: Battle Sight Zero Range ("BZO Range")
- Range 2: Known-Distance Pistol Range ("Pistol Range")

During the first phase of this project, Battelle characterized the ranges, performed an Environmental Assessment, established a soil-processing goal for total lead concentration based on a Human Health Risk Assessment, performed treatability studies, designed a soil management pad, and selected the appropriate soil-processing technology. During the second phase, Battelle constructed the soil management pad, removed contaminated soils from the ranges, selected and managed the soil-processing vendor, constructed infrastructure, and installed bullet traps at each of the three ranges.

SITE ASSESSMENT

In 1996 and 1997, the Naval Facilities Engineering Service Center (NFESC) performed an initial site assessment of some of the small arms ranges at MCAGCC. Results from the rifle range indicated that the highest total lead concentrations were in the impact berm and the area immediately behind the impact berm, with detected values of up to 35,000 mg/kg (all reported values from NFESC are after removal of visible lead fragments). The concentrations fell rapidly with distance behind the impact berm, falling to less than 1,000 mg/kg within 250 feet of the berm.

At the pistol range, the highest total lead concentrations were also in the impact berm, with detected values up to 4,300 mg/kg. As expected, the impact berm at the BZO range also had the highest total lead concentrations, with detected values up to 14,000 mg/kg. The concentrations behind the impact berms of both these ranges again fell rapidly with distance.

Lead concentrations also fell rapidly with depth. A location with a total lead surface concentration of 26,000 mg/kg had a concentration of 700 mg/kg two feet below ground surface. Based on the depth profile data and the surface data, the lead at the small arms ranges is essentially immobile except when surface materials are carried away by wind and water erosion.

Battelle performed an additional assessment during the summer of 1997. To avoid duplication of effort, the sampling and characterization plan prepared by Battelle worked in concert with the assessment performed previously by NFESC. The Battelle effort focused on complete characterization of the berms at the three ranges. The results of the Battelle effort are summarized in Table 1.

Table 1. Summary of Load Concentration Data at the Surface

Location	Mean Lead Concentration[(a)]
Rifle Range Berm	Total: 81,508 mg/kg <10 mesh: 32,258 mg/kg
Pistol Range Berm	Total: 233,142 mg/kg <10 mesh: 2,010 mg/kg
BZO Berm	Total: 27,021 mg/kg <10 mesh: 4,930 mg/kg

[(a)] Total lead concentration is the mean concentration for all sizes including whole bullets. The <10 mesh is the concentration of lead from small particles, once soils have been screened to removed the large bullet fragments and rocks.

Part of the sampling effort involved trenching into the various berms to determine the lead distribution throughout the berm. At the rifle range, bullets were found throughout the berm, suggesting that the berm had been rolled over or constructed from previously impacted soils. Based on our findings, the entire rifle range berm was removed for processing. The interior berm soils at the pistol and BZO ranges were essentially free of bullets. Analytical results confirmed the visual observations, so only 1 foot of soil was removed from the front, top, and back of these berms. The top 6 inches of soil in the areas behind the berms was also removed because of the large amount of visible lead in those areas. This 6-inch cut was taken 150 feet behind the rifle range and 50 feet behind the pistol and BZO ranges.

Part of the sampling and characterization work performed by Battelle included the collection of large representative samples for use in treatability studies. The largest samples were 55-gallon drums of bullet pocket soils and general (non-bullet-pocket) berm soils. Hazen Research in Golden, Colorado was subcontracted to process the large samples through a physical separation pilot plant. These representative samples provided a very useful understanding of the lead distributions in the various size fractions of the soil.

An observation made during the sampling effort was confirmed during characterization of these large samples. A large portion of the bullets found on the rifle range consisted of copper jackets only, or copper jackets with small pieces of lead clinging to the inside. The majority of the lead appeared to have corroded or weathered away, perhaps through galvanic action between lead and copper. About 62% of the lead was found in the ¾-inch by 10-mesh fraction. The remainder of the lead was reported as 26% in the 10 by 200-mesh fraction, and 11% in the minus 200-mesh fraction. The distribution appears to be consistent with the observation. The soil from the BZO range had a similar but less dramatic distribution of lead: over 77% in the ¾-inch by 10-mesh fraction, 19% in the 10 by 200-mesh fraction, and 4% in the minus 200-mesh fraction. Another on-site observation was that bullets found at the pistol range were intact, that is, they did not show evidence of corrosion. This observation is confirmed by the lead distribution: greater than 99% of the lead reported to the ¾-inch by 10-mesh fraction, and only a fraction of a percent in the finer fractions.

TECHNOLOGY SELECTION

Before selecting the soil-processing technology, it was necessary to establish the goal that the processing technology would need to achieve. Because this range maintenance and repair work was performed on an active range, the USEPA Military Munitions Rule (40 CFR, Part 260) applied, and the soils were not considered hazardous waste under the Resource Conservation and Recovery Act (RCRA). The local regulators were also in favor of adopting this position and did not apply the California hazardous waste regulations (CCR Title 22). Consequently, the soil-processing technology did not have to meet leachability and total metals criteria that would otherwise apply if the soils were classified as hazardous waste and were being disposed of off site. In addition, because the range will continue as an active range, criteria for cleanup scenarios in which the land might be returned to residential, commercial, or other military use did not apply.

The major concern at the site was the potential for human exposure to lead during normal range operations. Because the ranges remain in active use, the main receptors are Marines assigned to range duties. Lead exposure can occur if lead-containing dust is inhaled or inadvertently ingested. To determine an acceptable soil-lead concentration, the Blood Lead Spreadsheet, Version 6 ("LeadSpread"), developed by the California Environmental Protection Agency, Department of Toxic Substances Control (DTSC), was used. The LeadSpread model is an Excel™ spreadsheet that calculates blood-lead concentrations resulting from five different exposure pathways (dietary intake, drinking water, soil and dust ingestion, inhalation, and dermal contact). The spreadsheet also back-calculates a preliminary remediation goal for soil that would result in a blood-lead level of 10 μg/dL, for a given exposure scenario and for a specific set of input values.

Site-specific data were used as input values to determine an acceptable soil concentration for an industrial worker (a Marine) exposed to the soil 8 hours/day, 5 days/week. The LeadSpread model gave the value of 5,451 μg/g (mg/kg). This value was rounded down to 5,400 mg/kg to provide a conservative soil-processing goal.

When considering range remediation projects, Battelle uses the following logic for selecting the most cost-effective processing technology. If the quantity of material is small (e.g., less than 1,000 tons), then the material is simply disposed of in a secured landfill. If the quantity of material is large enough for processing to be cost-effective, then physical separation of the particulate lead is the first technology considered. If physical separation alone is not able to meet the total metals criteria, then acid leaching is used to further remove lead not susceptible to physical removal. After achieving the total metals criteria, the leachable metals criteria, if applicable, must be met. It is often necessary to further reduce the total metals concentrations to meet the leachable metals criteria. If further leaching is not cost-effective or if the leachable metals criteria cannot be met by leaching, then solidification/stabilization is used to meet the leachable metals criteria. This logic is the most basic approach used. Site-specific conditions and economics must always be considered in the final analysis.

Based on our knowledge of the lead distribution in the various size fractions of the contaminated soil and the results of the physical separation treatability studies, Battelle determined that physical separation could easily remove enough particulate lead to meet the soil-processing goal.

No other treatment was required. A performance specification for physical separation was developed using the results obtained during the first phase of the project.

SOIL PROCESSING

A soil management pad was designed and constructed to serve as (1) a staging area for soils to be processed, (2) a staging area for processed soils awaiting verification results, (3) a staging area for lead-bearing materials awaiting recycling, and (4) an area for the soil-processing operation. About 7,800 cubic yards (11,700 tons) of contaminated soils was excavated and stockpiled on this large (300-foot by 300-foot) asphalt pad. The pad was bermed with an asphalt curb to contain water. The water was collected in a sump and reused in the process. Electric power and water were brought to the soil management pad, which was located in an area that was close to the ranges but that would not interfere with ongoing range operations.

To select the soil-processing vendor, Battelle conducted an initial review to identify vendors capable of providing the needed services. More than 70 vendors were contacted to request information on capabilities, prior experience, and budgetary cost estimates for a range of services relevant to the planned range maintenance activities. The 25 responses received were screened to identify vendors to receive the performance specification and request for proposal (RFP). Five vendors were selected to receive RFPs, and three responded. Brice Environmental Services Corporation (BESCORP) was the vendor selected.

BESCORP began mobilizing in June 1998 and began shakedown testing at the end of June. Full-scale operations commenced in mid-July and continued until mid-September 1998. The average daily soil-processing rate was 127 cubic yards (190 tons) per day. During the final month of processing, the average daily soil-processing rate was 176 yards (265 tons) per day.

The processed soils were kept in daily stockpiles until analytical data were available to verify that the goal of 5,400 mg/kg was being met. Once the verification data were available, the processed soil was returned to the range for use on the face of impact berms, since everything greater than ¾-inch had been removed from it. The material removed was essentially washed rock and was stockpiled for use by the range.

The average total lead in the unprocessed soil stockpile was 24,700 mg/kg lead, while the average total lead in the processed soil was 1,800 mg/kg, about 1/3 of the goal of 5,400 mg/kg. Therefore, about 93% of the lead in the contaminated soils was removed. In fact, 230 tons of high-purity particulate lead was removed from 11,700 tons of soil. Gravity separation techniques were employed to both separate the lead and concentrate it into a recyclable product that was 90% metal. Because of the very clean condition of the recovered metal, it could be easily recycled. The Base Defense Reutilization and Marketing Office (DRMO) accepted the containerized metal for the purpose of selling the materials and using the proceeds for the base.

The total cost for processing the soils (including the treatability study, mobilization/ demobilization, documentation, soil processing, packaging and managing recovered metals, equipment/pad decontamination, and stockpiling the treated soils) was $66 per ton or $99 per cubic yard.

INFRASTRUCTURE

Cement pads, drainage ditches, and retention ponds were constructed at each of the three ranges prior to installing the bullet traps. The design specification for the concrete in the pads used to support the bullet traps was set at 4,000 pounds per square inch. Concrete pad dimensions for the rifle, pistol, and BZO ranges were 520 × 30 feet, 208 × 30 feet, and 80 × 30 feet, respectively. The concrete pads were 8 inches thick in the front and 12 inches thick in the back to accommodate the design loads.

Concrete pads (8 × 12 feet) were constructed behind the bullet traps to support the dust-control units (DCUs) installed at each range. Two DCU pads were required for the rifle range, while only one was required at both the pistol and BZO ranges.

Permanent electrical power (480 V, 3-phase) was installed at each range to provide power for the DCU systems. The DCUs installed included metal ductwork, blower motors, control circuits, air compressors, particulate filters, and a containment system.

TRAP INSTALLATION

As part of identifying the appropriate pollution system for MCAGCC, Parsons Engineering Science, Inc. of Pasadena, California was subcontracted to perform a screening study to identify and evaluate the available types of bullet-containment systems. Three types of systems were evaluated including friction, deceleration, and impact traps. To select the most appropriate trap, an extensive set of performance criteria were developed, and weighting factors were applied to each trap and for each range. For each of the three ranges, Action Target's Target Total Containment Trap (TCT) scored best. Action Target, Inc., of Provo, Utah was subcontracted to provide and install its TCT at each of the three ranges.

From October to December 1998, Action Target installed a TCT at each of the three ranges. The design specifications included meeting a wind load of 100 mph and a live load of 20 psf. The TCT consists of 3/8-inch-thick sheet steel panels configured in a 3 × 5 or 4 × 4 panel V-shaped configuration. The V-shaped configuration ties into a steel deceleration chamber, where bullets and larger bullet fragments are captured and collected in 5-gallon buckets. The DCU is connected to the deceleration chamber and is designed to collect particulate lead dust. Air discharge permits were required for each of the DCUs.

OPERATION AND MAINTENANCE

A secondary phase of this study was to identify operation and maintenance (O&M) costs associated with the entire pollution prevention system, including the TCT, DCUs, and storm water retention ponds. During a 12-month period starting January 1999, Battelle has procured a local subcontractor (El Adobe Partners, Inc.) to manage O&M activities. After completing one year of O&M, Battelle will provide MCAGCC with an O&M manual for the entire system, including a summary of labor and material costs and recommendations for future O&M.

Installation Restoration at Naval Weapons Station Earle

Remedial Action at Closed Pistol Ranges
Navy and Contractor Personnel—Partnering in Cleanup

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ABSTRACT

Installation Restoration Sites 24 and 25 were formerly used pistol ranges at Naval Weapons Station Earle. The sites were targeted for cleanup to mitigate the potential for runoff of metals (primarily lead) in surface water and groundwater. The cleanup objective was to remove 90% of the small-caliber projectiles deposited in sandy berms without interfering with mission critical operations. Therefore, the cleanup work required a tight execution schedule and close communication between Navy and contractor personnel.

A cleanup approach maximizing the use of Naval Weapons Earle personnel and equipment in the cleanup process was implemented. The strengths of station personnel and equipment were supplemented with those of Metcalf & Eddy, a contractor accessed via the Navy's Remedial Action Contract (RAC) administered by Northern Division, Naval Facilities Engineering Command.

Initially, dry screening and disposal were evaluated to separate lead from berm soils. However, a treatability study of this method indicated as much as 59 percent of the berm material would be commingled with the lead, making recycling impractical. Subsequent soil-washing feasibility studies indicated more than 95% of the berm material could be recovered for reuse in restoration, while recovering more than 98% of the lead in the berm. Based on these findings, soil washing was selected for implementation.

Over the period September 3, 1996 through October 3, 1996, the cleanup was executed. The station provided not only direct labor to the job, such as heavy equipment operators, truck drivers and hazardous waste handlers, but also support personnel and infrastructure. Additionally, the station's Explosives Ordnance Disposal team was on standby and was consulted when live rounds were found. The station's fire department also issued hot work permits and monitored the job from start to finish. The Navy forces were augmented by construction management personnel, process operators, and field-sampling personnel from Metcalf & Eddy.

INTRODUCTION

The mission of Naval Weapons Station Earle is to receive, store, segregate, and issue ammunition to the U.S. Navy Atlantic Fleet. Past operations included ordnance maintenance activities, such as washout, stripping, painting, and restenciling of mines and torpedoes and demilitarization of ammunition items. Areas of the 12,000-acre station were used for training and for disposal of domestic and industrial wastes. Training areas included the two outdoor pistol ranges, which were closed after approximately 25 years of use. The ranges were cleaned up under the auspices of the Installation Restoration Program at Naval Weapons Station Earle.

OVERVIEW OF REMEDIATION PROGRAM

The Installation Restoration Program at Naval Weapons Station Earle addresses sites where previous activities may have caused, or have the potential to cause, environmental impact. An Initial Assessment Study in 1983 identified 29 such sites. The program will evaluate those sites to identify those that will require remedial action, further study, or no further action. To date, approximately 60% of the sites identified in the 1983 study have been either remediated or determined through further investigations (e.g., soil analysis, groundwater analysis, etc.) to warrant no further action. The two closed pistol ranges addressed by this paper were identified as Sites 24 and 25 under the Installation Restoration Program.

As a consequence of the use of Sites 24 and 25 as pistol ranges, a significant number of small-caliber bullets and empty casings were deposited in the sandy berms and in the firing line areas. The primary contaminant of concern was lead, as the ranges were to be closed and converted into multiuse recreation areas. In accordance with the U.S. Environmental Protection Agency (USEPA) and the New Jersey Department of Environmental Protection, a minimum of 90% of the projectiles would be removed, with the soil cleanup goal for total lead not to exceed 400 mg/kg.

A removal action was selected as the most appropriate method to meet cleanup goals because this alternative would serve to minimize the potential for runoff of metals in surface water and groundwater from the sites and reduce the potential of people coming in contact with the contaminants after range closure. The removal action was consistent with Navy policy to close existing small arms ranges that are no longer necessary to support mission requirements in a manner that is protective of human health and the environment.

SCHEDULING CONSTRAINTS

One of the logistical challenges of this project was to ensure the availability of equipment and personnel for ship loading/off-loading operations; this project had to be scheduled such that those mission critical operations could be adequately supported. Therefore, phasing of labor and equipment for mobilization, project execution, and demobilization required close attention to the demands of port operations. The tight scheduling constraints required solid planning on the part of management personnel. This aspect of the project demonstrated command commitment and teamwork to bringing this task to successful completion, and station personnel and equipment were positioned at the sites when needed. The entire project was completed in about one month.

FEASIBILITY STUDY

Prior to mobilization, a feasibility study[1] was conducted on a five-gallon sample of soil from each range to evaluate three removal alternatives: nonhazardous direct disposal, screening/ recycling, and soil washing/recycling. Of the three, it was originally anticipated that the direct disposal option could be the most cost-effective. However, initial assessment of the berm soils showed the total lead levels to range from 19,346 mg/kg to 38,529 mg/kg. In addition, the corresponding TCLP lead levels exceeded the 5 mg/L RCRA level; therefore, all of the berm material had to be classified as "characteristically hazardous" and disposed of as hazardous waste. In addition to the higher cost of this option was the never-ending long-term liability associated with hazardous waste disposal.

The second option evaluated was screening/recycling. Since the samples consisted of a well-graded sand with the bulk of the lead present in the form of particulates larger than ¼ inch, it seemed logical that passing the berm soils over a ¼-inch "dry screen" would remove the larger than ¼-inch lead in a form suitable for recycling, while rendering the balance of the soil suitable for reuse. To evaluate this option in the lab, the soil was screened into nine size fractions, with total lead analysis conducted on each fraction. Elevated lead levels were found not only in the larger than ¼-inch material, but also in material down to 28-mesh sand particles and clays finer than 150-mesh. As such, the screening option would have required removal of all material larger than 28-mesh and all material smaller than 150-mesh, which represented 59% of all material at the site. While the lead content of this material was in percent concentrations, it was not high enough to recover any salvage value; and in fact, recycling this material would have required payment similar to that for hazardous waste disposal. The recycling option, however, does break the cradle-to-grave chain of responsibility associated with disposal.

To further reduce the amount of material going off site, soil washing, a water-based process combining both physical and gravity separation, was also evaluated. As with the screening option, the soil was first screened into nine size fractions. Those fractions with lead levels above the cleanup goals then under went a subsequent gravity separation step, further separating the lead fragments from similar-sized sand/stone particles. This process resulted in recovery of more than 99% of all lead present, with more than 95% of the berm material meeting the cleanup goal and suitable for reuse. As such, this option could save more than $134,000 over either of the other two options, and it was selected for implementation.

While the feasibility study was being conducted, Navy personnel were preparing the site and stockpiling impacted materials. These concurrent activities shortened an already tight project schedule by more than a week and allowed for implementing field activities without delay after the remedy was selected.

PROJECT TEAM

This project was made unique by joining the process expertise of Metcalf & Eddy, subcontracted by the Navy's Remedial Action Contractor, Foster Wheeler, with the manpower, equipment, and support infrastructure of Naval Weapons Station Earle. In this era of fiscal austerity, the partnership established on this project team enabled a substantial savings to be realized in contrast to the conventional turnkey remediation contract.

The use of heavy earthmoving equipment located on station reduced the mobilization cost and demurrage charges; use of station-qualified personnel to operate equipment assured an accessible workforce for the job, reducing the need to pay for travel expenses for equipment operators and laborers. Maintenance mechanics were available to repair hydraulic equipment in the event of failure. Nonhazardous process water (6500 gallons) was disposed of at the station's wastewater treatment plant. Additional support to the job was provided by the station fire department to ensure effective oversight of the job from a safety perspective. The station's Explosives Ordnance Disposal Unit was also available to respond in the event of the discovery of unfired rounds. A Navy industrial hygienist monitored the workers for lead exposure on site; he also conducted the required Site Safety and Health briefings.

SOIL PROCESSING

The objectives of the project were to remove at least 90%of the lead in the berm, with soils containing less than 400 mg/kg total lead deemed suitable for reuse. To expedite field activities and minimize material handling, the process equipment was set up at the larger of the two ranges. It was staged on a polyethylene liner and configured to mimic the process proven effective during the feasibility study. Processing water was recycled in a closed loop, with makeup water obtained from a nearby fire hydrant.

Approximately 85%–90% of the metal bullets were found to be located between the surface soil and as much as 18 inches below ground surface. Careful excavation and close coordination between Navy personnel and the contractors' sample technicians performing postexcavation sampling resulted in "surgical" removal of contaminated material, resulting in a 500-ton reduction of material requiring treatment versus the original anticipated volume.

The soil-washing system provided three output streams: concentrated lead (bullets), washed sand, and fine clays. The washed sands were conveyed to a Navy dump truck and staged on plastic to await post-treatment confirmation samples. The fine clays collected were also sampled for reuse criteria, and the bullets were collected in drums for subsequent recycling. In accordance with USEPA and the New Jersey Department of Environmental Protection, soils had to test below 400 mg/kg lead to be reused on site. The recovered bullets were sold to a recycler for scrap value, with the proceeds used to fund subsequent quality of life projects at the base. The clays were either reused (less than 400 mg/kg total lead) or solidified and recycled at a local asphalt plant (more than 400 mg/kg total lead).

PARTNERING

Call it partnering, teamwork, or cooperation, this remediation project was a reflection of what a dedicated group of Navy, contractor, regulatory personnel, and concerned citizens can accomplish working together toward a clear goal. The willingness to attempt an unconventional project collaboration, but one that made sense from the perspectives of technical merit and cost, contributed to drive this project to success.

Naval Weapons Station Earle, in consonance with the Policy of the Chief of Naval Operations (CNO), had established a Restoration Advisory Board (RAB) of concerned local citizens that

supported the need for and the approach of this project before it was undertaken. This project also proved that partnering with the community is an essential ingredient to effective execution.

Subsequent to a RAB meeting of November 14, 1996, the *Asbury Park Press* published a very positive article on November 15, 1996 entitled "10 Tons of Bullets Cleaned Up at Earle." Additionally, USEPA stated in its August 9, 1996 letter, "we are very supportive of the Navy's efforts through this removal action to address environmental concerns at NWS Earle." In reference to the pistol range cleanups, USEPA offered that, "Excellent coordination with your contractor (Metcalf & Eddy) and Navy Northern Division [Naval Facilities Engineering Command] and good communication with USEPA and NJDEP helped ensure a quick, efficient and professional operation."

The Navy's Remedial Action Contractor, Foster Wheeler, also realized the advantage of subcontracting with Metcalf & Eddy, who delivered key personnel, equipment, and technology in a timely manner. Notwithstanding, Foster Wheeler played a major role in the disposal of process residuals and in managing tight schedule constraints.

CONCLUSIONS

The objectives were met. Approximately 1500 tons of soils was processed, and 10 tons of bullets was recovered and recycled. About 70 tons of clay fines required recycling at an asphalt batch plant. The remainder of processed soils met the criteria and were reused on the sites, with residual total levels ranging from 14.6 mg/kg to 92.2 mg/kg.[2] The combination of proven, commercially available soil-washing equipment, an existing contract, and a "can-do" project team enabled the successful completion of the project within the schedule constraints and without disrupting mission-critical operations. The benefits of partnering afforded all concerned the opportunity to achieve a successful remediation effort. With all of the above considered, the tangible benefit of this Navy-contractor team yielded a project cost savings of approximately 30% over more traditional approaches.

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Stabilization Case Studies

Twin Cities Army Ammunition Plant, Arden Hills, Minnesota

BACKGROUND

The former Twin Cities Army Ammunition Plant (TCAAP) is a 4-square-mile site located in New Brighton/Arden Hills, Minnesota. The extent of contamination covers a 25-square-mile area. Land use in the area consists of residential, commercial, and industrial with on-site wetlands and woodlands surrounding the Rice Creek watershed. From 1941 to 1981, the site was used to manufacture, store, and test small arms ammunition and related equipment. Waste materials such as VOCs, heavy metals, corrosive materials, and explosives were disposed at 14 source areas. Several of the source areas impacted by test firing activities were targeted for remediation to remove metals and reduce the toxicity characteristic concentrations of the soil.

REMEDIAL OBJECTIVES

The remedial objective for this work included on-site stabilization of contaminated soil to below the Toxicity Characteristic (TC) criteria for lead and antimony and off-site disposal.

SELECTION OF TECHNOLOGY

Phytoremediation and lead-extraction processes were implemented in earlier remediation phases of the TCAAP project. In 1998, EnviroBlend® was selected in a competitive bid process to stabilize additional soil. Total lead concentrations in the soil were between 113,000 and 330,000 mg/kg. Stabilization with EnviroBlend® achieved results below the TC criteria of 5.0 mg/L for lead in the Toxicity Characteristic Leaching Procedure (TCLP) test.

IMPLEMENTATION OF TECHNOLOGY

Contaminated soil at the TCAAP site was characterized, excavated, and stockpiled. A coarse granular EnviroBlend® was thoroughly mixed in the stockpiles using conventional construction equipment at a recommended dosage rate of 3%. The EnviroBlend® stabilization process does not require the use of water or a curing period. The treated material was then analyzed using the TCLP test. All stabilized material passed the TC criteria and was disposed in a Subtitle D landfill.

Ethylene diamine tetra acetic (EDTA) acid was found in soil at a portion of the site, potentially left over from former lead-extraction processes implemented at the site. EDTA complexes lead and other heavy metals and increases their leachability. Through a quick-turnaround treatability study in RMT's applied chemistry laboratory, RMT demonstrated treatment effectiveness using EnviroBlend® on a representative sample of soil contaminated with lead and EDTA.

COSTS

EnviroBlend® was used for the stabilization of 47,000 tons of soil. The total project cost was $777,000 for soil stabilization assistance, including treatability studies, technical assistance, pilot studies, and reagent supply.

POINT OF CONTACT

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Cedar Rapids Firing Range, Cedar Rapids, Iowa

BACKGROUND

The site is an active firing range in Cedar Rapids, Iowa for police officer training. The backstop berm area was reconstructed to address environmental concerns with high-lead concentrations in the soil and to provide additional protection for neighboring properties.

REMEDIAL OBJECTIVES

The remedial objectives at this site were to stabilize the lead-impacted soil to meet the Toxicity Characteristic (TC) criteria for lead, recycle lead bullets, and restore the berm for future use.

IMPLEMENTATION OF TECHNOLOGY

Soil Stabilization

Prior to screening lead from the berm soil at the gun range, soil was stabilized using EnviroBlend®, a dry, coarse chemical delivered to the site in dump trucks. EnviroBlend® was applied surficially to site areas requiring treatment, then mechanically blended into the soil using a tracked excavator. The soil was blended until a homogenous mixture was achieved. *In situ* treatment of the soil prior to excavation allowed the material to be rendered nonhazardous prior to further management, avoiding generation of an unpermitted hazardous waste pile. Following treatment of the soil, two samples were collected for Toxicity Characteristic Leaching Procedure (TCLP) -lead analysis. The TCLP results demonstrated lead concentrations below 5 mg/L in the stabilized material.

Lead Screening

After the soil was treated and confirmed to be nonhazardous, RMT screened lead bullets from the soil using a MKII PowerScreen with a 3-inch upper deck and a ¼-inch lower deck. Soil was fed into the hopper on the screen, and three material piles were generated:

1. Material retained on the 3-inch screen—typically large soil clods, debris, and rocks.
2. Material retained on the ¼-inch screen—expected to be lead material.
3. Material passing through both screens—fine soil particles.

Lead Management
Lead recovered from the soil was to be transported to the Doe Run Resource Recovery Facility in Boss, Missouri for recycling. Analysis of the lead-containing material screened from the soil indicated it was approximately 50% lead by weight and not suitable for recycling. EnviroBlend® stabilizes soil, and the treated material is stable over a wide range of conditions and is protective of leaching to groundwater. Because of this quality, the screened and stabilized material could be used as backfill for reconstructing the core of the backstop berm.

COSTS

The total project cost for EnviroBlend® stabilization and screening was $45,000.

POINT OF CONTACT

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Nahant Marsh, Davenport, Iowa

BACKGROUND

The Nahant Marsh site in Davenport, Iowa is a former shooting range with lead-contaminated soil and sediment. Heavy-metal contamination consisting of lead, arsenic, silver, and antimony was found in soil and sediment surrounding the five shooting platforms on site. An additional shooting area was identified that appeared to have been used early in the history of the site. An estimated 9 tons of lead shot was deposited on the site annually for 27 years for a total of 243 tons of lead shot.

The source area was identified as the area impacted by past shooting activities. The U.S. Fish and Wildlife Service conducted sampling of the marsh area and found up to 283 lead pellets per grab sample in sediment samples collected between 109 and 177 yards from the shooting platforms. Local waterfowl were diagnosed with lead poisoning from lead shot. Since arsenic, silver, and antimony concentrations did not exceed RCRA Toxicity Characteristic Leaching Procedure (TCLP) limits, lead was the only constituent of concern.

REMEDIAL OBJECTIVES

The remedial objectives for this site included development and implementation of a stabilization approach to meet the Toxicity Characteristic (TC) criteria of 5.0 mg/L for lead in the TCLP test, followed by off-site disposal of stabilized material.

IMPLEMENTATION OF TECHNOLOGY

Through bench-scale treatability study analysis, RMT determined a 2% dose of EnviroBlend® would effectively reduce TCLP-lead concentrations in the soil to below 5.0 mg/L. EnviroBlend® was applied to stockpiled material, then thoroughly mixed using conventional construction equipment. After receiving confirmational results from a certified laboratory, the stabilized material was disposed of at an off-site landfill.

COSTS

The total project cost for EnviroBlend® stabilization was $52,000 for 7,700 tons.

POINT OF CONTACT

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Beneficial Uses for Recycling of Organic and Inorganic Contaminated Soil with Encapco's $_2$RM™ Process

INTRODUCTION

In many areas where aggregate materials are not locally available and must be imported, the cost savings from recycling contaminated soils that would otherwise not be useable can be substantial. Recycling of contaminated soils can reduce the time that land remains nonproductive until site remediation can restore it to a beneficial use. In the United States, large quantities of soil on deactivated military bases and industrial properties must be remediated before site closure is possible. Encapco's $_2$RM™ technology can provide a time-saving solution to these problems.

Since early 1994, federal and state of California agencies have completed two projects that evaluated the effectiveness of contaminated soil remediation using a cold-mixed asphalt emulsion technology. These studies were conducted at a military facility and state highway project in northern California for the U.S. Army Corps of Engineers and the California State Department of Transportation (Caltrans). Last year, the U.S. Environmental Protection Agency (USEPA) and the Civil Engineering Research Foundation (CERF) of the American Society of Civil Engineers established an Environmental Technology Verification (ETV) Center. The ETV Center will conduct pilot studies to verify the performance of new, commercial-ready environmental technologies and transfer this information to users, such as trade and consulting engineering organizations. Encapco's use of organic emulsions to chemically encapsulate soil contaminated with inorganics such as lead was selected as one of the first pilot programs under the ETV program.

OBJECTIVES

Recent asphalt stabilization pilot studies have demonstrated that an environmental liability can be transformed into an asset and a useable end product that meets regulatory requirements as a comparative cost savings over alternative treatment and disposal methods. These technology projects developed contaminated soils remediation data that

- Demonstrated the feasibility of transforming a hazardous waste to a nonhazardous construction material that meets conventional engineering design and materials standards for roadway bases, light traffic pavements, landfill caps, berms, and levees, while mitigating a concern over the fate of encapsulated contaminants.
- Addressed regulatory compliance requirements, including demonstration of the effectiveness of encapsulation of contaminants in the emulsified asphalt matrix by certified test results.
- Provided a practical, cost-effective substitution for a commercial roadway construction product that meets industry standards.
- Provided owner-users, developers, and governmental agencies with an acceptable project alternative to other soil remediation options with the added benefit of a reusable product.

GENERAL CONSIDERATIONS

There is a wide range of technologies that are applicable to the remediation of contaminated soil. An approach developed in the United States to help project site cleanup managers identify parameters for evaluating the suitability of alternative technologies is a matrix called "Treatment Technologies Applications Matrix for Base Closure Activities." (Ref. 1) This matrix was prepared to help in efforts to accelerate restoration and reuse of closing military bases throughout the state of California. It emphasizes that determining the best technology requires careful evaluation of several, mostly site-specific, considerations.

Unless the type and degree of contamination is known, it is difficult to choose the most suitable technology. It is very costly to fully characterize an unknown waste, so it is important to identify both the compounds of concern and the compounds suspected of being in the soil. Soil characteristics can also have a limiting effect on many processes. The most common problem is the ineffectiveness of many in-situ processes on clay formations due to their imperviousness to vapor and liquid flow.

The volume of soil to be treated influences the cost of selected processes because of economies of scale. The depth below ground surface of the contaminant must also be considered because of the costs of deep excavations to reach lower contaminated zones. The length of time it takes to reduce contaminant concentrations below target levels and restore a site to productive use often becomes a cost that many site owners cannot afford. Technologies that speed up the remediation cycle will often be more desirable than slower processes.

Some remediation processes produce emissions or other side effects that are undesirable or prohibited by local governments or the public. For example, high temperature oxidation (incinerators) or thermal desorption can be very effective in destroying organic materials but be politically unacceptable.

Because the end product of this technology is typically a roadway pavement base, or fill material placed on or in the land, the relevant environmental rules and regulations in the United States come under USEPA and State of California Department of Toxic Substances Control (DTSC) regulations for materials classified for "use in a manner constituting disposal." USEPA has issued regulations that exempt recycled waste from Resource Conservation and Recovery Act (RCRA) regulations, provided the following conditions apply:

- The resulting product is produced for the general public's use.
- The product contains recyclable materials that have undergone a chemical reaction as to become inseparable by physical means.
- The product meets the Land Disposal Restriction (LDR) standards.

Most states administer the RCRA program within their jurisdictions without any modifications. The state of California has adopted regulations that exempt such materials under the same conditions as USEPA, except that the recycled waste products must be derived from non-RCRA hazardous wastes and meet specific criteria for toxicity and leachability after mixing and encapsulation.

Under Article 3, Section 66366.30, Chapter 16, Division 4.5 of Title 22, California Code of Regulations (CCR), contaminated soils that may be used in the production of asphalt pavement or asphalt-treated road base are considered recyclable materials that are placed on the land. Under specified conditions, these recycled products can be excluded from classification as a waste. Included in these conditions is the requirement that hazardous constituents in the recyclable material whose concentrations are greater than or equal to the Soluble Threshold Limit Concentrations (STLC) set forth in Section 66261.24 (a)(2)(A) of Title 22 CCR shall be chemically reacted or become physically bound so as not to leach from the product containing the recyclable material.

ASPHALT EMULSION TECHNOLOGY

Site remediation treatment technologies generally fall under the following categories: biological treatment, chemical treatment, physical separation, stabilization, and thermal treatment. Asphalt stabilization has some fundamental differences from the most commonly used cement or pozzolonic-based stabilization processes. Pozzolonic materials consist of lime and other silicates, which are high-pH inorganics. In contrast, emulsified asphalt is an organic material with a more neutral pH. Asphalt stabilization has been used to remediate relatively large volumes of soil (more than 3,000 cubic yards), contaminated with heavy petroleum hydrocarbons (e.g., diesel, crude oil, or motor oil) or with some metals (e.g., copper, lead, and zinc). Contaminated soil is mechanically crushed and/or screened to yield a graded aggregate that is mixed with asphalt, resulting in an asphalt paving mixture. The contaminants are stabilized by the $_2$RM™ process, that is, chemically and physically fixated by the asphalt to reduce leaching.

The use of emulsified asphalt in paving goes back some 50 years. The first commercial asphaltic emulsions for paving were emulsified-asphaltic oils for dust-laying. In order to be used for a paving material, asphalt concrete or asphalt-treated bases must be strong enough not to shove, flow, or rut under traffic loading, yet be resilient enough not to crack, chip, or break apart under the same loads through weather extremes of heat, cold, water, snow, or ice. Guidelines have been developed and published for the use of asphalt emulsions to create road-base materials. The Asphalt Institute Manual series (Ref. 2) publishes specifications and methods for emulsified-treated base.

Asphalt emulsions consist of intimate mixtures of asphalt, water, and an emulsifying agent. The physical and chemical properties of the emulsion depend on the emulsifying agent's chemical type and molecular structure. When the emulsifying agent is mixed with asphalt and water, its molecules align with those of the asphalt and water, forming an emulsion with a negative (anionic) or positive (carbonic) surface charge. The presence of charged chemicals in emulsions improves the adhesion of asphalt to aggregates over the adhesion that occurs in asphalt concrete. The surface of aggregates carry a charge; and if this charge is opposite that of the emulsion, a stronger bonding can take place.

The objective is to make a dispersion of the asphalt emulsion in water, stable enough for pumping, prolonged storage, transportation, and mixing. During mixing, the emulsion coalesces and encapsulates the soil particles. The hydrocarbons in the soil preferentially adsorb onto the asphalt surface and diffuse into the asphalt. The result is a blending of the contaminant with the

asphalt into an integral, stable part of the mixture that is chemical bonded. Upon curing, the emplaced $_2$RM™ product retains the adhesive, durability, and water-resistant properties of the asphalt cement from which it was produced, provided the emulsion mix was properly designed.

The $_2$RM™ product meets the Caltrans design specifications for aggregate road base or sub-base for highway construction projects. Test cases have shown that the product is stronger than a typical aggregate base course and can have characteristics of higher-grade construction materials as well. It reaches full hardness in approximately 30 days and can be used as a substitute for standard Caltrans Class 2 or 3 aggregate base rock.

The potential for encapsulating heavy metals using a proprietary organic emulsion process that is comparable with asphaltic emulsions has been studied and found to be feasible under certain conditions. The technology used to solve contamination problems while creating a useful product utilizes specialty emulsions designed for total petroleum hydrocarbons (TPH), heavy metals (primarily lead), and PAHs. Because of the organic chemistry used in the technology, the assimilation of TPH and PAHs into the cured product is an expected result, based on the principle of "like dissolves like."

PROJECT PLANNING AND CONSTRUCTION OPERATIONS

The remediation projects were conducted by Encapco in cooperation with federal and state of California agencies. The projects included evaluation of site-specific soil conditions, laboratory treatability (bench-scale) testing, and field pilot studies to determine feasibility. The projects consist of three basic stages:

Site-specific Mix Design – Site samples are taken to a testing laboratory for

- chemical/toxicity analysis for contaminant encapsulation,
- structural analysis for engineering design purposes, and
- formulation of mix design to satisfy environmental criteria and construction industry specifications.

On-site (ex-situ) Mixing (for micro or chemical fixation) – Excavated soil is stockpiled and prepared for

- screening to remove deleterious material,
- feeding to a rotary pug mill,
- addition of emulsion and mixing with soil, and
- delivery of mixed $_2$RM™ product in trucks to placement location.

Placement (macro encapsulation) – The product is placed using conventional construction techniques:

- road preparation and grading,
- placement and compacting, and
- curing.

OBSERVATIONS AND RESULTS

Two demonstration projects were performed in the state of California. Fort Hunter Liggett (FHL) treatability studies for the U.S. Army Corps of Engineers, and Interstate 80 Highway Corridor in Emeryville and Richmond for Caltrans (Ref. 3). The Fort Hunter Liggett study was previously reported in a paper presented to the Air Force Center of Environmental Excellence Conference in San Antonio, Texas in August 1995 (Ref. 4).

Fort Hunter Liggett Pilot Treatability Study

Laboratory testing for the FHL pilot study was started in August 1994, and fieldwork was completed in September 1994. Approximately 780 tons of contaminated soil was made available for the study. Prior to the start of the pilot study, a site investigation was completed to collect soil characteristics data. The maximum concentration of TPH as motor oil in the soil samples was 8,000 milligrams per kilogram (mg/kg). In order to start with a concentration of 15,000 mg/kg, the soil samples were "spiked" with motor oil. Two months prior to the field study, Encapco performed laboratory bench-scale testing on samples collected from the stockpiled contaminated soil and formulated a site-specific emulsion mix design. Bench-scale analytical test results are shown in Table 1.

Table 1. Bench-Scale ETB Product Samples Test Results

ENGINEERING PROPERTIES		ANALYTICAL		
R Value	18@17% emulsion	Tests	Requirement	Result
Flow, 0.01 in.	10.6 – 11.7	TCLP Extraction		
Expansion pressure (300 psi)	380	Volatile Organics	EPA 8240	ND
Marshall Stability, lb.	520 – 722	Semivolatile Organics	EPA 8270	ND<100 ug/l
% Bitumen by dwa	12.16 – 13.44	STLC – Metals		
% Emulsion by dwa	19.0 – 21.0	Lead, mg/l	5.0	ND<0.5
		Cadmium, mg/l	1.0	0.1

On-site mixing was based on a maximum aggregate size of 1 inch because of pug mill auger capacity limitations. A portable screening unit was set up to screen out materials greater than 1 inch. All premixing operations were performed within a delineated exclusion zone in accordance with proper hazardous waste operation procedures. This included stockpiling, screening, pug mill hopper, conveyor, and mixer equipment.

The screened soil was processed with the designed emulsion over a two-day production period. On average, the pug mill produced approximately 75 tons of soil/asphalt emulsion mixed product per hour. This production rate was considered relatively low because of the special steps taken to calibrate the digital belt scale to maintain asphalt emulsion loading rates between 17 percent and 22 percent by dry weight aggregate (dwa). A number of improvements were identified that could

effectively raise hourly production to a minimum of 300 tons per hour, while maintaining the same daily quality control.

The product produced from the pug mill was transported by dump trucks to a dirt roadway and recreational vehicle parking area located approximately six miles away. The product was placed by conventional road grading means as a substitute for Class 2 aggregate base rock. A double chip seal surfacing was applied over the product to function as a wearing surface. Core samples of the final roadway section were taken and analyzed for the leachability potential of hydrocarbons in the $_2$RM™ product. A summary of the core samples test result is shown in Table 2.

Table 2. ETB Core Samples Analytical Results

ENGINEERING PROPERTIES		ANALYTICAL		
Flow, 0.01 in.	10.5 – 12	Tests	Requirement	Results
Marshall Stability, lb.	748 – 1045	TCLP Extraction		
% Bitumen by dwa	12.21 –13.94	Volatile Organics	EPA 8240	ND
% Emulsion by dwa	19.1 – 21.8	Semivolatile Organics	EPA 8270	ND
		STLC – Metals		
		Lead, mg/l	5.0	ND<0.25
		Cadmium, mg/l	1.0	0.060
		Zinc, mg/l	250	ND<10

Interstate 80 Highway Field Project

The Caltrans project was conducted between two sites along the Interstate 80/580 Corridor east of San Francisco Bay. The first project site involved widening roadway sections and constructing connector ramps along Route 580 to northbound Interstate 80 in Emeryville. The second project site involved an interchange at Richmond Parkway and I-80, roadway sections, and a commuter "park and ride" lot.

Approximately 11,000 tons of contaminated soil was removed from a former steel mill site in Emeryville. The soils contained lead concentrations of up to 2,3000 mg/kg. Analytical tests characterized the soil as a "California-only" hazardous waste but below the federal limit for a RCRA characteristic waste. According to Waste Extraction Test (WET) results, leachable lead concentrations were as high as 17 mg/l. However, Toxicity Characteristic Leaching Procedure (TCLP) results were below the federal limit of 5 mg/l. A representative set of samples was taken from the site and evaluated for chemical and engineering structural characteristics. Strict testing protocols were followed to ensure thorough characterization of the material and to provide accurate data for the asphalt emulsion mix design. A summary of the Emeryville site soil characteristics prior to treatment is shown in Table 3.

Table 3. Caltrans Project Soil Characteristics Prior to Treatment

STRUCTURAL CHARACTERISTICS		ANALYTICAL		
Sieve Size	% Passing	Tests	Composite	Lot 4
1 inch	100	TCLP Lead, mg/kg	1,800	2,300
#4	59.1	STLC Lead, mg/l	20	335
#200	12.9	TPH, mg/kg	110	160
Sand Equivalent	32			
Plasticity Index	N/P			
Maximum Density	142.2@7.6%			

Bench-scale evaluation and testing led to an emulsion design capable of physically encapsulating the lead contamination while creating a high-quality road base product. The resulting mix design was applied to the stockpiled soil at the Richmond site using a conventional pug mill. Test pellets were prepared and bench-scale tested to verify that performance criteria were met or exceeded.

The on-site mixing stage involved excavation and stockpiling of the contaminated soil at the Emeryville site. The soil was screened to a sieve size of 1 inch or less, then mixed by weight and moisture conditioned as required. No additional aggregate was added during the process. The soil was hauled to the Richmond site and stockpiled. At the Richmond site, the asphalt emulsion was proportioned by batch weight and mixed with the soil in a pug mill. The quantity of water was adjusted to meet optimum moisture content requirements.

Quality control sampling and testing were used throughout the process to verify field performance. Following completion of the production phase, core-drilled samples of the in-place product were taken to verify performance. Testing protocol included chemical analysis and structural integrity testing for residual asphalt binder within the mixture, Marshall Stability, flow, softening point, and penetration. A summary of the postproduction product characteristics is shown in Table 4.

Table 4. ETB Postproduction Characteristics

STRUCTURAL INTEGRITY		ANALYTICAL				
Test	Result	Tests	1	2	3	4
Cohesion Value	769	STLC Lead, mg/l	.45	.33	ND	ND
Moisture/Density	131 lb. @ 10.8% moisture	TPH	N/A	N/A	N/A	N/A
R-Value (cured)	95					
Marshall Stability	@ 15% 2617					

The structural strength of the product was further verified by the use of field deflection measurements on a section of roadbed. A preliminary evaluation of the Caltrans Gravel Factor equivalent was made by Dynaflect deflection measurements and AASHTO structural evaluation

calculations. These tests resulted in a Gravel Factor of 1.5, which is slightly higher than assumed for asphalt-treated permeable base (1.4) but significantly higher than Class 2 aggregate base (1.1).

BENEFITS

The Fort Hunter Liggett and Caltrans projects demonstrated the commercial viability of the $_2$RM™ process from the standpoint of remediating hazardous materials and recycling the treated materials into an economical construction material that would otherwise not be available. In addition, the projects demonstrated the resolution of an expensive environmental problem of disposal of the contaminated soil.

Some benefits of ETB realized on both projects were the following:

- Successful elimination of the hazardous waste generator liability by transforming it into a commercial construction product at an economical cost.
- Application of ETB emulsion and contaminated soils without the need for additional aggregate material.
- Achievement of structural strengths for roadway base courses, above those required by Caltrans specifications.
- Production of an emulsion that is highly effective in encapsulating TPH and soluble lead.
- Provision of a cost-effective solution to waste management problems for owners and operators of a wide variety of facilities with heavy petroleum and metal-contaminated soils.

NEW DEVELOPMENTS WITH OTHER ORGANIC EMULSIONS

Other organic emulsions have been developed recently for use in recycling of metal-bearing RCRA-contaminated soils. These new emulsions are compatible with the asphalt emulsions used on the Fort Hunter Liggett and Caltrans projects but are capable of chemically encapsulating heavy metals. Soil characterized as “yellowish-brown clayey sand with gravel/sandstone” was used in an on-going laboratory testing program conducted by Encapco to provide guidelines for the innovative emulsions. The soil contained approximately 30 percent silt or clay and had an optimum moisture content of 11.4 percent. Lead sulfate was added to the soil as a dry powder at a concentration of 2,000 mg lead per kilogram. This would typically result in about 55 mg/l when the spiked soil was tested under the TCLP. USEPA regulations classifies a waste as hazardous if its TCLP is 5 mg/l or greater.

Two emulsion formulas using both asphalt and tall oil pitch as a base have been successful in chemically fixing lead in the spiked soil in recent laboratory tests. A typical emulsion formula consists of about 50 percent organic base material, emulsifier, and additives. The remaining 50 percent is water. A dosage of 8 percent by weight, a material suitable for $_2$RM™ construction, has been produced, which reduced the soluble lead from 55 mg/l to below 5 mg/l when tested by the TCLP.

These emulsions are readily produced using conventional equipment and techniques and have shown good stability and handling properties. Test data indicate that scaling up to the field-mixing stage with these improved emulsions should not present any significant problems. Field-

scale performance of these organic emulsions will be the focus of Encapco's planned pilot studies with the Civil Engineering Research Foundation's Environmental Technology Verification program.

CONCLUSIONS

With the current focus on waste reduction by recycling, cold-mix asphalt stabilization technology provides a viable, cost-effective alternative to other on-site soil remediation technologies. The $_2$RM™ product provides a practical solution to the environmental problems of contaminated soil and provides a direct benefit to agencies and owners who have projects involving roadways, landfill caps, berms, levees, and other similar facilities.

Data from the projects described in this paper show that the chemical and engineering properties of the end product can be managed as a nonhazardous, nonregulated construction material. Upcoming USEPA/CERF ETV pilot studies of organic emulsions designed to chemically fix heavy metals and other semivolatile organics will produce more data to confirm the feasibility of exempting recyclable contaminated soils that fall under the regulatory definition of "use constituting disposal." In short, this technology offers a cost-effective and timely answer to the waste management concerns of owners and developers of a broad range of sites with contaminated soils problems.

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APPENDIX B

Mining-Based Sampling Overview

Courtesy of
Brice Environmental Services Corporation

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Mining-Based Sampling Overview

Field sampling of small arms ranges poses many challenges that render conventional sampling methods insufficient for range soils with particulate contaminants. Not recognizing the unique features of small arms firing range contamination and applying conventional sampling and analytical techniques will result in widely varying data, making interpretations difficult as outlined in the following examples.

Example #1

Consider the following:

- A 1.0-lb (454 g) sandy-soil sample that contains 20 pieces of small particulate lead (0.07 g each or 1.4 total g of lead), and there is no other lead contamination in the soil.
- The 1.0-lb sample contains 3,084 mg/kg total lead (1.4 g/454 g = 0.308% or 3,084 mg/kg)

Now let's suppose that an analyst weighs out triplicate 2-g subsamples for total lead analysis following the standard USEPA method:
Sample #1: Consider that there was 1 piece of lead in the sample. If the lead completely digested, the analytical result would be 0.07/2 g = 3.5% lead or 35,000-mg/kg Pb.

Sample #2: Consider that this time that there was no particulate lead in the sample. The analytical result would be 0.0-mg/kg total lead.

Sample #3: Consider that there are 2 pieces of lead in this sample (statistically unlikely but not beyond the level of probability). The analytical result would be 0.14/2 g = 7% lead or 70,000-mg/kg total lead.

Essentially, the true total lead content of the sample (3,084 mg/kg) cannot be determined following USEPA methods. Either a value of 0.0 mg/kg will be generated or a value much higher than the true value. If the particulate lead is not removed first, the only way that the true total lead value for the sample can be determined is if the complete 1-lb sample were analyzed (a total of 227 2-g samples) and the results averaged.

The solution is to employ both mining-based methods and USEPA methods. The particulate lead should be removed using density separation techniques, followed by triplicate digestion and analysis of the particulate lead-free soil. The mass of recovered particulate lead (mg/kg) can then be added to the average soil total lead result (mg/kg) for a more accurate accounting of the total lead in the soil.

Example #2

The distribution of nonparticulate lead contamination in the soils of small arms firing ranges is a function of soil particle size, with the highest total lead residing in the finer soil fractions. Table 1 contains residual lead concentrations for soil collected from Range 13 at Fort McClellan during a range assessment project and illustrates the distribution of lead as a function of decreasing particle size.

Individual granules of the soil can be significant relative to the size of a subsample taken for analysis, so the analytical results can vary depending on the particular group of granules selected in the subsample. As shown below, the minus 50-mesh soil fraction comprises 61% of the soil yet contains over 97% of the nonparticulate lead in the soil. The minus 200-mesh soil fraction alone makes up only 34% of the soil gradation yet contains over 72% of the nonparticulate lead in the soil. Note also that there is more than an 18-fold difference in total lead between the 4 x 10 fraction and the minus 200-mesh fraction.

Typically, the coarse soil fraction (plus ¼ inch) is not included in the 2-g sample taken for digestion and total lead analysis (given the 2-g sample size typically used for digestion, only fine soil fractions can be used). With no controls governing the granule size and number of granules selected for digestion, each 2-g sample will contain a different soil gradation. Consequently, for example, one sample that contains more minus 200-mesh soil portions will generate a higher total lead result than a sample containing more 10 x 50 soil.

Table 1. Residual Lead Concentrations for Soil Collected from Range 13 at Fort McClellan

Soil Gradation (Standard Sieve Mesh Size)	**Soil Gradation (%)**	**Residual Lead Concentration by AA (mg/kg)**	**Residual Lead Distribution (%)**
+3/8"	18.85	10	0.20
-+4	4.53	50	0.24
-4 x 10	3.65	108	0.43
-10 x +50	11.25	165	2.00
-50 x +200	27.80	836	25.06
-200	33.92	1,970	72.07
Treated Soil Totals	100%	927	100%

The complete soil contains an actual weight-averaged total lead value of 927 mg/kg. In order for this value to be derived from the standard 2-g soil sample, digested, and analyzed for total lead in the laboratory, the sample would have to contain the same fractional soil percentages (gradation) as the raw soil shown above.

The mining-based solution when analyzing small arms range soils is to first determine the soil gradation and remove the particulate lead from each fraction using density separation techniques. Then, analyze each particulate-free soil fraction individually for total lead using USEPA

methods. The residual total lead value for each fraction is then weight-averaged with the fractional percentage to derive the total residual lead value for the composite or "whole" soil.

Mining-Based Sample Collection

The number one challenge with regard to small arms firing ranges is an accurate and cost-effective assessment of total lead in soil. Large variation is prevalent at firing ranges because lead particulates are present in various size ranges and individual soil granules contain differing amounts of nonparticulate lead contamination.

The mineral processing industry has established guidelines for sample size to generate results that have a high confidence level and relative precision. Those guidelines are shown in Table 2. The table indicates that small arms range soil samples would need to be too large to analyze directly since soils can contain gravel particles 0.375 inch and larger in diameter, and bullets are in the range of 0.22 to 0.5 inches in diameter. Even if the soil was found to be uniform, more than 100 lbs. of sample are required.

Brice has developed field sample collection and reduction approaches that incorporate the required sample size to help control the adverse effects of sample heterogeneity. These approaches include:

- For impact berms at rifle and pistol ranges, use an excavator test trench in selected locales. A composite sample representing the vertical soil column and lead contamination can be collected from the walls and floor of the excavation. The vertical extent of lead contamination is typically driven by the visual presence of particulate lead. With this approach, the quantity of soil requiring treatment can be approximated.
- For trap/skeet ranges, typically only the top 6 inches to 1 foot of soil is contaminated. Excavating a series of small areas within the range can be performed with an excavator or shovel, based on the size of the area and the nature of the soil.
- Place the soil collected from each of the above approaches on a large tarp. The sample is then "rolled" and homogenized by lifting the corners of the tarp and mixing the soil. With two people, over 300 lbs of soil can be mixed using this approach. A 5-gallon subsample is then taken with a garden trowel from numerous random points.

The actual sampling steps employed are site-specific and a function of particulate lead distribution and soil gradation. A stratified sampling approach, done by dividing the area to be sampled into more homogeneous groupings, may be required to reduce variation in analytical results. A stratified sampling approach may be required for impact berms containing obvious bullet pockets with large depositions of lead, skeet ranges containing discrete areas of heavy lead shot accumulation, and firing ranges that utilized different soil types in the construction of the impact berm and range floor.

It is important when designing a sampling plan for a small arms firing range to recognize that

- uncertainty will never be reduced to zero, and
- the money spent collecting samples to reduce uncertainty should be balanced against the value of the reduced uncertainty.

Once a representative sample is collected, the next step is an accurate analysis of the sample for total lead.

Table 2. Required Sample Size as a Function of Sample Heterogeneity

	Sample Weight Needed for Various Ore Types		
Diameter of Largest Piece (in./mesh)	**Uniform Ore Sample Size (lbs.)**	**Medium Ore Sample Size (lbs.)**	**Heterogeneous Ore Sample Size (lbs.)**
0.5	250	556	3,200
0.375	141	313	1,800
0.312	98	217	1,250
0.25	63	139	800
0.1875/4	35	78	450
0.131/6	17.2	38.1	220
0.093/8	8.65	19.2	111
0.065/10	4.3	9.5	55
0.046/14	2.16	4.8	28
0.0328/20	1.075	2.37	13.76
0.0232/28	0.539	1.2	6.9
0.0164/35	0.269	0.59	3.44
0.0116/48	0.135	0.3	1.73
0.0082/65	0.067	0.15	0.86
0.0058/100	0.034	0.075	0.43
0.0041/150	0.017	0.038	0.215
0.0029/200	0.009	0.019	0.107

Source: Taggart, 1945

Both physical recovery techniques for particulate metal and USEPA methodology are required for an accurate assessment of lead contamination. Steps for performing this include

- a gradation determination,
- particulate metal recovery and a determination of total lead content (gravimetric analysis), and
- particulate-free fractional analysis for total lead using 8-g digested subsamples instead of 2-g digested subsamples.

The soil gradation is required because the fractional percentages will be utilized in the subsequent steps. Wet screening instead of dry screening should be utilized to ensure that each fraction is free of small soil granules, which may be more contaminated and, consequently, bias the analytical results.

Once the soil is wet-screened, each fraction should be density-treated to recover the particulate metal. The particulate metal recovered from each fraction should be dried, weighed, and the results recorded. Small arms firing range soils contain copper and zinc jackets, while the lead may contain hardening agents such as antimony. The recovered metal should be subjected to pyrometallurgical analysis to determine the percent lead as outlined below.

Mining-Based Sample Analysis

Contaminated soil samples from firing ranges are usually a heterogeneous mixture of matrix materials and contaminants. Individual granules of the soil samples can be significant relative to the size of a subsample taken for analysis, so the analytical results can vary considerably depending on the particular group of granules selected in the subsample. Variation caused by subsampling can be reduced by using a large subsample; but for heavy metals in particular, the digestion techniques for analysis of total metals usually call for a maximum subsample size of only 2 grams.

With no controls over the granules selected for digestion and ignoring the coarser soil fractions, analytical results for metals in soil can vary wildly. Brice has found that heavy metal contamination, for example, can vary by over two orders of magnitude between the finest soil fraction (minus 200-mesh) and medium sand (10- by 40-mesh) alone. Consequently, one sample that contains more minus 200 will generate a higher total metal result than a sample that contains more 10 x 40 soil and so forth. In summary, for an accurate determination of soil contamination, the sample analyzed has to contain the same fractional soil percentages (gradation) as the raw soil.

The situation regarding an accurate determination of soil contaminant levels is further compounded by the presence of particulate metal and organic matter. Clearly, particulate metal presents a significant source of variation when analytical subsamples are limited to several grams. Organic matter (leaves, sticks, grass, etc.) can also present a source of variation because it functions as a contaminant “sink” for organics and inorganics. Brice has found metal contamination in organic matter to be as high as three orders of magnitude above the contamination level of the soil at some sites, thus the impact of varying amounts of organic matter in the small subsample being analyzed can be significant.

The approach developed by Brice to accurately determine feed soil and post-treatment soil contaminant levels is as follows:

- Perform no composite soil analyses, but rather fractional analyses.
- Remove all particulate metal and organic matter from the specific fractions prior to any fractional analyses.
- Analyze the particulate- and organic-free soil fractions individually for listed contaminants.
- Increase the sample size to 8 grams for the conventional total metals acid digestion method.
- Weight-average the fractional soil analytical results with the percentage contribution of each fraction to derive the composite feed soil contaminant concentrations.
- Add the percentages of particulate metal from each fraction to derive the total percentage in the feed soil. Add the lead and copper determinations for the particulate metal to the feed soil concentrations.
- Add the percentages of organic matter from each fraction to derive the total percentage in the feed soil. Weight-average the contaminant contribution from the organic matter and add to the feed soil concentrations.
- Multiply the contaminant concentrations found in the water used for each sample with the volume of water used, and add to the feed soil concentrations.

By using larger subsample sizes and removing particulate metal and organic matter from the soil for separate analysis, soil contaminant concentrations will be more accurately derived. These sample preparation and analysis approaches will help control the adverse affects of sample heterogeneity and reduce the coefficient of variation in analysis results.

Gravimetric Analysis

The representative sampling and accurate analysis of soil containing particulate metal contamination is imperative to prevent erroneous results and bias. To avoid the "nugget effect" in feed soil analyses caused by particulate metals, the particulate metal will first be removed and accounted for in the soil fractions amenable to density treatment. The concentrations of lead, copper, zinc, and antimony in the recovered metal will then be determined by pyrometallurgical means. Note: Although zinc and antimony are not traditionally listed as metals of concern, the concentrations of these metals may affect recycling options and costs. Gravimetric results for lead and copper will then be added to the soil analytical results for those metals to yield more accurate feed soil concentrations.

Removing the particulate metal prior to analyzing the soil for metals reduces the coefficient of variation. In addition, the pyrometallurgical method overcomes three shortcomings of the conventional acidic extraction method used to prepare environmental samples for metals analysis:

- limited sample size,
- saturation of the extraction fluid, and
- inability to dissolve metal lumps.

The pyrometallurgical method involves taking a sample of the recovered particulate metal and blending it with sufficient carbon and borax to maintain a reducing environment and produce a stable slag that minimizes metal volatilization. The mix is then placed into a silicon carbide crucible and heated to 2,000 F until melting is complete.

Upon cooling, the slag is chipped away from each metal ingot and combined to form one slag sample. The ingot is sampled by drilling, followed by digestion and analyses of the drill cuttings. Both the ingot and slag are analyzed for lead, copper, antimony, and zinc, and the results from each product combined to generate the percentage of each element in the metal sample. The metal percentages are converted to mg/kg and added to the mg/kg nonparticulate metal results for the soil to derive total feed soil-metal concentrations.

The pyrometallurgical method is designed for analysis of metals in the percent range and is not subject to saturation effects that limit the maximum metal content that can be determined. Up to 4 lbs of sample can be smelted per crucible, thus sample heterogeneity and bias is substantially reduced when compared to the acidic digestion method for soils in which 0.5 to 2 grams of soil is typically used.

With this approach, the percentage of particulate metal in the soil can be determined, and the quantity of metal to be recovered can be estimated. The pyrometallurgical method reveals the quantity of lead, copper, zinc, and antimony in the recovered metal, enabling the recycling value, or recycling cost, to be determined.

Once the particulate metal is removed, each soil fraction (less than ¼ inch) should be digested in triplicate and analyzed for total lead. Oversize soil granules such as gravel and cobbles are generally too large to digest. Typically, when washed of fines, this rock contains no lead and subsequently does not require analysis.

Standard USEPA SW-846 Method 3051 is used for digestion of samples for total metals analysis. Increasing the sample size for digestion from 1 or 2 grams to 8 grams enhances the representativeness of samples from small arms firing ranges. The digestates can then be analyzed by flame AA or by ICP according to SW-846 Standard Method 6010.

The pyrometallurgical results will reveal the total lead content of the recovered particulate metal. The USEPA method results will reveal the total lead content of the particulate-free soil. The USEPA method results for each fraction should be weight-averaged with the percentage of each soil fraction to derive the nonparticulate total lead in the composite soil.

When the percent total metal from the soil is multiplied by the percent lead making up the particulate metal, the percent lead as particulate is determined. Adding the nonparticulate lead for the composite soil and the percent lead as particulate generates the accurate total lead in the soil.

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APPENDIX C

Template: Scoping Document for Soil Washing Treatability Study and Engineering Report

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Template: Scoping Document for Soil Washing Treatability Study
&
Engineering Report

XXXXXXXXXXX is currently performing remedial investigation activities at XXXXX.

Soils at the site contain particulate metal resulting from former firing range operations at the facility. The scope of this treatability study will involve bench-scale testing and analysis of soils from this site. Representative sample(s) will be analyzed to

- verify the effectiveness of mining-based soil washing/gravity separation techniques for the recovery of particulate metal and to
- determine what, if any, additional treatment is required to meet cleanup goals after soil washing.

Interested vendors must have the following qualifications and experience:

- treatability study and field experience employing density treatment soil-washing techniques on soils similar to those at this site,
- five successfully completed full-scale projects in which density treatment technology was part of the soil-washing treatment train,
- five years of soil-washing experience, and
- 15 treatability studies for which density treatment techniques were evaluated.

The study will include a step-wise evaluation of

- grain-size analysis/contaminant by fraction,
- contaminant removal by size segregation and gravimetric techniques,
- oversize-fragment removal by size segregation and screening, and
- post-treatment total and TCLP lead results for each individual size fraction.

The treatability study will focus first on material characterization of the sample, followed by optimizing treatment of specific fractions using physical treatment methods. Recoverable quantities of metals will be estimated in the treatability study in order to quantify the amount requiring recycling.

Treatment Processes

Soil-washing techniques evaluated during this treatability study should include the following:

- deagglomeration steps to separate sod/organic material from soil fractions,
- physical treatment employing wet screening for particulate partitioning, and
- density treatment to further separate geologic material from same-sized metal particulates.

Results of the treatability study will reveal the appropriate treatment approach for implementing the full-scale remediation. Treatment effectiveness will be presented in the treatability study report.

Analytical Methods
Treatability study analytical methods used must be based on their suitability to the soil matrix, level of soil contamination, analysis time, and reliability for treatment verification. The representative sampling and accurate analysis of soil containing particulate lead shot contamination is imperative to prevent erroneous results and bias. To avoid the "nugget effect" in feed soil analyses, initial lead concentrations will be determined gravimetrically. Once particulate lead has been removed and accounted for in the soil fraction amenable to density separation, AA analyses will be performed on the soil samples. Gravimetric results will then be added to the AA total lead results to yield more accurate feed soil concentrations.

Quality Control/Quality Assurance
Quality control (QC) objectives of the treatability study are to provide accurate, precise, and complete data sufficient to identify conditions under which lead is removed from contaminated soil. The primary comparison made during the bench study is between the contaminant level in the feed soil and the contaminant levels in treated soil following successive levels of treatment. This comparison will be made to determine the effectiveness of each step of the treatment process. Comparability will be assured by preparing and analyzing feed and treated soil under identical conditions.

Other QC checks to be employed during the treatability study include the use of check standards during AA analyses to ensure that the instrument is operating within acceptable limits of the calibration curve over a period to time. This will be performed during each analytical run. All in-house laboratory procedures and analytical results will be recorded in a bound laboratory notebook.

Soil Sampling
The treatability study will use one bulk 5-gallon composite soil sample from each area of concern collected from the site. Representatives of XXXXXXXX will perform soil sampling. The bucket of soil will be roll-mixed upon receipt at the treatability lab.

Gradation Analysis
Physical testing will begin with a visual inspection of the sample, followed by size gradation analysis to predict the physical behavior of the soil within process equipment and the usefulness of a soil classification step. Wet sieving will be used to separate the soil into its constituent particles of gravel, sand, and fines for an accurate determination of soil gradation. Individual soil fractions obtained form sieving will be oven dried and weighed to determine the distribution of particle sizes in the bulk soil. Sieve sizes used during the treatability study should simulate the generation of soil fractions appropriate to specific density-treatment processing equipment.

Contaminant Distribution and Feed Soil-Lead Concentration
During gradation analysis, particulate metal within each soil fraction will be retained with soil particles on the screens listed above. Particulate metal will then be separated from soil retained in each size fraction using density-based techniques. The mass of metal recovered from each soil fraction will be extrapolated into the entire soil volume.

Wet Screening
Wet screening will be evaluated for its ability to separate soils by size class.

Density Separation
Density-separation techniques will be evaluated for particulate metal removal. Different methods of density separation will likely be required for treating the different size classes of soil generated during screening. Water-pulse jigging and other density separation methods will be utilized to remove coarse and fine lead from the coarse and fine soil fractions, respectively. Observation of lead recovered and subsequent analysis of the treated soil will determine the efficiency of water-based density-separation techniques after dewatering and drying. At the conclusion of the physical treatment evaluation, the in-house total lead analytical results will be summarized.

Wash-Water Evaluation
The total lead concentration of the used wash water will be measured after the physical treatment evaluation is completed. If required, the wash water will be treated to reduce the solution lead concentration to meet the assumed discharge criterion of 5-mg/L lead. This concentration is typically the acceptance level for a publicly owned treatment works (POTW). Reagent consumption values will be generated to predict the chemical demand to treat wash water following a potential field-scale remediation project.

Soil Sample Disposal
After completion of the treatability study, soil samples will be returned to XXXXXXXXXXXXX for replacement at the site.

Report
Following completion of the treatability study, a treatability study report will be prepared. The report will contain the following sections:

- Summary
- Methods
- Treatability Study Results
- Findings and Conclusions
- Recommendations

The Summary will present a brief statement of the findings of the treatability study. The Methods Section will review the methods used during the treatability study. The Treatability Study Results Section will contain tabulated analytical results. The Findings and Conclusions Section will highlight the significance of the findings of the treatability study results. The Recommendations Section will include recommended processes for the field-scale remediation, as well as a cost estimate for full-scale implementation.

Deliverables associated with this solicitation include

- treatability study proposal, including qualifications, technical approach, and pricing to complete the scope of work;
- past project experience in support of the qualifications listed above; and

- client references and phone numbers for completed projects listed.

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APPENDIX D

Template: Scoping Document for Treatability Testing and Asphalt Emulsion Mix Design

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Template: Scoping Document for Treatability Testing and Asphalt Emulsion Mix Design

INTRODUCTION

The scope of this treatability study is to do lab testing to develop an emulsion design for field implementation. The soil to be treated with ENCAPCO emulsions is contaminated with metals and organic contaminants and will subsequently be used as asphalt sub-base for paving projects. As such, the following parameters must be addressed:

- chemical fixation/treatment effectiveness and
- physical properties of treated soil.

Ultimately, the goal of the treatability study is to provide a mix design and procedures for field implementation that meet both the site reuse goals for treated soils as well as the physical characteristics to support the soil's intended end use.

Since the treated soil is to be used as a product, particulate metals must be removed prior to emulsion treatment. This particulate-removal step is critical as encapsulated heavy-metal particles could be re-exposed during placement or subsequent work on the treated sub-base material. Also, certain metals like copper are detrimental to the asphalt matrix and must be removed to ensure long-term structural integrity of the sub-base material.

To ensure effective particulate removal, all metal-leachability testing will be done after the emulsion mix has cured, been strength tested, and the cured sample subsequently pulverized. The aliquot selected for leachability testing will be taken from the pulverized sample.

The initial step of the treatability study will include a step-wise evaluation of density separation for particulate metals consisting of

- grain-size analysis/containment by fraction,
- contaminant removal by size segregation and gravimetric techniques,
- oversize-fragment removal by size segregation and screening, and
- post-treatment and TCLP metal results for each individual size fraction.

The treatability study will focus first on material characterization of the sample, followed by optimizing treatment of specific fractions using physical treatment methods. Recoverable quantities of metals will be estimated in the treatability study to quantify the amount requiring recycling. Once completed, residual soils free of particulate metals will undergo subsequent emulsion treatability studies.

DENSITY SEPARATION TREATMENT PROCESS

Density separation/soil-washing techniques evaluated during this treatability study should include the following:

- deagglomeration steps to separate sod/vegetative material from soil fractions,
- physical treatment employing wet screening for particulate partitioning, and
- density treatment to further separate geologic material from same-sized metal particulates.

Results of the treatability study will reveal the appropriate treatment approach for implementing the full-scale remediation. Treatment effectiveness will be presented in the treatability study report.

Analytical Methods

Treatability study analytical methods used must be based on their suitability to the soil matrix, level of soil contamination, analysis time, and reliability for treatment verification. The representative sampling and accurate analysis of soil containing particulate lead shot contamination is imperative to prevent erroneous results and bias. To avoid the "nugget effect" in feed soil analyses, initial metal concentrations will be determined gravimetrically. Once particulate metal has been removed and accounted for in the soil fraction amenable to density separation, AA analyses will be performed on the soil samples. Gravimetric results will then be added to the AA total lead results to yield more accurate feed soil concentrations. Recovered metal concentrates will undergo a metallurgical assay to aid in developing potential recycling scenarios.

Quality Control/Quality Assurance

Quality Control (QC) objectives of the treatability study are to provide accurate, precise, and complete data sufficient to identify conditions under which lead is removed from contaminated soil. The primary comparison made during the bench study is between the contaminant level in the feed soil and the contaminant levels in treated soil following successive levels of treatment. This comparison will be made to determine the effectiveness of each step of the treatment process. Comparability will be assured by preparing and analyzing feed and treated soil under identical conditions.

Other QC checks to be employed during the treatability study include the use of check standards during AA analyses to ensure that the instrument is operating within acceptable limits of the calibration curve over a period to time. This will be performed during each analytical run. All in-house laboratory procedures and analytical results will be recorded in a bound laboratory notebook.

Soil Sampling

The treatability study will use a bulk 5-gallon composite soil sample from each area of concern collected from the site. Representatives of XXXXXXXX will support soil-sampling efforts. The buckets of soil will be roll-mixed upon receipt at the treatability lab.

Gradation Analysis

Physical testing will begin with a visual inspection of the sample followed by size gradation analysis to predict the physical behavior of the soil within process equipment and the usefulness of a soil classification step. Wet sieving will be used to separate the soil into its constituent particles of gravel, sand, and fines for an accurate determination of soil gradation. Individual soil fractions obtained from sieving will be oven dried and weighed to determine the distribution of particle sizes in the bulk soil. Sieve sizes used during the treatability study should stimulate the generation of soil fractions appropriate to specific density-treatment processing equipment.

Contaminant Distribution and Feed Soil-Metal Concentration
During gradation analysis, particulate metal within each soil fraction will be retained with soil particles on the screens listed above. Particulate metal will then be separated from soil retained in each size fraction using density-based techniques. The mass of metal recovered from each soil fraction will be extrapolated into the entire soil volume.

Wet Screening
Wet screening will be evaluated for its ability to separate soils by size class.

Density Separation
Density separation techniques will be evaluated for particulate metal removal. Different methods of density separation will likely be required for treating different size classes of soil generated during screening. Water-pulse jigging and other density separation methods will be utilized to remove coarse and fine lead from the coarse and fine soil fractions, respectively. Observation of lead recovered and subsequent analysis of the treated soil will determine the efficiency of water-based density separation techniques after dewatering and drying. At the conclusion of the physical treatment evaluation, the in-house total lead analytical results will be summarized.

Wash-Water Evaluation
The total lead concentration of the used wash water will be measured after the physical treatment evaluation is completed. If required, the wash water will be treated to reduce the solution metal concentration to meet the required discharge criterion. Reagent consumption values will be generated to predict the chemical demand to treat wash water following a potential field-scale remediation project.

ENCAPCO EMULSION DESIGN PROCESS

Organic-based emulsions are effective in stabilizing and immobilizing some heavy metal–contaminated soils as determined by the TCLP method. Additionally, the soil/emulsion system can be engineered through conventional methodology to produce a product suitable for road construction or various engineered fill purposes. The process can be used for on-site treatment by excavation, mixing, and compaction, or by excavation, mixing, and transport to a remote site for later use. The process is designed to comply with USEPA 40 CFR 266.206 (b) (i.e., use constituting disposal or recycling) and has the following attributes:

- Stabilization of heavy-metal species in the emulsion/soil matrix, rendering contaminants inaccessible for dissolution into water bodies.
- Creation from hazardous waste of a product suitable for use in the construction industry.
- Capability through accepted chemical and civil engineering practice to design reliable systems resulting in the above bulleted uses.

Following is a description of the engineering process.

Emulsion Treatment Approach
When recycling metals-contaminated soil for use as a structural material, the structural capabilities of the soils must be evaluated while at the same time treating the metals contamination. The soil is stabilized with an emulsion to improve strength and durability. The same emulsion contains an additive to bind the metal to the soil and prevent it from leaching out.

To recycle the contaminated soil in this manner, the final soil mix design must be a balance of the correct amount of mix water, emulsion, and emulsion additive. Lime or cement is also added to improve the cure time of the emulsion-stabilized soil to facilitate construction schedules.

In any application of this technology, a site-specific engineering evaluation must be undertaken. The following steps outline our general engineering approach when the recycled product is to be used as a road base:

Step 1. AASHTO Soil Classification

During this step, the gradation, liquid limit, plasticity index, and moisture density curve are determined. The soil can then be classified according to ASSHTO and some feeling for the soil as a structural material obtained.

The optimum moister is needed to determine the amount of mix water to be added along with the emulsion so that maximum density can be achieved.

Step 2. Metals Analysis

The contaminated soil is tested to determine the level of metal in the soil. USEPA Test Method 3050A and 7420A are used to determine the total content (TTLC), and USEPA Test Method 3010A and 7420 are used to determine the leachable concentration as optimized in Step 5.

Step 3. Determine Starting Soil Mix Design

Using the data from Steps 1 and 2 and a knowledge of the end product desired, the additive level and base stock (i.e., asphalt or tall oil pitch) is selected for the emulsion. Three emulsion levels and three lime levels are selected for a total of nine (9) samples to be tested in Step 4. The lime is necessary to optimize curing, mixing, and strength characteristics of the product.

Step 4. Strength Testing, ASTM 1559

During this step, Marshall specimens are fabricated for each of the samples referenced in Step 3 at about optimum water content. The specimens are allowed to cure under conditions anticipated at the site. Marshall stability and flow tests are run on the samples. From the data generated, optimum emulsion and lime content can be determined.

Step 5. Treatability Analysis (Evaluate Leachability of Metal)

A soil sample is prepared at the optimum soil design and tested for TTLC and TCLP (see test methods listed in Step 2). A sample that was tested in Step 4 that is at a near-optimum design may be used in this step. If the TCLP results satisfy the USEPA specification and the sample from Step 4 was tested, Step 6 may be skipped. If the USEPA specification is not satisfied and the additive needs to be adjusted, then a recheck of the strength is needed and Step 6 is required.

Step 6. Final Mix Design Verification

If the additive level is changed from the level in the emulsion in Step 4, a recheck is required. This involves preparing a single set of samples at optimum lime, emulsion, additive, and water and performing a Marshall stability test.

Step 7. Material Design

Using the Marshall stability obtained in Step 4, a structural coefficient for the recycled material can be determined. The Marshall stability relationship for bituminous-treated base is contained in the AASHTO guide for design of pavement structures. This structural coefficient can then be used in the design of the road section to be constructed.

Depending on the end use of the recycled material, other design procedures may be appropriate. For instance, if the end use of the treated soils is for a granular base or sub-base, the compressive strength characteristics of the soils should be investigated using Resistance R-Value, CBR, or unconfined compressive strength.

Prior to initiating the emulsion design work, an initial soil-washing treatability study will be conducted. This study will evaluate the grain-size distribution of the impacted soil and the optimum screening "cut-points" for wet screening the soil into fractions suitable for gravity separation of gross metal particulate, as described in previous sections.

This study should document the volumes of material generated at each cut, together with the costs associated with the screening steps. From this information, a stabilization/reuse treatability study can be conducted in accordance with the steps detailed above. The only modification to our customary approach would be evaluating what, if any, reaggregation is needed to meet the recycled material end use structural requirements. It might also allow the emulsion content or chemical makeup to be adjusted in a manner proving to be more cost-effective.

Soil Sample Disposal
After completion of the treatability study, soil samples will be returned to the site for replacement at the site.

Report
Following the completion of the treatability study, a treatability study report will be prepared. The report will contain the following sections:

- Summary
- Methods
- Treatability Study Results
- Findings and Conclusions
- Emulsion Mix Design
- Recommendations

The Summary will present a brief statement of the findings of the treatability study. The Methods Section will review the methods used during the treatability study. The Treatability Study Results Section will contain tabulated analytical results. The Findings and Conclusion

Section will highlight the significance of the findings of the treatability study results. The Emulsion Mix Design will provide a summary of the optimized mix design/performance. The Recommendations Section will include recommended processes for the field-scale remediation, as well as a cost for full-scale implementation.

Deliverables associated with this solicitation include

- treatability study proposal, including qualifications, technical approach, and pricing to complete the scope of work;
- past project experience in support of the qualifications listed above; and
- client references and phone numbers for completed projects listed.

APPENDIX E

White Paper on Created Wetlands for Range Runoff Control

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EFFICACY OF USING PASSIVE CONSTRUCTED WETLAND SYSTEMS TO PREVENT MIGRATION AND EROSION OF LEAD FROM SMALL ARMS RANGES

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White Paper on Created Wetlands for Range Runoff Control

Charles Harman AMEC

EFFICACY OF USING PASSIVE CONSTRUCTED WETLAND SYSTEMS TO PREVENT MIGRATION AND EROSION OF LEAD FROM SMALL ARMS RANGES

The use of lead-containing ammunition at small arms firing ranges results in a continual contribution of lead into the environment. Lead accumulates in berms and other structures used to backstop targets on ranges. Bullets will lodge into the berm either whole or in fragments. Once there, the erosional processes of storm water can result in the movement of these fragments off the berm and into the environment. In cases where the storm water and/or soils in and around the berm are acidic, lead may leach from the bullets or fragments, further dispersing into the environment. As noted in USAEC (1998), the dispersal of lead through these mechanisms results in a potential ecological risk and may be in violation of the Clean Water Act, the Safe Drinking Water Act, and Section 7003 of the Resource Conservation and Recovery Act (RCRA).

As various methods of active and passive controls are being investigated to halt the migration of lead from firing ranges and limit both the liability and risk associated with this metal, it is my contention that the use of constructed wetlands should be considered as one of the tools in this process. The rationale is that as distinct ecological units, wetlands perform certain functions in their positions on the landscape (Mitsch and Gosselink, 1993). Functionally, wetlands play a role in flood conveyance, flood storage, sediment control, and as habitat for various biota. However, the critical function from a range standpoint is the improvement of water quality through either filtration or biochemical processes (NWPF, 1988).

This white paper discusses the efficacy of using constructed wetlands to prevent the migration of lead from small arms firing ranges and into the environment.

Wetlands Overview

Wetlands are unique and sensitive ecological units and provide valuable functions in the natural environment. These functions include providing necessary breeding habitat for a variety of organisms such as waterfowl, fish, and shellfish; erosion and storm water flood control; groundwater recharge; and nutrient transport. Wetlands can be found in freshwater, brackish, and saline conditions and can be found along coasts, in forests, and along rivers or creeks. They can be found anywhere that the saturated soil conditions necessary for wetland development exist.

Hydrology is probably the single most important determinant for the establishment and maintenance of specific types of wetlands and wetland processes. It is the permanent or periodic saturation of a wetland area that results in the anaerobic conditions in the soil under which typical wetland biogeochemical processes occur. The result of these processes is the development of characteristic wetlands soils, which will support a dominant plant community adapted to living in saturated soils. The hydrologic state of a wetlands can be represented by a hydrologic budget, which is essentially the difference in the amount of water moving into the

wetlands and the amount of water moving out. Factors that influence wetlands water budgets include: 1) the balance between inflows and outflows of water; 2) surface contours of the landscape; and 3) subsurface soil, geology, and groundwater conditions.

Overview of Constructed Wetlands

Constructed wetlands are engineered structures that bring together wetlands components (plants, soils, and hydrology) into positions on a landscape that is not presently occupied by a wetlands (or a fully functioning wetlands). The term "constructed wetlands" refers to wetlands that have been designed for water quality treatment purposes (Hammer, 1992). The benefits provided by constructed wetlands include the natural filtering of sediments and other constituents of concern from water flowing through them. The aim is to construct wetlands that mimic the actions of a natural system and, therefore, can be utilized to improve water quality or manage storm water.

In general, there are two types of wetlands constructed for water treatment purposes: surface flow (SF) and subsurface flow (SSF) wetlands (Kadlec and Knight, 1996). SF wetlands (sometimes called free water surface wetlands (FW) (Reed and Brown, 1992) are densely vegetated by a variety of wetlands plant species and have depths less than 1.5 feet (though several authors note deeper uniform depths). Open water areas may be incorporated into the design. Capital expenditures for the construction of SF wetlands typically range from $10,000 to $100,000/ha, primarily as a result of earthwork (Knight, et al., 1993). Based on a review of 19 FW wetlands constructed in the southeastern United States, Reed and Brown (1992) found an average construction cost of $55,000/ha ($22,000/acre) from project inception.

SSF wetlands utilize a bed of soil or gravel as a substrate for the growth of rooted vegetation and rely on gravity to move water through the system. Bed depth of a SSF wetland is usually less than 2 feet (Kadlec and Knight, 1996). Capital expenditures for the construction of an SSF wetlands typically ranges from $100,000 to $200,000 (Knight, et al., 1993). Based on a review of 18 SSF wetlands constructed in the southeastern United States, Reed and Brown (1992) found an average construction cost of $215,000/ha ($87,000/acre) from project inception. WPCF (1990) reported an average operation and maintenance cost for both SF and SSF wetlands ranging from $0.03 to $0.09/$m^3$.

The actual form that a constructed wetlands may take is a function of numerous issues, including space, cost, constituents to be addressed, aesthetic needs, and pollutant loads. Constructed wetlands are often built as a series of cells, which allow for an increase in efficiency and ease of maintenance. Wetlands can be ponds, marshes, simple detention basins, or combinations thereof. Depending on the permeability of the soil, constructed wetlands can be either lined or unlined.

Lead in the Environment

Lead occurs in the environment (particularly in surface waters) most often in the divalent form (Pb (II)). This form tends to form salts with sulfides, carbonates, sulfates, and chlorophosphates. Lead combines with organic ligands to form soluble complexes and is likely to be insoluble above a pH of 8.5, with increasing solubility at lower pH values (Kadlec and Knight, 1996). Lead is most soluble and bioavailable under conditions of low pH; low organic content; low

concentrations of suspended sediments; and low concentrations of calcium, iron, manganese, zinc, and cadmium salts (Eisler, 2000). Vymazal (1995) notes that sorption to sediments plays a very important role in the fate of lead complexes in the environment. May and McKinney (1981) note that most lead entering natural waters is precipitated to the sediment bed as carbonates or hydroxides. At low stream flows, lead is rapidly removed from the water column by sedimentation (Benes, et al., 1985).

Lead is toxic to most ecological receptors. Excessive amounts of lead result in growth inhibition and impairment of biochemical processes in plants. Ingestion of lead shot has resulted in direct mortality in a wide variety of waterfowl species, as well as over 30 other avian species. Lead is toxic to all manner of aquatic biota, though the effects can be significantly modified by various biological and abiotic variables (Wong, et al., 1978). In mammals, lead modifies the function and structure of the kidney, bone, the central nervous system, and the hematopoietic system (Eisler, 2000).

Efficacy of Lead Removal

Wetlands remove metals such as lead, copper, chromium, and arsenic from water through a variety of biogeochemical processes. Wetlands remove metals through filtration of suspended particles out of the water column, uptake and absorption of metals by plants within the wetlands, and precipitation of the metals as a result of adjustments in pH. The ability of wetlands to remove metals is generally a function of the high proportion of humic material and other organic substances found within the wetlands substrate (Wildeman, et al., 1991). The processes of note include adsorption onto plants or soil particles, ion exchange, bioaccumulation, bacterial and abiotic oxidation, sedimentation, neutralization, reduction, and dissolution of carbonate materials (Perry and Kleinman, 1991). Sobolewski (1997) notes that plant roots will retain arsenic, lead, and other metals. Schooner (1997) notes that emergent and submergent aquatic plants within created wetlands will remove lead, copper, nickel, cadmium, and zinc through rhizofiltration processes.

Fennessy and Mitsch (1989) note that soluble metals are converted to insoluble forms as a result of the anoxic conditions found within wetlands sediments. One of the control factors in this function is the pH of the supporting waters. In acidic waters, metals are soluble and tend to remain mobilized. In waters with higher pH, the metals are insoluble and are acted upon by adsorption and precipitation mechanisms. Therefore, one of the features of a constructed wetlands is a mechanism such as a limestone barrier to raise the pH and precipitate out the metals.

The removal efficiency of lead increases with the concentration of the inflow supporting water source. Kadlec and Knight (1996) note that lead removal in wetlands is primarily accomplished through formation of insoluble compounds in the water column, followed by subsequent sedimentation. Schiffer (1989) reported removal efficiencies of 83.3% for a marsh wetlands in Florida receiving urban runoff, while USEPA (1993) reported removal efficiencies of 45% for vegetative filter strips and 65% in constructed storm water wetlands. In evaluating the available literature, Kadlec and Knight (1996) concluded that SF marshes and SSF wetlands are effective at removing lead from storm water.

Mæhlum (1999) cites a large number of studies in cold weather (mean temperatures below 26.6^{o} F in winter and above 50° F in the summer) regions of the world (Canada, northern United States, Scandinavia, and eastern Europe) documenting the success of constructed wetlands in treating wastewaters. He reports that the processes that primarily affect metals in wetlands (sorption and precipitation) are unaffected by temperature. Kadlec and Knight (1996) support this premise.

Conceptual Design

The primary mechanism to remove lead in a constructed wetlands is precipitation of lead hydroxides, due to oxidation within aerobic sediment zones and sulfate reduction to insoluble metal sulfides in anaerobic sediment zones. Both the dissolved and precipitated lead will contact adsorptive surfaces and ion-exchange sites provided by both plant and sediment surfaces, allowing the lead to be fixed into the organic base of the developing constructed wetlands. The full efficiency of such a system is not expected to occur until after two or three growing seasons have allowed the full establishment of the plant material within the constructed wetlands (Loer, et al., 1999).

Designing a constructed wetlands to address lead migration is a function of several considerations, including loading rate, retention time, slope, substrate, vegetation, season, and sediment control. The most critical element in designing the wetlands is in calculating the hydrologic characteristics of the system. That means the wetlands under design must be constructed deep enough to contact groundwater on a periodic basis; or if groundwater is deep, then the substrate of the wetlands must be impervious enough to retain water. This will allow for the creation of anaerobic conditions in the sediment zone, which would lead to the development of a strong organic or humic layer for binding lead moving through the system.

A passive wetlands system could be designed to receive storm water runoff from small arms firing ranges. The constructed wetlands could be placed at either the toe of the berm slope so as to receive sheet flow runoff from the berms, or designed to receive storm water through channels that contain and direct storm water runoff. The wetlands could be designed in combination with biofilters (using the storm water channel as prefilters to remove large particles prior to polishing in the wetlands) and/or detention basins to allow the settling of large-particle sediments prior to discharge of the storm water into the constructed wetlands. The designed slope for such systems should be between 1% and 5% (USEPA, 2000). In circumstances where the supporting water is acidic, anoxic limestone drains or other mechanisms can be introduced to raise the pH and allow for lead precipitation.

As part of a conceptual constructed wetlands to address arsenic, chromium, and copper dissolved in storm water at a site in Florida, modifications to storm water channels and retention basins were proposed. The anticipated effect was to reduce storm water infiltration and increase storm water residence time through the installation of a low-permeability liner to the channel and/or the basin, followed by the planting of wetlands vegetation to develop the organic base for retention of the metals. Initially, excavation and grading of the existing channel and basin would be performed to contour the subgrade. The channel and basin would be lined with a low-

permeability liner consisting of a geosynthetic clay liner (GCL) or compacted low permeability soil (e.g., clay). Vegetative soil material (e.g., topsoil) would be placed above the liner and further covered with a layer of humic material (*Sphagnum* or peat moss) to facilitate organic binding of metals. Soils would be a sandy loam and contain approximately 8% to 10% organic matter. The channel basin would be planted with a combination of native emergent wetlands species that are known to remove metals from surface water. All plants would be planted on one-foot centers, with the planted stock being 2-inch plugs.

Loer, et al. (1999) presents a study of a diverse, integrated treatment system, which included sedimentation basins and constructed wetlands, to address metals in landfill leachate. When in operation, their system, constructed in Minnesota, had a lead-removal efficiency of 80%.

Conclusions

A review of the literature and experience with constructed wetlands suggest that the use of these passive wetlands systems would be an optimal approach to cost effectively control lead migration from small arms firing ranges. Lead is a metal easily managed by the biogeochemical processes present in functional wetlands, and the filtration of this material is within the expected functional performance of wetlands. It is recommended that continued studies, including field pilot studies, be conducted to evaluate the efficacy of these systems.

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APPENDIX F

Baseline Risk Assessment

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BASELINE RISK ASSESSMENT

1. General Information

Baseline risk assessment (BRA) provides an evaluation of the potential threat to human health and the environment in the absence of any remedial action. It provides the basis for determining whether or not remedial action is necessary. Detailed guidance on evaluating potential human health impacts are provided in *Risk Assessment Guidance for Superfund* (RAGS), EPA/540/1-89/002, December 1989. Detailed guidance on evaluating potential ecological impacts is provided in *Ecological Risk Assessment Guidance for Superfund* (ERAGS), EPA/540-R-97-006, August 1997.

In general, the objectives of a BRA may be attained by identifying and characterizing the following:

- Toxicity and levels of hazardous substances present in relevant media (e.g., soil, groundwater, etc.)
- Environmental fate and transport mechanisms within specific environmental media such as physical, chemical, and biological degradation processes and hydrogeological conditions
- Potential human and ecological receptors
- Potential exposure routes and extent of actual or expected exposures
- Extent of expected impact or threat, and the likelihood of such impact or threat occurring
- Level(s) of uncertainty associated with the factors used to derive the risk estimate

The goal of the BRA is to gather sufficient information to adequately and accurately characterize the potential risk from a site.

2. Components of a BRA

The risk assessment process can be divided into four components:

- Contaminant identification
- Exposure assessment
- Toxicity assessment
- Risk characterization

a. Contaminant Identification

The objective of this component is to screen information that is available on substances that may have been released on the site in order to identify chemicals to focus subsequent efforts in the risk assessment process. Chemicals of potential concern (CoPCs) are selected because of their intrinsic toxicological properties, because they are present in large quantities, or because they are present in, or may migrate into, critical exposure pathways.

b. Exposure Assessment

The objectives of this component are to identify actual or potential exposure pathways, to characterize the potentially exposed populations, and to determine the extent of the exposure. Identifying potential exposure pathways helps to conceptualize how chemicals may migrate from

a source to an existing or potential point of contact. An exposure pathway may be viewed as consisting of four elements: (1) a source and mechanism of chemical release to the environment; (2) an environmental transport medium; (3) a point of potential contact between a receptor and an environmental media; and (4) an exposure route to the receptor at the point of contact (e.g., ingestion, dermal). Once the source(s) and release mechanisms have been identified, an analysis of the environmental fate and transport of the chemicals can be conducted. This analysis considers the potential migration, transformation, and transfer mechanisms to provide information on the potential magnitude and extent of the contamination. This is a vital part of developing your conceptual site model. From this information, the actual or potential exposure points for receptors can be identified. The focus of this effort should be on those locations where actual contact with the CoPC will occur or is likely to occur. Last, potential exposure routes that describe the potential for the CoPC to enter the receptor's body is identified and described.

After the exposure pathway analysis is completed, the potential for exposure needs to be assessed. Information on the frequency, mode, and magnitude of exposure(s) has to be gathered. These data are then combined to yield a value that represents the amount of affected media contacted per day. This analysis needs to be done for both the current situation and the exposures that are expected to occur in the future if no action is taken at the site. Therefore, as part of this evaluation, a reasonable maximum exposure scenario needs to be developed, which reflects the type(s) and extent of exposures that could occur based on the likely and expected use of the site.

c. Toxicity Assessment

This assessment considers (1) the types of adverse health or ecological effects associated with individual and multiple chemical exposures, (2) the relationship between magnitude of exposures and adverse effects, and (3) related uncertainties such as the weight of evidence for a chemical's potential carcinogenicity in humans. Typically, the BRA process relies heavily on existing toxicity information and does not involve the development of new data.

d. Risk Characterization

In this final component, the chemical concentrations, exposures, and toxicities are combined to develop an estimate of risks of adverse effects. This final analysis includes a summary of the risks associated with a site. It consists of risks associated with each exposure route, media, and CoPC, as well as a total risk for each exposure scenario for both carcinogenic and noncarcinogenic effects.

e. Lead

The methodology used for assessing risk from lead differs from that used for other chemicals. It relates soil and airborne lead concentrations to blood-lead concentrations in the exposed population according to the equations described below. The most sensitive receptor for these equations is the fetus of a pregnant female worker/resident; however, it also calculates the blood level of the adult. This receptor was chosen since the fetus of a pregnant worker is more sensitive to chemical exposure than a regular adult or child receptor.

The effects of lead are the same regardless of the route it enters the body. The major health threat from lead arises from the effects on the nervous system, especially in fetuses, infants, and young children. Fetal exposure may result in preterm birth, reduced birth weight, and decreased IQ.

Lead exposures may increase blood pressure in middle-aged men. High-level exposure can affect the brain and kidneys in adults or children. In addition, high doses of lead may lead to abortion and damage to the male reproductive system.

a. The basis for the calculation of the blood-lead concentration in adults and women of child-bearing age is the algorithm given by Equation 1:

$$PbB_{adult,\,central} = PbB_{adult,0} + \frac{PbS \bullet BKSFs \bullet IR_S \bullet AF_S \bullet EF_S}{AT} + \frac{Pba \bullet BKSFa \bullet AFa \bullet EFa}{AT}$$

where:

$PbB_{adult,\,central}$ = Central estimate of blood-lead concentrations (ug/dL) in adults (i.e., women of child-bearing age) that have site exposures to soil and airborne lead at concentration, PbS/Pba.

$PbB_{adult,\,0}$ = Typical blood-lead concentration (ug/dL) in adults (i.e., women of child-bearing age) in the absence of exposures to the site that is being assessed.

PbS/Pba = Soil/air lead concentration (ug/g)/(ug/m3) (appropriate average concentration for individual).

BKSFs/a = Biokinetic slope factor relating (quasi-steady state) increase in typical adult blood-lead concentration to average daily lead uptake (ug/dL blood-lead increase per ug/day lead uptake).

IR_S = Intake rate of soil, including both outdoor soil and soil-derived dust (g/day).

AF_S = Absolute gastrointestinal absorption fraction for ingested lead in soil and lead in dust derived from soil (dimensionless).

AFa = Respiratory absorption fraction for inhaled lead in air (dimensionless).

$EF_{S/a}$ = Exposure frequency for contact with assessed soils/air (days of exposure during the averaging period).

AT = Averaging time; the total period during which soil contact may occur.

b. The root of equation 2 is the relationship between the soil and airborne lead concentration, and the blood-lead concentration in the developing fetuses of adult women that have site exposures. As a health-based goal, USEPA has sought to limit the risk to young children of having elevated blood-lead concentrations. USEPA, following the suggestions of the Centers for Disease Control, has defined an elevated blood-lead concentration as exceeding 10 ug/dL to 5% of the exposed target population. Equation 2 describes the estimated relationship between the blood-

lead concentration in adult women and the corresponding 95th percentile fetal blood-lead concentration ($PbB_{fetal, 0.95}$).

$$PbB_{fetal,0.95} = PbB_{adult,central} \bullet GSD_{i,adult}^{1.645} \bullet R_{fetal/maternal}$$

where:

$PbB_{adult, central, goal}$ = Goal for blood-lead concentration (ug/dL) in adults (i.e., women of child-bearing age) that have site exposures. The goal is intended to ensure that $PbB_{fetal, 0.95, goal}$ does not exceed 10 ug/dL.

$PbB_{fetal, 0.95, goal}$= Goal for the 95th percentile blood-lead concentration (ug/dL) among fetuses born to women having exposures to the specified site soil and air. This is interpreted to mean that there is a 95% likelihood that a fetus, in a woman who experiences such exposures, would have a blood-lead concentration no greater than $PbB_{fetal, 0.95, goal}$.

$GSD_{i, adult}$ = Estimated value of the individual geometric standard deviation (dimensionless); the GSD among adults (i.e., women of child-bearing age) that have exposures to similar on-site lead concentrations but that have nonuniform response (intake, biokinetics) to site lead and nonuniform off-site lead exposures.

$R_{fetal/maternal}$ = Constant of proportionality between fetal blood-lead concentration at birth and maternal blood-lead concentration (dimensionless).

Equations 1 and 2 are based on the following assumptions:

- Blood-lead concentrations for exposed adults can be estimated as the sum of an expected starting blood-lead concentration in the absence of site exposure ($PbB_{adult, 0}$) and an expected site-related increase.

- The site-related increase in blood-lead concentrations can be estimated using a linear biokinetic slope factor (BKSF), which is multiplied by the estimated lead uptake.

- Lead uptake can be related to soil and airborne lead levels using the estimated soil and airborne lead concentration (PbS/PbA), the overall rate of daily soil ingestion (IR_S), and the estimated fractional absorption of ingested lead/respired lead ($AF_{S/a}$). Soil exposure is assumed to be limited predominantly to top layers of the soil, which gives rise to human contact.

- The default value recommended by USEPA for IR_S (0.05 g/day) is intended for occupational exposures that occur predominantly indoors. More intensive soil contact would be expected for predominantly outdoor activities such as would occur at a firing range. For this reason, we are using a value derived by USEPA for outdoor activity (0.48 g/day).

- A lognormal model can be used to estimate the variability in blood-lead concentrations between individuals.

- Expected fetal blood-lead concentrations are proportional to maternal blood-lead concentrations.

3. Application of the BRA Process to Small Arms Ranges

While most of the general BRA process applies directly to a small arms range, a few of the steps can be modified to address the special circumstances of these ranges.

a. Contaminant Identification

While the evaluation of a generalized hazardous waste investigation site involves the consideration of a full target analyte list of chemical parameters, the focused nature of a small arms range provides some opportunity to similarly focus the analytical suite. Unless otherwise indicated in the site history, the use of small arms ranges is limited to projectiles of small caliber (less than 0.50 caliber). These projectiles are overwhelmingly lead or copper-jacketed lead with a few being some other metal, usually steel or a polymer. The remainder of the ammunition is composed of a casing (usually brass, steel, or tin); a primer composed of a metallic fulminate, styphnate, or azide compound (usually lead); and a propellant (granular, smokeless powder, or black powder). Modern propellants are composed of nitrocellulose or of nitrocellulose and nitroglycerine mixtures. Both the propellants and the primer are rapidly burning materials that leave little residue as either decomposition products or uncombusted compounds. Additionally, both the original compounds and the decomposition products are mostly analyzed as common soil compounds, which are difficult to evaluate (Organic carbon, CO2, nitrates, etc,). As such, the analytical suite can be focused on metals, mostly lead and copper.

[**CALIBER:** The nominal diameter of a projectile of a rifled firearm, usually expressed in hundreds of an inch. Abbreviated Cal. As a loose rule, the larger the decimal fraction, the "higher" the caliber and the more powerful the ammunition (e.g., a .22 caliber is smaller and weaker than a .45 caliber). To put "caliber" in a general context, a .22 is the smallest common caliber. Calibers ranging from .22 to .32 are considered "light" and are best suited for target shooting. Calibers from .38 to .45 (which includes the common 9 mm and .357 magnum) are commonly selected by law enforcement agencies as "defensive calibers." "Heavy" calibers such as .44 magnum, .454 Casuals, and .50 cal produce incredible amounts of energy and may require special care with respect to a safe shooting area.]

b. Exposure Assessment

The exposure assessment is highly dependent on the current and future land use expected for the site. While the general method handles most uses adequately, one existing and future use is not adequately addressed without modification. When a small arms range is to continue its operation, the risk assessment should be based on the range's impact on groundwater with no quantitative ecological risk assessment, unless a migratory pathway away from the range can be established.
The reasons for this type of assessment are not obvious. If the range is to continue to be used, metallic deposition in the backstop/berm area will continue. The only human receptors will be

site workers, who are covered by the exposure standards of the Occupational Safety and Health Administration (OSHA). For safety, site visitors are not allowed near the backstop/berm area, thus eliminating their exposure. Ecological concerns are addressed by the nature of the range operation.

APPENDIX G

Acronyms

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Acronyms

APC	Air Pollution Control
ARAR	Applicable or Relevant and Appropriate Requirement
ASTM	American Society of Testing and Materials
BNA	Base/Neutral/Acid
BRA	Baseline Risk Assessment
BRAC	Base Realignment and Closure
CAMU	Corrective Action Management Unit
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CEM	Continuous Emissions Monitor
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CO	Carbon Monoxide
CoPC	Contaminant of Potential Concern
DCA	Dichloroethane
DCE	Dichloroethene
ERA	Ecological Risk Assessment
EPA	Environmental Protection Agency
GC/ECD	Gas Chromatograph/Electron Capture Detector
GC/MS	Gas Chromatograph/Mass Spectrometer
ITRC	Interstate Technology and Regulatory Council
NPL	National Priority List
OSHA	Occupational Safety and Health Administration
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PIC	Products of Incomplete Combustion
POC	Point of Contact
POP	Proof of Process
POTW	Publicly Owned Treatment Works
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation and Recovery Act
SAFR	Small Arms Firing Range
SMART	Small Arms Range Team
SMPD	Scientific Management Decision Point
SPOP	Sustainable Practices and Opportunities Plan
SPLC	Synthetic Precipitation Leaching Procedure
TCLP	Toxicity Characteristic Leaching Procedure
TDU	Thermal Desorption Unit
TSD	Treatment, Storage, and Disposal
TSCA	Toxic Substances Control Act
USEPA	U.S. Environmental Protection Agency

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APPENDIX H

ITRC Small Arms Firing Range Team Response to Comments from the POC Preconcurrence Review and the U.S. Army Environmental Center

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Illinois

1. **Comment**

A number of the regulatory interpretations included in the ITRC document are essentially policy decisions that are better left up to the individual states to decide. We have found that the regulations related to lead shot and contaminated soils at shooting ranges are being interpreted differently across the USEPA regions and by various states. These policies have been shaped by the following court cases:

Review of *Connecticut Coastal Fisherman's Assoc. v. Remington Arms Co.*, 989 F.2d 1305 (2d Cir.1993) and review of previous Illinois EPA documents and correspondence is that this determination of the material meeting the definition of a solid waste is applicable **only** (emphasis added) if the lead, where it has been applied to the land, poses an imminent hazard as defined by RCRA.

The U.S. Court of Appeals, Second Circuit, evaluated the lead shot issue in *Connecticut Coastal Fishermen's Assoc. v. Remington Arms Co.*, 989 F.2d 1305 (2d Cir.1993) (the stated basis for the determination that the lead shot meets the regulatory definition of a solid waste) and modified the USEPA position somewhat. In addition to decisions based on procedural issues involving citizen suits, the court concluded that the definition of solid waste in the statute was broader than that in the RCRA regulations. The import of that was that the deposition of the lead shot was not likely subject to regulatory requirements (i.e., permitting) but was subject to remedial requirements for an "imminent hazard" suit under the statute. Further, without deciding how long was long enough, the court said that the material had been left to accumulate long enough to be considered solid waste (shooting had ceased as of December 31, 1986, and the appeal was decided in June 1993).

In *Long Island Soundkeeper Fund v. New York Athletic Club*, 1996 WL 131863 (S.D.N.Y.), the court followed Connecticut Coastal Fishermen's Assoc. regarding the unpermitted RCRA facility claim using the USEPA position on the regulatory applicability. So, no RCRA permit was required. However, the court held that the trap range was an identifiable source of pollutants (shot and targets) being discharged into U.S. waters, and that further operation was enjoined without an NPDES permit.

In addition, a suit in the U.S. District Court for the Northern District of Illinois (*Stone v. Naperville Park District, et al.*, 38 F. Supp. 2d 651 (N.D. Ill. 1999)) reaffirmed the previous court cases with regard to the RCRA solid waste issue. The Naperville Sportsman's Club operated trap and skeet shooting ranges at a city-owned park with the shotfall zones potentially impacting one or both of two ponds and a ditch connecting them. The lower pond then drains off site. The court dismissed the count for unpermitted RCRA operation and granted summary judgment for Stone regarding the Clean Water Act claim of operating a point source discharge of pollutants to waters of the United States without a permit. The summary judgment enjoined the defendants from resuming trap shooting without an NPDES permit. An NPDES has been issued to the Naperville Park District, and trap shooting has resumed with nontoxic shot.

Therefore, until USEPA and/or the states develop policies on how these materials should be regulated, Illinois EPA feels the ITRC guidance document should be revised to omit references to the regulatory status of the lead shot or contaminated soil at shooting ranges, and how these materials should be regulated. Furthermore, we suggest that the users of the document be directed to contact the regulatory authority for their site when addressing regulatory interpretations on shooting ranges. Illinois EPA cannot support many of the regulatory interpretations presented in the draft document.

Response
We agree that the regulatory status of lead shot can be a complicated regulatory issue, and we will emphasize that users of the document should contact the regulatory authority for their site when addressing regulatory interpretations on shooting ranges. However, we feel that we must provide at least some guidance regarding the regulatory status of lead shot to at least acquaint the user of the document with a rudimentary understanding of the regulatory issues so as to be aware of opportunities for recycling, necessity for waste classification, and other issues regarding the handling of soils containing lead during the remediation of closed shooting ranges.

USEPA has, in fact, developed policy on how lead shot and projectiles should be regulated. The regulatory status of these materials is addressed in Chapter 1 of USEPA's *Best Management Practices for Lead in Outdoor Shooting Ranges*, January 2001. This guidance, developed by USEPA Region 2, was subsequently adopted as national guidance (in a letter from Elizabeth Coxworth, OSWER, and dated October 12, 2001). USEPA sought the support of states on the content of the Best Management Practices Manual. At the time of its printing, 40 states had contacted USEPA and given their concurrence.

Some examples of the portions of the guidance document of concern to Illinois EPA include the following:

2. **Comment**
Sections 3 & 4. When to determine the regulatory classification of the contaminated soil via TCLP.

Response
TCLP testing of contaminated soils should be conducted at the point in the process when remedial options for the site are being identified and evaluated (to determine what soil will require handling as a hazardous waste). TCLP testing is not part of the sampling and analysis conducted to characterize risk; for the risk characterization, total metals analyses are performed. However, in practice, both total metals analyses and initial TCLP tests are often performed at the same time in the investigation process. The decision tree documents the timing for the determination of the regulatory classification of contaminated soils so that proper handling and disposal/reuse of lead-contaminated soil can be accomplished.

3. **Comment**
Section 4.0, Regulatory Requirements, Barriers, and Flexibilities. The regulatory requirements for active ranges may be different than those for closed ranges.

Response
The requirements for remediation should be quite similar. The risk assessment will recognize different exposure scenarios based on use of the site, for example, as a range or other industrial, commercial, or residential use. In addition, in 2003, the Small Arms Firing Range Team of ITRC will develop a management and maintenance guidance document for active ranges.

4. **Comment**
Section 4.1, Classification of Spent Ammunition. This section does very little to expose the problems associated with the regulatory classification of spent ammunition. A major consideration that was not addressed in this section was that a state may consider a material, such as lead shot at an abandoned/closed shooting range and any soil contaminated by it, to be a solid waste because it has been abandoned or discarded (40 CFR 261.2).

Response
Out of necessity we have considered USEPA to be the baseline. Often the determination of "abandoned" is based on previous experience or case history such as those you have previously provided. See Section 4.2, paragraph 2.

5. **Comment**
Section 4.3, State Regulations & Guidance. The BMPs at active ranges may be different from those at closed ranges. In particular, the addition of lime to adjust the pH of the soil may be acceptable at an active range but not at a closed range since its effects are only temporary.

Response
Please see the response to Comment #3 (also see Section 3.3).

6. **Comment**
Section 4.2, Federal Regulations. The document states in Section 4.2 that lead shot at a shooting range meets the definition of a hazardous waste if it is abandoned (or determined to become abandoned). This position is contrary to the stated position of the United States Environmental Protection Agency (USEPA). Since at least 1988, USEPA has taken the position that the discharge of ammunition at shooting ranges does not constitute hazardous waste disposal. The shooting is not a discarding of the rounds. Rather, it is the normal and expected use for which the shells were manufactured and is not a hazardous or solid waste activity falling under RCRA.

Response
The activity itself is not considered a disposal activity, nor is the activity of shooting a hazardous waste management activity; however if through other regulatory processes or investigations it is determined that soils or other material at the surface contain lead in excess of TCLP requirements, then disposal of the contaminated material must be at a hazardous waste disposal facility.

7. **Comment**
Section 4.6, Live Rounds/UXO. The statements in the following paragraph cannot be supported by Illinois EPA:

> …Under 40 CFR 261.23 (6), live rounds are considered characteristically reactive as they are capable of "detonation or explosive reaction if it is subjected to a strong initiating source, or heated under confinement". Also, under 40 CFR 261.23 (7), material is characteristically reactive if "readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure."…

Small arms ammunition does not meet the regulatory definition of unexploded ordnance, or even ordnance and explosive waste. Additionally, small arms ammunition does not meet the definition of a characteristically hazardous waste (D003, 35 Illinois Administrative Code 721.123). In a November 30, 1984 USEPA memorandum (OSWER Directive Number 9443.10-84), Office of Solid Waste Director John H. Skinner stated that based on testing performed by both the Remington Arms Company and the U.S. Army, small-caliber ammunition, up to and including 0.50 (ammunition for the .50 caliber Browning Machine Gun) is not reactive within the meaning of 40 CFR 261.23 (35 Illinois Administrative Code 721.123). Small arms ammunition is typically classified as ORM-D materials for shipping, not explosives.

Traditionally, Illinois EPA has defined UXO as projectiles greater than one-half inch in diameter, with an explosive or incendiary charge of greater than one-quarter ounce (26 United States Code 5845(f)(1)(D)) fired into an impact range that did not function or function properly and completely (i.e., explode or burn) and unfired projectiles that have been discarded prior to being deactivated. This definition does not apply to known inert projectiles and other known inert items, such as small arms ammunition.

Illinois EPA considers this UXO at a facility to meet the definition of a solid waste as identified at 35 Illinois Administrative Code (35 IAC) 721.102(a)(1) because they are discarded materials. The UXO became discarded material 1) when it was abandoned (i.e., the UXO has been abandoned in place when the impact range or target area was deactivated (i.e., closed or transferred) or due to a long, relatively undocumented history of a facility, and 2) when DoD makes the decision to discard/dispose of UXO by detonation or open burning (as identified at 35 IAC 721.102(b)(1) and (2). It is the Illinois EPA's position that UXO remediation efforts are best handled by the experts (i.e., the Department of Defense).

Response
We have removed the regulatory citations classifying live ammunition or UXO and replaced it with language that better represents our intent. Please refer to the new language in Section 4.6.

8. **Comment**
Section 4.7, Soil Recycling. The contaminated soil from a range may not be a "recyclable material."

Response
There are specific guidelines a party must accommodate if they desire that contaminated soil be classified as a recyclable material [see 40 CFR 266.20 (b)].

9. **Comment**
Section 4.8, Transporting or Relocating Range Soil for Reuse as a Backstop on Range Property. Until the USEPA publishes further regulations or interpretations on shooting ranges in the Federal Register, the decision of whether to require testing soil generated from the reclamation of lead shot for hazardous waste characteristics before reuse needs to be left up to the states. It will likely depend on whether the range is active or closed and if the state views the contaminated soil as a solid waste. The flow chart (Figure 1-1) should also be revised to reflect this important issue.

Response
Active ranges are a separate issue addressed by clear guidance from USEPA as referenced. It should be noted that the focus of this document is removal of contaminated soils at closed ranges. For closed ranges, states should always be consulted regarding their authorities and guidance. Within this, the states have the ability to be more stringent than USEPA within a delegated authorization. It is our team's understanding that USEPA is in the process of seriously considering the on-site reuse of berm soils as construction material, and the ITRC Small Arms Firing Range Team supports this. However, it is our understanding that, even though there are individuals within USEPA and the states that support the reuse of berm material to construct berms off site, it is of serious concern and may not be supported agencywide.

Our decision tree has been clarified regarding definition of construction material (i.e., intended for active ranges on site) in response to this comment. The decision tree supports what our team considers the baseline but does not intend to deplete states' authority to be more stringent.

10. **Comment**
Section 4.8, Transporting or Relocating Range Soil for Reuse as a Backstop on Range Property. The statement that it is USEPA's position that soil generated from the reclamation of lead shot is a "construction material" and can be used off site (without even testing to determine if it is a hazardous waste) needs to be followed up by referencing the specific document in which this position was published (e.g., the Federal Register). A policy memorandum, or general correspondence from USEPA on the issue may not be sufficient for a state to accept this position.

Response
Please see response to previous comment.

11. **Comment**
Section 4.8, Transporting or Relocating Range Soil for Reuse as a Backstop on Range Property. Taking contaminated soil off site to another facility may require the receiving site to be permitted to receive nonhazardous or hazardous waste. This may be the case even if the site is a range adjacent to the generating site and owned by the same person.

Response
Please see response to Comment #9.

Illinois Comments on Specific Sections

12. **Comment**
Figure 1-1, Flow Chart. The flow chart indicates that the first step in the process is to determine the postremediation land use and refers to Section 2.7.2 of the document. However, Section 2.7.2 does not appear to include any discussion on determining whether the range will remain active or if it will be closed. This is an important distinction that should be addressed in the document. Is Section 2.7.2 the correct reference for this part of the flow chart? Finally, since this is the first step of the flow chart, it seems like it should be addressed before site characterization (Section 2.0) in the document.

Response
The team determined that the term "active" indicated a range would remain a range and appropriate environmental management plans would be implemented according to USEPA's BMP. Otherwise, land use would define exposure scenarios described (as an example) in Figure 2.5 of the document. Section 2.7 describes the process of assessing the risk associated with a change in the land use at a site.

13. **Comment**
Section 4.2, Federal Regulations & Guidance. This section refers to the Military Munitions Rule (MMR). The ITRC guidance document should be revised to note that the MMR does not include shooting ranges that are closed or closing. Specifically, USEPA realized the regulatory requirements for closed ranges were different from those at active ones and addressed this point on pages 6631 and 6632 in the preamble to the MMR [FR Vol. 62, No. 29. February 12, 1997]. In fact, page 6631 states that USEPA did not generally intend to include range clearance activities at transferring or closed ranges within the scope of the MMR. Page 6632 goes on to state that used or fired munitions that are recovered and then treated on range at a closed or transferred range would be a solid waste potentially subject to RCRA Subtitle C regulations. It further states that this aspect of the rule (the MMR) is being postponed, along with the closed and transferred aspect discussed in Section H of the preamble, because these issues are being addressed under DoD's range rule.

Response
The comment that the Military Munitions Rule does not apply to closed ranges is correct. The document is amended to clarify the relevance of the MMR to range remediation

14. **Comment**
Section 4.3, State Regulations & Guidance. This section focuses on the use of best management practices (BMPs) to control storm water from ranges. It needs to be revised to include a broader spectrum of issues that individual states may face during the remediation of a shooting range.

Response
The team agrees that during remediation of small arms firing ranges there may be a variety of issues encountered; however, we feel that the decision tree gives the general sequence of the major decisions, which should be made during the course of removing the hazard from the site.

The section you referenced is a description of a state's baseline authority to control discharges from an operating site.

15. **Comment**
Section 4.8, Transporting or Relocating Range Soil for Reuse as a Backstop on Range Property. The first paragraph in this section states that soil generated from the reclamation of lead shot at a range that is closing may be placed back on the range (or elsewhere on the range property) without testing the soil for hazardous waste characteristics. It also states that this position is consistent with the MMR. This statement appears to be in conflict with the preamble of the MMR (62 FR 6631-6632) and USEPA's *Best Management Practices for Lead at Outdoor Shooting Ranges* (EPA-920-B-01-011).

Response
It was not the intent of the team to imply that soils could be placed back on the closed range without proper testing. The guidance states "it may be possible and desirable to reuse soils from the backstop of a range that is being closed to construct a new berm or rebuild an existing berm located in **another area of the range's property**"[emphasis added]. That is, soil would not be placed back on the closed range but rather reused on an active range on the same property or at the same facility. To clarify, the guidance will replace the term "range property" in the above sentence with "same property" or facility property.

The team agrees that the statement, "This position is consistent with the Military Munitions Rule" is misleading. It was intended to draw a comparison between the allowed relocation of soils at active ranges, permitted under the MMR, with the reuse of soils from a former range at an active range. Because of the confusion created by this statement, however, it will be dropped from the document.

16. **Comment**
Section 5.4, Soil Stabilization. This section should be revised to include a discussion regarding the stabilization/solidification of contaminated soil with lime. Specifically, it is our understanding that treating contaminated range soils with lime is generally considered to be a temporary adjustment to the soil and should be done only at active ranges, not as part of a final remediation at a range that is going to be closed.

Response
Please review Section 3.3, Soil Stabilization, for the requirements to design and test the soil's ability to be maintained and an applicable range of pH to prevent dissolution of lead from the soil.

17. **Comment**
Section 7.0, References. Does not include the USEPA guidance *Best Management Practices for Lead at Outdoor Shooting Ranges*, EPA-902-B-01-001, January 2001. If this guidance was used in the preparation of this ITRC document, it needs to be referenced in this section. If it was not used, ITRC should provide the reasoning for omitting it from consideration.

Response
It has since been included.

New York

18. **Comment**
I [New York] have looked at the document, mostly the Executive Summary and Section 6 and have a few comments. The biggest one is that while some of this may be of value for commercial ranges, very little of this information would be of use to the hundreds of shooting club ranges that exist in New York and, I am sure, everywhere else. Lead at these ranges is an issue from time to time, but the sites generally don't rise to a level of concern where they would trigger a remediation requirement. Further, many of these ranges have annual budgets of a few thousand dollars, and the idea that they would use any kind of treatment like soil washing is not well conceived. The material that is in Section 6, which I guess you are calling "issues" are mostly comments on different topics (e.g., current models use residential or industrial exposure criteria, but BRAC bases are recreational areas that don't fit into either category). I think you should take a hard look and separate the issues from the commentary.

Response
You are correct in your assessment that this only applies to ranges under remediation. We intentionally excluded management of operating ranges from this document.

I'll [New York] list a few specific comments. It is not a complete review, but these are a few things that jumped out:

19. **Comment**
Page 65, 1st bullet under "Technical Issues." It is an incomplete sentence. What should be done with the more thorough understanding?

Response
The statement is misleading and has been deleted from the text.

20. **Comment**
Page 60, 1st bullet under "Soil Washing." New York would have a regulatory impediment with the use of "on-site capability." Except for screening, analysis would have to be done by a certified lab.

Response
We have added the following sentence to the end of the bullet. "Some states may require certified labs to be used for these tests."

21. **Comment**
Section 6.6.1, Soil Washing. The last two bullets are identical.

Response
The 7th bullet has been deleted.

22. **Comment**
Page 67, 3rd bullet. This bullet implies (as do several others) that the site is contaminated with more than just lead from a firing range. If this is the case, the document should not apply or at least should identify the complete remedy.

Response
This section has since been rewritten; however, as the document clearly describes, the focus is on lead in soils. We have identified other related contaminants in Table 1-1. This comment from a stakeholder expresses interest in PRPs' paying attention to mixed contaminants resulting from multiple use of a site. Table 1-1 has been incorporated to document that fact; however, to effectively cover an issue without anticipating every scenario caused the team to focus on lead primarily (normally, the cleanup driver), again noting that other contaminants associated with ammunition and the activity of shooting should be recognized in the site investigation.

23. **Comment**
I can answer the question in your e-mail about how soil that has residual lead contamination should be used after remediation is complete. We would allow the soil to be used on the range for building a new berm (backstop) or another construction-type project. If the soil did not fail TCLP, we probably could issue a beneficial use determination (BUD) to allow it to be used to build a berm on another site, but it would have to go through the process contained in Part 360 of our regulations (6NYCRR360, available on our Web site) because otherwise it would be regulated as a solid waste.

Response
Thank you for the information.

24. **Comment**
The table of contents doesn't indicate section numbers or list any tables, figures, or appendices. It's difficult to get an overall picture of the contents.

Response
The automated table of contents and associated numbers will be in subsequent versions.

25. **Comment**
Reference to USEPA's January 2001 BMPs for Lead appears in the Executive Summary and Introduction but doesn't get listed in Reference section. Another reference to same document should be fixed (see page 48, third paragraph).

Response
Thank you for pointing out our omission. It has been added.

26. **Comment**
Format tables consistently. Sometimes title appears at top of the table, others at bottom.

Response
Thank you for the excellent formatting suggestion. All figure descriptions have been moved to the bottom of each figure.

27. **Comment**
Consider providing hot links to go to reference documents.

Response
We will consider hot links. Please attend the upcoming Internet training on this document. It contains a links page providing these hotlinks where available.

Ohio

28. **Comment**
We agree with ITRC's Small Arms Firing Range Team position concerning reusing the soil for a backstop (after the lead is reclaimed) at ranges that are either active or inactive. We define inactive ranges as those ranges not currently being used but planned for use in the future. We also agree with comments provided by the state of Florida, which state that reclaiming lead as part of routine range maintenance, and then reusing the soil on the same area of concern (AoC) (without testing) does not constitute a hazardous waste management activity.

However, we do not agree with the ITRC Small Arms Firing Range Team's position that lead-contaminated backstop soil can be moved out of the contiguous AoC. We agree with Florida's comments that this contaminated soil becomes "discarded material" within the meaning of 40 CFR 261.2(a)(1), because it is "used in a manner constituting disposal" and it is "reclaimed." Therefore, the removed backstop soil would be subject to hazardous waste management regulations, including the requirement to make a hazardous waste determination, manifesting, and land disposal restrictions that prohibit "placement" of hazardous waste on the ground unless it meets the appropriate treatment standards set forth in 40 CFR Part 268. In addition to regulatory prohibition against this activity, we also think that it is a bad management practice to move contaminated soil away from AoCs because of the potential for the contaminated material to be mismanaged. This concern becomes even greater if the soil is allowed to be moved to off-property locations.

We also feel that the ITRC Small Arms Firing Range Team should discuss that, if the range is closed and no longer used (either by the current owner or future owner), the site (including the soils) should be characterized and, if necessary, remediated to appropriate standards for the intended reuse of the site. Reclaiming the lead and replacing the soil without characterization should be an option for only those ranges that will continue to be used as a range (including inactive ranges) and should not be an option for closed ranges.

Response
During the comment period we have received a number of states and even USEPA expressing concern that off-site reuse is likely not a position USEPA will take. This being the case, along with the strong comments from states against this position, the team has reconsidered automatically supporting a position with opposition from several states. The team will continue to investigate the possibility of alternative language conveying the value of on-site and off-site berm reuse. Please see response to Comment #15.

29. **Comment**
In the document, it states that, due to DoD range management practices, some small arms ranges may be located in areas where unexploded ordnance and live rounds may be located. In Section 4.6, it also goes on to state that addressing UXO as part of range management is not a problem, since soil washing would safely detonate this material. There are many different types and sizes of munitions that the military has used, depending on the range. We feel that though it may be safe to handle small rounds with soil washing, there are larger and more dangerous rounds where such practices would not be considered safe. Therefore, we feel that these ranges with potential

for UXO or live munitions should be deferred to an explosives and ordnance disposal expert to determine the safe method for clearing the range.

In addition, at sites with UXO or partially detonated material, there is a high potential that these sites will be contaminated with explosives. The document needs to recognize this, since it currently states that explosives contamination is not expected at ranges due to the complete detonation during firing.

Response
We have added language in Section 4.6 as follows: "The intent of this section is to emphasize that while the focus of this document is dealing with small arms firing ranges, experience has shown that unexpected UXO is occasionally present even if there are no historic records indicating large arms use or storage at the site. If physical evidence or historical records indicate the presence of UXO, an appropriate response should be conducted by an explosives or munitions response specialist prior to conducting any required intrusive activities at a closed range. If UXO is present, a second sweep/clearance should be performed in the feed pile just prior to treatment. The process plant operators should also be trained in UXO recognition, with appropriate shutdown and notification procedures in place in the unlikely event UXO makes its way into the treatment plant."

30. **Comment**
The document should devote as much emphasis on the characterization of the small arms firing range (SAFR) sites as it does to the various remedial technologies. Proper investigation and characterization of the SAFRs will lead to the proper selection and implementation of remedial technologies.

Response
The team believes that the aspects unique to characterizing small arms firing ranges have been included in this document. Characterization as a technique of its own has been repeatedly addressed. Please go to www.itrcweb.org, "Guidance Documents," and click on "Accelerated Site Characterization." ITRC also has a UXO Team addressing the much larger issue of UXO separately, and both documents will reference the other when completed.

31. **Comment**
The document seems to support the use of institutional controls (recreational use) as a means to vary from cleaning up the range to either residential or commercial/industrial standards (400 ppm lead and 1000 ppm lead). Though cleanup standards for sites should be based on future use, there are other considerations (necessary funding for long-term monitoring and enforcement) that should be considered as part of this evaluation. If the range is small, it may actually be more cost- effective to remediate the site to more stringent standards than the use would require so that institutional controls would no longer be required.

Response
Conditions at the site and negotiations among the parties always play a role in the final decision. It is not the team's standard to alter that.

32. **Comment**
The entire document needs to be run through spell check as well as a grammar/punctuation check.

Response
This will be done and is occurring again during the preconcurrence review. We hope the misspelling and punctuation errors have not severely affected your review.

33. **Comment**
The risk assessment section recommends following *Risk Assessment Guidance for Superfund* (USEPA, 1989) and *Ecological Risk Assessment Guidance for Superfund* (ERAGS, 1997). This is standard USEPA guidance for conducting baseline risk assessment. The risk assessment discussion basically is a repetition of the USEPA guidance and process. The information provided in this guidance document would better serve the user by briefly summarizing the USEPA guidance and allowing the reader to refer to the USEPA guidance for more detailed discussion and focusing on specific details of the risk assessment that are common to small arms firing ranges. One common hurdle in the risk assessment process is obtaining consistency. Consistency is very important in the risk assessment process and allows a degree of comparability among sites and in risk management and remedial decision making. Utilizing a standardized process will promote consistency and accelerate the evaluation process. When assessing risk at small arms firing ranges and developing exposure pathways, many characteristics and receptor exposures will be similar, simply as a result of common land uses. On that note, we suggest developing a standard list of receptors and exposure assumptions that reflect RME exposures that are common and reasonable for decision-making purposes. In addition to defining a standard set of receptors, exposure assumptions, and exposure pathways, we recommend developing site-specific preliminary remediation goals (PRGs) based on the standard assumptions/receptors/exposure pathways determined to be common at small arms firing ranges. Another option is to specify an existing source of PRGs, such as the USEPA Region 9 PRGs, that is acceptable for screening purposes in the risk assessment. These factors are the practical considerations of the risk assessment, and nailing this detail down would facilitate the development of risk assessment on small arms firing ranges and promote consistency in the evaluations and remedial decision making.

Response
Your recommendations have been addressed in revising the document.

34. **Comment**
The information provided in this guidance document on ecological risk assessment is a repetition of the information already provided in the USEPA *Ecological Risk Assessment for Superfund* guidance document. Providing default exposure assumptions and generic receptors for the ecological risk assessment process would help promote consistency among sites.

Response
Ecological risk assessments are very site-specific, so it is impractical to provide default assumptions and generic receptors. Risk assessment references are provided in the appendix. Also please see the response in Comment #33.

35. **Comment**
Section 1, Introduction. This guidance document over-generalizes the type of contamination that may be found on these types of sites and suggests limiting characterization primarily to lead, which is not acceptable. Some sites may have UXO issues to manage during the characterization and remediation of these sites, which should be noted in this guidance. The determination of the nature of contamination, in addition to the determination of the extent of contamination should be included in the bulleted items listed in this section. Nature of contamination should not be limited to only lead and should include all potential types of contaminants such as TAL metals, explosives, propellants, nitrocellulose, UXOs, and dioxin, if appropriate. Also, the bullets should mention that the BRA is designed to assist risk management and remedial decision making. This clarifies to the public how the information from this BRA is used in remedial investigations. In addition, a discussion should be added about the recent development of green ammunition, and whether or not this type of munitions would cause any contamination or differences in the range management practices described in this document.

Response
Please see Section 2.3, Rifle/Handgun Firing Range Layouts, for the team's discussion of the issue of UXO. Also please note the reference to the ITRC Web site, taking the reader to the ITRC's UXO Team Web page.

The team noted the contaminants related to the ammunition used at small arms firing ranges as well as the material used in the activity of shooting. See Table 1-1. In studies to date, lead has been the primary driver (CoC).

This document addresses remediation of ranges. ITRC is considering a team to research the issue of range management as a follow-up to this document in future years. Green ammunition would be a topic for discussion at that time.

36. **Comment**
Section 1.0 (page 1), Table 1-1. This table should be expanded to include lead as a potential contaminant that may be found at small arms firing ranges, or specify that this table solely lists co-contaminants of lead.

Response
Good point. It has been included.

37. **Comment**
Section 1.0, last paragraph (page 2). Why was the EP Toxicity Test used in 1995, given that TCLP testing was already in use?

Response
The following paragraph does not specify that the EP Toxicity Test was used rather then the accepted TCLP. In fact, Baer used the TCLP test: "The disk-like, flying targets used at shotgun ranges contain PAHs. However, Baer (1995) found that the targets did not exhibit the characteristics of toxicity as determined by an USEPA toxicity test even though they contained

high levels of PAHs. The state of Connecticut accepted these findings and treated the targets at the site as solid rather than hazardous wastes."

38. **Comment**
Figure 1.1, Decision Tree. The first step in the process is to determine the postremediation land use. Given this, the Army and other services must become more proactive in working with regulators to determine future land use, writing Land Use controls into Records of Decision/Decision Documents, etc., otherwise the formulation of this guidance is essentially an exercise in futility.

Response
You are correct.

39. **Comment**
Appendix F, Section 2b, Components of a Baseline Risk Assessment, Exposure Assessment. It would be helpful to include a detailed discussion of the importance of determining current and future land use at the site, prior to developing exposure assumptions and the role that this information plays in the development of these exposure assumptions. It is equally important to discuss the importance of having a mechanism in place to ensure future use restrictions and institutional controls if the future use of the site is restricted. In the state of Ohio, we assess future risk as unrestricted (a.k.a. residential) exposure. In addition, it would be helpful to have a list of default receptors and exposure assumptions that are applicable to most small arms firing range sites. This would help standardize the assessments at these sites and instill consistency in the evaluation.

Response
Please our response to Comment #30. Your comments are very thoughtful and have application to every remediation effort, not only lead and related compounds at small arms firing ranges.

40. **Comment**
Appendix F, Section 2c, Components of a BRA, Toxicity Assessment. This section/discussion should provide a list of acceptable sources for obtaining information on toxicity for use in a BRA. Many sources of this information are available, and providing an acceptable list of sources helps standardize the process and promotes consistency. For instance, Ohio EPA recommends IRIS, HEAST, NCEA, etc.

Response
This level of detail should be dealt with on a site-specific basis.

41. **Comment**
Appendix F, Section 2d, Components of a BRA, Risk Characterization. This section should include a discussion of how to assess exposure to multiple contaminants via multiple routes and pathways.

Response
The procedure is included in Appendix F.

42. **Comment**
Appendix F, Section 2e, Components of BRA, Lead. A lot of detail is provided for lead, and little information is discussed on other contaminants of potential concern (CoPCs), such as arsenic, copper, chromium, etc. This section should be expanded to include a brief discussion of each COPC. In addition, this guidance document should specify the USEPA goals of 400 ppm for residential/unrestricted exposure sites and 1000 ppm for industrial exposure sites.

Response
The team considered lead to be the driver in most risk assessments conducted at small arms firing ranges. Including multiple compounds or cumulative risk is a risk assessment issue applicable to every remediation activity regardless of the contaminant driver. See Section 2.7. The narrative is not simply discussing two exposure pathways—all options are discussed in the document in detail.

43. **Comment**
Section 2.5, Fate & Transport Considerations. The text should be revised to read: "....about lead dissolving into the surface or groundwater, entering the soils or being ingested by birds or other wildlife."

Response
This section has been revised, and this sentence no longer appears in the text.

44. **Comment**
Section 2.6, Sample Collection & Analysis. The text in the first paragraph indicates that the site use and history will provide information regarding volumes and types of ammunition used and indicate the likely CoCs at the range. The readily obtained historical information is not always accurate and adequate. At this stage of the process, it would be inadvisable to prematurely limit the analytical testing suite.

Response
Review of the historical information is just a first step. Section 2.6 continues to suggest a walkover of the site to confirm what the site history might reveal and document addition indications of contamination distribution. This iterative and systematic process leads the investigation, rather than attempting to blanket the site with sample locations and analyzing the aliquots for a suite of parameters unrelated to the use of the site.

45. **Comment**
Section 2.6.2. The third bullet in this section indicates that background concentrations of CoCs should be determined. The determination of background is always a critical and much-debated issue. As such, there should be a statement in the text that regulatory acceptance/concurrence/ approval of how background is determined, how many samples are needed, what statistical tests are utilized, etc. is necessary. This point also goes back to general comment #3, which indicates that the characterization portion of this entire document is underdeveloped.

Response
The determination of background is not an issue specific to small arms firing ranges nor to contaminants associated with ammunition and targets. It is a larger debate surrounding the acceptability of background sampling location, depth, analytical methods, natural occurring or anthropogenic, statistical analysis, and presentation of the data. We have included the configuration used to design a sampling program on the contaminated areas, including the depth interval in the shadow of the firing pattern. See Section 2.6.2.

46. **Comment**
Section 2.6.2.1, Use of Field Screening. The text should be revised (first sentence) to indicate that field screening using XRF may be one way to define boundaries of the area, etc. Given our experience at Ravenna Army Ammunition Plant, we have not had much good fortune in the use of XRF (both in-situ and ex-situ techniques). The position that we have taken with respect to the use of XRF at the RVAAP is that it is not accurate or reliable enough to guide field investigations or to conduct soil-removal activities.

Response
We have footnoted the fact that this method is sensitive to particle size and that the analysis should be confirmed with lab analysis. We have also replaced "can" with your suggested term "may."

47. **Comment**
Section 2.6.3. With respect to the use of composite samples for metals analyses, we use a similar technique for explosives-contamination determination. However, it would need to be up to the appropriate regulatory agency to determine if composited results could be used for risk assessment purposes.

Response
Yes, it is always up to the state agency, if it has a procedure previously developed. This is not intended to circumvent existing procedures, only add to the tools available to users.

48. **Comment**
Section 2.7.4, Measuring Bioavailability for Determining Risk. Second paragraph implies that lead, arsenic, and copper are the only contaminants evaluated in the risk assessment. All contaminants of potential concern, where there is complete exposure pathways for a receptor and where those CoPCs exceed screening levels, must be evaluated in the risk assessment, and the focus should be broadened beyond lead, arsenic, or copper.

Response
We agree that bioavailability of all the compounds is of concern. All potential CoCs will be included in the discussion.

49. **Comment**
Sections 2.7.4, Measuring Bioavailability for Determining Risk. These sections provide a great amount of detail on the toxicity and bioavailability of lead and, to a much lesser extent, arsenic. This information is not necessary in this detail. From a risk assessor perspective, information

such as default assumptions for the percent uptake, BAF, and other input parameters for evaluating risks quantitatively in the risk assessment would be more useful information expected in a guidance document. This would also lead to consistency in the risk process.

Response
The bioavailability of lead is discussed as an example of the current state of the art for evaluating risk. This is appropriate since lead is the primary CoC at SAFRs. Additional discussion of effective soil-stabilization techniques with regard to bioavailability is presented in Section 3.3.3.

50. **Comment**
Section 2.7, Risk Assessment Variability. Ohio EPA has written draft guidance on ecological risk assessment that is soon to be released. This guidance is based on the state of Oregon's ecological risk guidance. Ohio recommends that all sites first conduct a level 1 scoping assessment to determine if ecological receptors, habitat, land use, sensitive environments, important ecological resources are present at the site. This information will help determine if further eco assessment is necessary. For instance, if contamination is present but not any important ecological resources, receptors, or sensitive environments, then ecological exposure pathway is not completed and does not occur.

Response
The risk assessment section will be modified to add the suggestion that individual states may have guidance, which should be consulted prior to conducting a risk assessment

51. **Comment**
Section 2.7, Components of a Risk Assessment. The assessment of bioavailability should be part of the toxicity assessment. We suggest developing a standard list of receptors and exposure assumptions that reflect RME exposures that are common and reasonable for decision-making purposes. In addition to defining a standard set of receptors, exposure assumptions, and exposure pathways, we recommend developing site-specific preliminary remediation goals (PRGs) based on the standard assumptions/receptors/exposure pathways determined to be common at small arms firing ranges. Another option is to specify an existing source of PRGs, such as the USEPA's Region 9 PRGs, that is acceptable for screening purposes in the risk assessment. This should be done for both the human health and ecological risk assessments.

Response
The risk assessment section (including bioavailability) will be edited to present only the relevant details and references. It is beyond the scope of this document to develop PRGs for SAFRs; however, reference to existing sources of PRGs, such as USEPA's Region 3 RBC tables and Region 9 PRG tables, will be made.

52. **Comment**
Section 2.7.1, Contaminant Identification. Compounds such as nitrites and nitrates may be important to sample for and evaluate, especially in groundwater where blue baby syndrome can occur as a result of exposure. This may be an important consideration for sites where UXO or explosives are an issue. In addition, the document should specify that site-specific background

for inorganics be determined and used for screening, along with risk-based screening values for the selection of CoPCs.

Response
Please go to www.itrcweb.org and to the Guidance Document section. Locate the box labeled "In Situ Biodenitrification," which contains a technology overview of in situ biodenitrification and an additional document, *Systematic Approach to In Situ Bioremediation of Groundwater, including Decision Trees for Nitrates, Carbon Tetrachloride and Perchlorate*, which addresses nitrate contamination, its sources, and additional health consequences of nitrate contamination other than blue baby syndrome.

Additionally, UXO is included to raise awareness. This document focuses on small arms firing range issues. UXO is better addressed in the UXO section of the ITRC Guidance Document section at the Web location identified previously.

53. **Comment**
Section 2.7, Contaminant Identification. With respect to contaminant identification, the conclusion indicates that the analytical suite should be mainly focused on metal, particularly lead and copper. The analytical suite should not be prematurely limited based upon the potential for other CoCs such as PAHs, explosives, and propellants. 100% of the samples would not need to be analyzed for a full suite, but a certain percentage should be in order to ensure that the range is properly characterized. Analyzing the samples for TAL metals, instead of just lead and copper, would not substantially increase the price. Given the constituents listed in Table 1.1 in this document, then TAL analysis is warranted. In addition, since tin is not on the TAL list, it would need to be added as an analyte.

Response
The team recommended that a suite of parameters for characterizing a small arms firing range would include those in Table 1-1. PRPs and oversight agencies may require additional parameters according to their assumptions and knowledge of the site.

54. **Comment**
Appendix F, Section 3a, Application of the BRA Process to Small Arms Ranges, Contaminant Identification. The last sentence of the first paragraph states that the analytical suite can be focused on lead and copper. We disagree with this statement, as previously noted in [in Comment #53 above]. TAL metals should be analyzed for initially at sites, since other metals such as arsenic, copper, chromium, zinc, UXO, explosives, nitrocellulose, etc. may potentially be present at these sites. After the initial investigation and the initial analytical results are evaluated, further analytical testing may be focused on certain contaminants that exceed screening criteria.

Response
See response to Comment #53. We should also note that team members have never found evidence of chromium at a SAFR site.

55. **Comment**
Appendix F, Section 3b, Application of the BRA Process to Small Arms Ranges, Exposure Assessment. Second paragraph states that site visitors are not allowed near the area where the backstop/berm is, thus eliminating exposure. Unless there is a mechanism to monitor and enforce this restriction, potential exposure could occur to site trespassers, site workers, maintenance workers, construction workers, and other users of the site. Therefore, the assumption that current use will not result in exposure must be substantiated and supported by specific details to demonstrate that this is true for all sites of this type.

Response
Our document states, "If the range is to continue to be used, metallic deposition in the backstop/berm area will continue. The only human receptors will be site workers, who are covered by the exposure standards of the Occupational Safety and Health Administration (OSHA). For safety, site visitors are not allowed near the backstop/berm area, thus eliminating their exposure. Ecological concerns are addressed by the nature of the range operation."

Trespassers are part of the undesirable behavior none of us can control or monitor. Site workers, maintenance workers, construction workers are covered under OSHA requirements as stated in the text, and on-site users are restricted to the shooting area.

56. **Comment**
Table in Section 3.1. The table should be revised to clearly indicate that the three metals listed are not the only RCRA TCLP requirements.

Response
The constituents listed are those related to the firing range activity. If for some reason other TCLP parameters and their concentration factors are considered present, they should be included. We focus on those parameters related to the firing range activity. Other parameters would be related to former use other than shooting ranges or off-site contamination.

57. **Comment**
Section 4.6, Small Arms Rounds. Wet screening and water-based density separation processes are referenced. These techniques should be described in more detail at some place in the guidance document.

Response
Please refer to Section 3.2, Soil Washing/Particle Separation.

58. **Comment**
Section 4.8, Transporting or Relocating Range Soil for Reuse as a Backstop on Range Property. This section is unacceptable. See general comment #1. In addition, this section completely contradicts the first paragraph in Section 5.0 on page 47.

Response
Please see our response to Comment #28.

59. **Comment**
Section 5.1, second paragraph, page 47. This paragraph seems to support the use of compositing for treating metals-contaminated soil. Though explosives can be degraded by compositing, metals cannot be degraded by this method. Please clarify why this is proposed as a technology for metals-contaminated soil.

Response
Our intent in this section is to discuss compositing samples to obtain a representative concentration of contaminant in the material.

60. **Comment**
Section 5.4, page 53, the last paragraph. Additional text should be added to the guidance document that supports/substantiates the sampling frequency of 250 cu yd and 500 cu yd.

Response
The sampling frequency is based upon the daily throughput of the operation for current technologies.

61. **Comment**
Section 6.0 needs to be revised based upon general comment #28 and specific comment #58.

Response
We agree. See response to Comment #15.

Pennsylvania

62. **Comment**
There are many instances of incorrect punctuation as well as several typographical errors. Wording in a number of places is difficult to understand and could be modified to make the concepts more understandable. It is assumed that the document will be proofread several more times to catch these areas.

Response
Proofreading is taking place during the preconcurrence review.

63. **Comment**
Section 2.2, page 7 (at the top). Shouldn't the word "parallel" be "perpendicular?"

Response
"Parallel" is used correctly. The firing line is perpendicular to the line of fire, and the targets are aligned perpendicular to the line of fire.

64. **Comment**
Section 2.4. The word "injected" should be "ingested."

Response
This section has been revised, and the words "injected" (or "ingested") no longer appear.

65. **Comment**
Section 6.6.1, Soil Washing. The 6th and 7th bullets under "Soil Washing" are identical. One should be deleted.

Response
The correction has been made.

66. **Comment**
Section 2.6.2.2, page 17. The last sentence of the third bulleted paragraph reads: "Soil-lead dissolution capacity may increase as a function of decreasing soil grain size due to the increase in particle surface exposed." This seems misleading. It could be restated, "Soil-lead sorption capacity may increase as a function of decreasing soil grain size due to the increase in particle surface exposed." This is simply because an increase in surface area provides more sorption sites. The sentence doesn't seem to have any usefulness.

Response
You are correct. The statement has been removed, and the section rewritten. .

67. **Comment**
Section 4.8, Transporting Range Soil for Reuse as a Backstop on Range Property. The dilemma of using backstop soil from one site at another site is mentioned. The caveat or provision that individual states should be contacted for approval prior to such action seems sufficient. This

would allow such actions to be addressed on a case-by-case basis. Pennsylvania has been grappling with this concept (transporting contaminated soil from a remediation site to another location, the "Safe Fill Policy") for several years. It has yet to be resolved.

Response
Thank you.

68. **Comment**
Decision Tree, page 4. Remediation in Pennsylvania is voluntary; however, if liability relief is being sought (i.e., if the site is to be deemed "officially" remediated), the remediation must follow what we will call the promulgated "cleanup standards." (We have several cleanup standards.)

Therefore, for two of the cleanup goals on the decision tree (Disposal and Soil Reuse), an additional green diamond (worded "Does total Pb meet cleanup level?") would be necessary. For the Disposal goal, the "yes" arrow coming from the existing green diamond would go to one of these two green diamonds. An answer of "yes" to that question would allow the soil to remain on site. An answer of "no" would require off-site disposal.

For the Soil Reuse goal, the arrow going from "Asphalt Emulsion Treatment" would go to the other of these two green diamonds. The Construction Material goal implies that liability would not be sought because the soil could remain on site as berm/backstop construction material.

Response
Does total lead meet cleanup level? – Disposal option. According to the referenced section, direct disposal is "Dig and Haul" (Section 3.1). If it met the cleanup standards, it would not have initially been excavated; therefore, the flow path applies only to the requirements for off-site disposal.

Does lead meet cleanup standards? – Soil Reuse. We disagree because the remaining lead in the soils is stabilized and has demonstrated through the TCLP and SPLP tests that it will remain so. There is no longer any need to dispose of the material as a hazardous waste, and it cannot be used as construction material in a berm. It is a paving product.

69. **Comment**
Of course, if liability protection is not being sought, remediation may be conducted apart from the cleanup standards, and the state would neither approve nor disapprove. No action would be taken by the state unless harm to human health or the environment was occurring or was likely to occur.

Response
Thank you.

Florida

70. **Comment**

Section 6.0, Issues, Concerns, and Recommendations. I have very grave concerns about the following proposed language:

"It is the ITRC Small Arms Team's position that range soil from a former backstop may also be reused, following lead reclamation, for constructing or rebuilding a backstop at a location that is not on the range property. Reclaimers should apply standard BMPs, mentioned in USEPA's *BMP for Lead at Outdoor Shooting Ranges*, to separate the lead from soil. Individual states may impose additional requirements for transportation, documentation, and approvals; however, state regulators should be consulted prior to transporting range soils to a property that is not the same as or adjacent to and under the same ownership as the property where the soils originated."

This language misrepresents or misunderstands the regulatory status of soil contaminated with lead shot under the federal Resource Conservation and Recovery Act (RCRA) and has serious implications for the hazardous waste management program adopted by the state of Florida to operate in lieu of RCRA.

Lead shot falling to the ground at a shooting range as the result of ammunition discharge is not regulated as hazardous waste disposal. (See letter, Sylvia K. Lowrance, USEPA, to Jane Magee, state of Indiana, September 6, 1988.)

When a backstop is in use, and lead is being reclaimed as part of standard or routine range maintenance, the recovered lead is considered "scrap metal" pursuant to 40 CFR 261.6(a)(3)(ii) and, therefore, excluded from most RCRA regulations. (See Memo, Jeff Hannapel, USEPA Office of Solid Waste, to Duncan Campbell, USEPA Region 5, March 13, 1997.) In addition, USEPA has made it clear that the range clearing principles of the Military Munitions Rule (40 CFR Part 266, Subpart M) apply as well to nonmilitary ranges. (See letter, Elizabeth Cotsworth, USEPA, to John P. Cahill, state of New York, April 29, 1997.) Therefore, the collection of fired bullets, including those that contain lead, and replacing the soil or other material separated from the lead bullets is not a hazardous waste management activity. (See 62 Federal Register 6631, February 12, 1997.)

Even if the backstop soil were considered to be toxic hazardous waste because it contains a lead concentration greater than 5 mg/l, the material could be properly managed within the "area of contamination" or "AoC," defined as the contaminated area contiguous to the existing backstop, because "movement of media contaminated by hazardous wastes within an area of contamination does not typically trigger RCRA requirements." (See letter, Michael Shapiro, USEPA, to Norman Nosenchuck, state of New York, March 25, 1996.)

However, when lead-contaminated backstop soil is moved out of the contiguous AoC to build a backstop at another location, whether on site or off site, the contaminated soil becomes a "discarded material" within the meaning of 40 CFR 261.2(a)(1) because it is "used in a manner constituting disposal" and it is "reclaimed." Therefore, the removed backstop soil would be subject to hazardous waste management regulations, including the requirement to make a

hazardous waste determination, manifesting, and land disposal restrictions that prohibit "placement" of hazardous waste on the ground unless it meets the appropriate treatment standards set forth in 40 CFR Part 268. (See EPA-902-B-01-001 *Best Management Practices for Lead at Outdoor Shooting Ranges*, USEPA Region 2, January 2001, pages 1–8; *Best Management Practices for Environmental Stewardship of Florida Shooting Ranges*, Florida Department of Environmental Protection, Hazardous Waste Compliance Assistance Program, June 2002, page 40.)

Soil that exhibits the hazardous characteristic of toxicity for lead should not be moved off site to build a new backstop. This is a practice that RCRA was designed to prohibit, because the potential for environmental contamination is too great.

In conclusion, I recommend that the Florida Department of Environmental Protection point out the legal infirmity of ITRC's proposal.

Response
ITRC appreciates Florida's full participation in the Small Arms Firing Range Team while researching, drafting, and reviewing this document. You have pointed out significant issues surrounding the reuse of soil and have contributed significantly to the rewording of the language in this document regarding on-site and off-site berm reuse.

71. **Comment**
The entire document should be revised to emphasize that it is only discussing closed ranges. Note that this is not the same as "closing" ranges. RCRA authorities are different for closed versus closing (i.e., still active) ranges. The entire document should be reviewed to delete "closing" range references and to appropriately insert references to "closed" ranges (or statements could later be read to apply to all ranges). For example, the first full paragraph on page 48 needs "on a closed range" inserted in both sentences or else the paragraph is inaccurate. Note that some of the statements pertaining to "closing" ranges are phrased as a "range that is being closed" and thus a search for the word "closing" will not catch them all.

Response
The title now includes the term "closed" and the paragraph you referenced has been changed as requested. The phrase "a range being closed" occurs in Section 5.0 and the Executive Summary. These references remain since they apply to closing as well as closed ranges.

72. **Comment**
The title of the document needs to include the fact that it relates to closed ranges.

Response
The change has been made.

73. **Comment**
Several portions of the document are confusing when discussing the RCRA status of soil. For example, soil does not have to be removed (i.e., dug up) just because it fails TCLP. Cleanup authorities require an unacceptable risk to human health or environment based on the future land use. Additionally, soil is not a RCRA waste. See for example *Chemical Waste Management v. EPA*, 869 F.2d 1526 (D.C. 1989). The contained-in policy, therefore, needs to be explained.

Response
See responses to the more specific comments below.

74. **Comment**
Executive Summary, 5th paragraph. Delete the first two sentences. (These sentences refer to best management practices, etc. that we may not agree with. Moreover, we may not agree with the statement that they allegedly will "prevent regulatory problems." More fundamentally, though, these types of BMPs would apply, if at all, to active ranges, not the subject of this document.)

Response
The sentences you suggest be deleted do not allege (i.e., declare) that regulatory problems will be prevented. The statements are a positive reinforcement to steps that have been taken and continue to be taken to improve practices that have raised concerns. The sentences remain for that very reason.

75. **Comment**
Executive Summary, 7th paragraph, second bullet. Add at the end of the 2nd sentence, "… if the soil is to be taken off site and the soil fails a RCRA characteristic."

Response
The reference to RCRA is made in paragraphs immediately preceding the referenced paragraph, so the reader is quite certain of the regulatory environment we are speaking about. There seems to be little value providing this level of clarity in an executive summary.

76. **Comment**
Executive Summary, 7th paragraph, 2nd bullet, last sentence. Delete "regulators" and insert "regulations and regulatory agencies."

Response
Thank you for that clarification. The change has been made.

77. **Comment**
Section 4.0. The references to "range operators" should be deleted as irrelevant to this document. Replace it with "owners/operators of closed ranges."

Response
The changes have been made as requested.

78. **Comment**
Section 4.1, 1st paragraph. Delete the last sentence.

Response
The team agreed that these are the appropriate regulatory avenues to evaluate the environmental performance at operating ranges if the site is not listed on the National Priorities List under Superfund. We will insert the words, "If the site is not listed on the National Priorities List under Superfund…" to the beginning of the sentence.

79. **Comment**
Section 4.1, 2nd paragraph. Rephrase the third sentence to read, "Additionally, as outlined in the Federal Register (62 Federal Register 25998, May 12, 1997), processed scrap metal is exempted from RCRA regulation (i.e., is not a RCRA solid waste) when it is being recycled (40 CFR 261.3(a)(13).

Response
The phrase has been changed; however, you err slightly on the CFR citation. We have confirmed that 40 CFR 261.4(a)(13) is correct.

80. **Comment**
Section 4.2. Delete this section in its entirety as it doesn't pertain to "Federal Regulations and Guidance" for closed ranges. Instead, insert the following, "The management of wastes at closed military ranges may be shaped by USEPA's Military Munitions Rule (MMR). The final MMR

did not address RCRA's application at closed ranges. USEPA may address this issue through future regulations."

Response
The section will be retained to inform the reader of the continually changing regulatory landscape for small arms firing ranges and the necessity to conduct the proper research and consult with the appropriate authorities for the most recent relevant regulations regarding range remediation. It lets the reader know that lead bullets are not considered hazardous waste upon deposition and, therefore, firing ranges are not hazardous waste landfills until the range has been "abandoned" (closed greater than 90 days). This understanding leads to greater flexibility while handling soils during remediation.

81. **Comment**
Section 4.3. The majority of this section deals with state laws and regulations that, if applicable at all, would be for an active range—again, this is irrelevant. This goes for the discussion of BMPs in the first part of the paragraph and bullets, the references to NPDES permitting in the second paragraph, and the discussion of permits for construction of new shooting ranges in the third paragraph.

Response:
We agree with your comment. However, we kept the section to make the reader aware of the wide degree of variation in regulations from state to state when it comes to managing lead-contaminated soils before, during, and after remediation.

82. **Comment**
Section 4.4 does not appear to discuss Remedial Objectives.

Response
The title of the section has been changed to Remediation/Future Use Issues.

83. **Comment**
Section 4.4, 2nd sentence. I recommend replacing "fail the TCLP test" with "are present in amounts that pose a risk based on the current or reasonably anticipated future land use" and replacing "violations" with "exceedances."

Response
These changes have been made.

84. **Comment**
Section 4.5, 1st paragraph, 1st sentence and 3rd paragraph, 1st sentence. Delete "firing range maintenance" as this phrase isn't relevant to closed/closing ranges.

Response
Comment accepted; the word "maintenance" will be removed.

85. **Comment**
Section 4.6, 1st & 2nd sentences. Rephrase as follows, "A potential hazard at Department of Defense small arms firing ranges are "live rounds," referred to as unexploded ordnance or UXO, from nearby or previously conducted large arms range activities. Additionally, all small arms ranges may contain live small arms rounds.

Response:
The changed paragraph now reads:

> **Live Rounds/UXO**
> A potential hazard at Department of Defense small arms ranges are "live rounds," referred to as unexploded ordnance or UXO, from nearby or previously conducted large arms range activities. Additionally, all small arms ranges may contain live small arms rounds. Quite often these items are overlooked in treatability testing or site characterization. Both are addressed in more detail below.

86. **Comment**
Section 4.6, 3rd paragraph. First sentence has a typo: change "he" to "the", and replace the second use of "UXO" with "large arms." Replace the rest of the paragraph with, "If physical evidence or historical records indicate the presence of UXO, an appropriate response should be conducted by an explosives or munitions response specialist prior to conducting any required intrusive activities at the closed range."

Response
Changes made to the first sentence as requested. With regard to the balance of the paragraph, the rest of the comment will be used to replace the second sentence.

The third and fourth sentences will remain unchanged, as the "hit" rate for UXO detection is typically expected to be 80% or better detection. With that in mind, it is imperative to have a second detection operation at the point of transfer to treatment operations, with the process operators trained in UXO detection in the unlikely event UXO turns up in the treatment plant.

The paragraph now reads:

> The intent of this section to emphasize that while the focus of this document is dealing with small arms firing ranges, experience has shown that unexpected UXO is occasionally present, even if there are no historic records indicating large arms use or storage at the site. If physical evidence or historical records indicate the presence of UXO, an appropriate response should be conducted by an explosives or munitions response specialist prior to conducting any required intrusive activities at the closed range. If UXO is present, a second sweep/clearance should be performed in the feed pile just prior to treatment. The process plant operators should also be trained in UXO recognition, with appropriate shutdown and notification procedures in place in the unlikely event UXO makes its way into the treatment plant.

87. **Comment**
Section 4.7, second to the last sentence. Please replace "permitted" with "allowed" to avoid confusion with the RCRA permitting process.

Response
Change completed.

88. **Comment**
Section 4.8, last sentence. Delete "performed as part of range closure" to avoid confusion with the RCRA closure process.

Response
The change has been made as requested.

89. **Comment**
Section 4.9 needs to be rewritten to accurately describe the "contained-in" policy. See redline/strikeout on attached page below.

Response
The redline/strikeout version you provided will be included, except the references to "live rounds" will be retained. Also, the last sentence of your correction will be inserted, but the word "not" will be removed so that it reads as follows, "It should be noted that individual states may not utilize the contained-in policy (and thus these soils **would be** regulated under RCRA) or may have additional, more stringent disposal requirements."

90. **Comment**
Section 4.9, last sentence. I don't think that state regulations can be less stringent than federal.

Response
Comment accepted. "Less stringent" will be removed.

91. **Comment**
Section 5.0, 1st sentence. Change "contaminated with" to "contains." In the second sentence, delete "thus." Just because soil exceeds a RCRA characteristic does NOT mean it has to be dug up and treated or removed. Again, a response is needed only if there is an unacceptable risk to human health or the environment. Delete the last sentence because it discusses active ranges.

Response
Comment accepted; the requested changes will be made.

92. **Comment**
Section 6.2. Replace "fail the TCLP test" with "are present in amounts that pose a risk based on the current or reasonably anticipated future land use" and replace "violations" with "exceedances."

Response
The change has been made as requested.

APPENDIX I

ITRC Contacts, ITRC Fact Sheet, and ITRC Product List

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Appendix C: Project Source Data – Site Specific

Electronic copies of reference materials for Appendix C are provided on the CD-ROM in folder: \Appendix_C

Appendix D: Ordnance Technical Data Sheets

Electronic copies of reference materials for Appendix D are provided on the CD-ROM in folder: \Appendix_D